NMP

NEW MILLENNIUM PROGRAM

Space Technology Carrier

Feasibility Study kickoff

California Institute of Technology, JPL

January 17, 2001

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Agenda

8:15	Welcome	Fuk Li (David Spencer)
8:25	NMP Program Overview	David Spencer
8:45	Space Technology Carrier Feasibility Study Schedule Concept Definition Study downselection	Dick Turner
10:00	Break	
10:15	Contract Administration	John Davis
10:25	Open Discussion and Questions	
11:00	Closed Meeting 1	BATC
12:00	Lunch Break	
1:00	Closed Meeting 2	OSC
2:15	Closed Meeting 3	SPACEHAB
3:30	Closed Meeting 4	Spectrum Astro

New Millennium Program Overview

David Spencer

California Institute of Technology, JPL

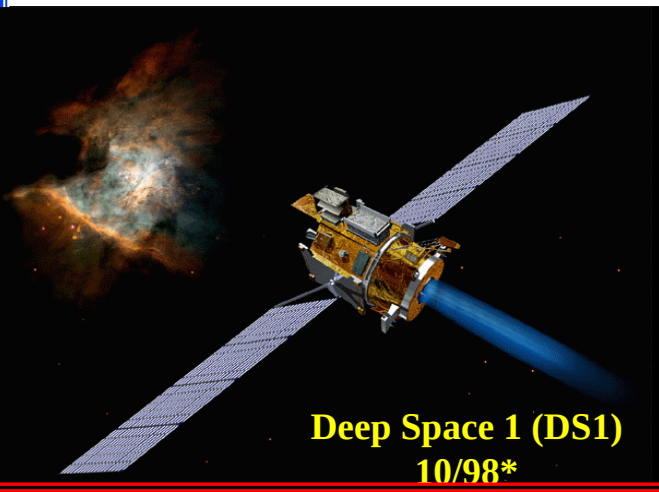
January 17, 2001

Space Technology Carrier Feasibility Study Kickoff

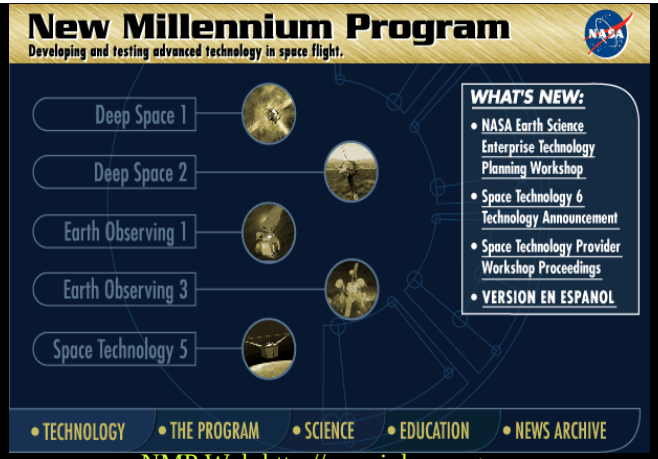
Program Overview

NMP

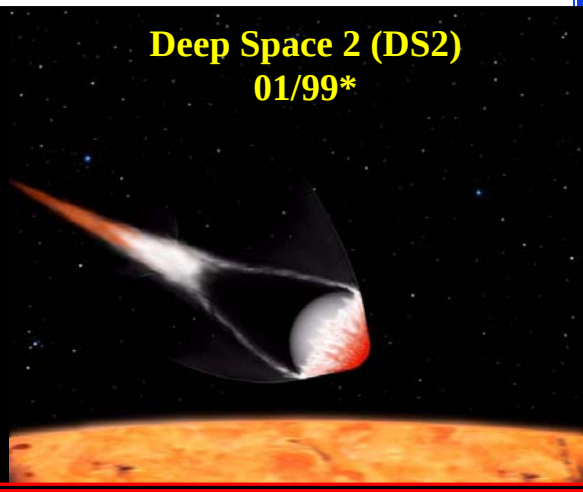
* Actual Launch Date



Deep Space 1 (DS1)
10/98*

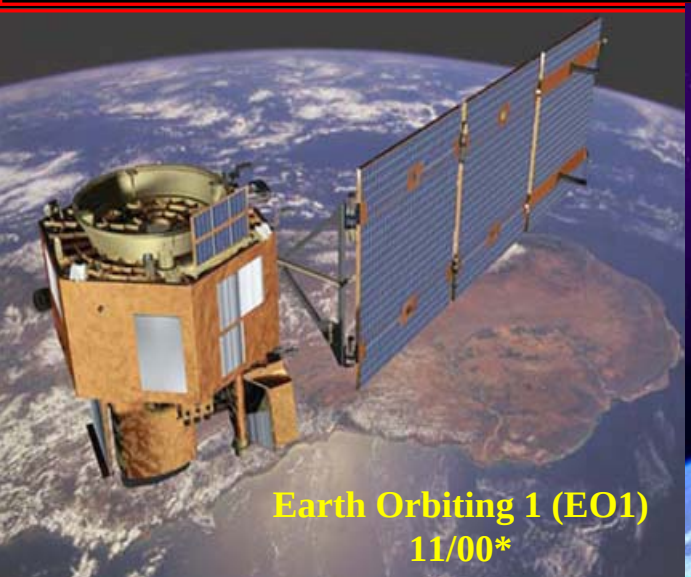


NMP Web http://nmp.jpl.nasa.gov

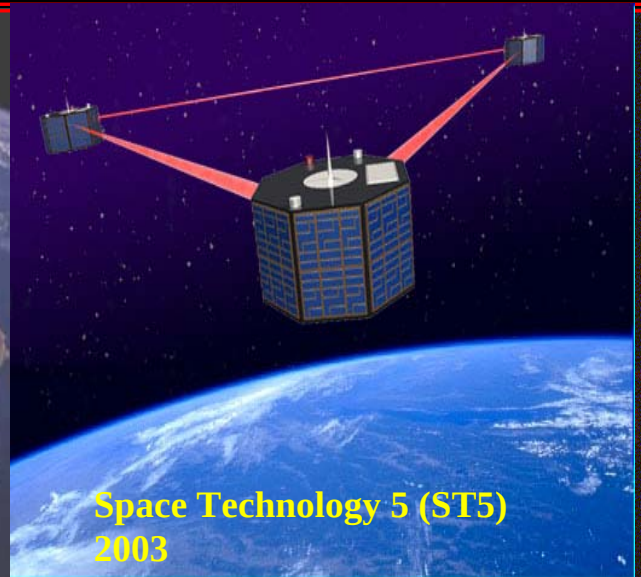


Deep Space 2 (DS2)
01/99*

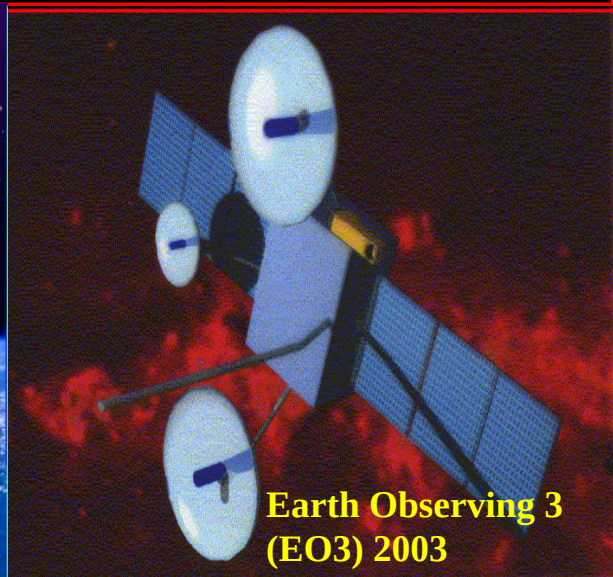
A cross-Enterprise program to identify and space flight validate breakthrough technologies that will significantly benefit future Space Science and Earth Science missions.



Earth Orbiting 1 (EO1)
11/00*



Space Technology 5 (ST5)
2003



Earth Observing 3
(EO3) 2003

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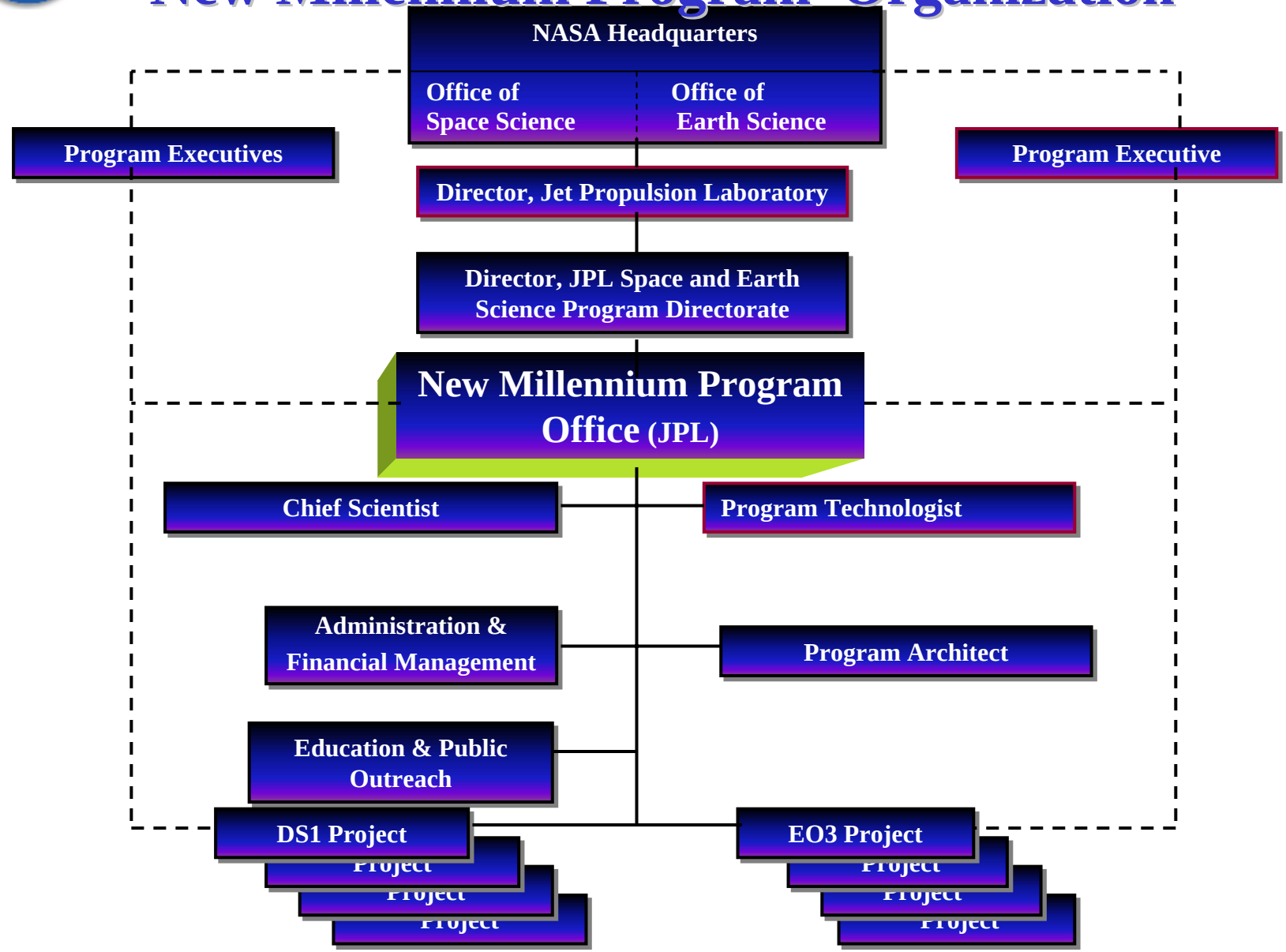
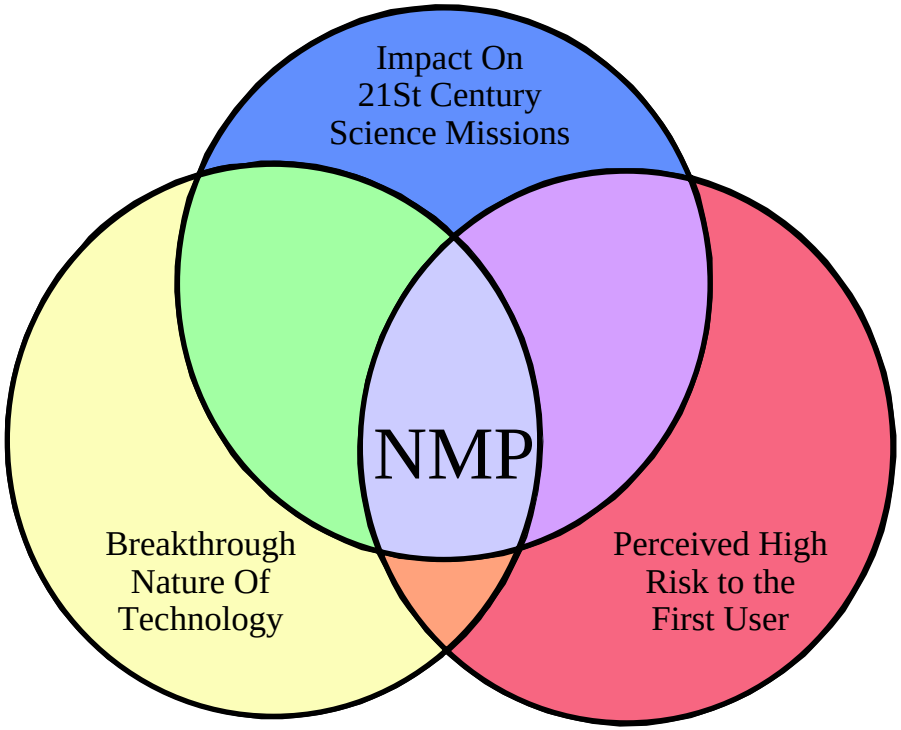
New Millennium Program Organization



NMP Focus

Flight validate breakthrough technologies that will significantly benefit future Space Science and Earth Science missions



- **Breakthrough technologies**
  - Enable new capabilities to meet Earth and Space Science needs
  - Reduce costs of future missions
- **Flight validation**
  - mitigates risks to first users
  - enables rapid technology infusion into future missions

Program Attributes

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Technology - Focused Projects

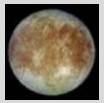
Phase A | Phase B

Technology - Focused Project Formulation Process

- Ensures focus on technology needs of future science missions

  NOT science return from NMP flights

Multi - Theme Technology Benefits



- Broad user community

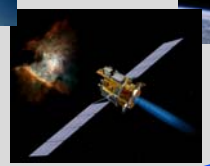
Breakthrough Technologies Requiring Flight Validation

Phase A

- Open competitive technology calls
- Strong rationale for flight validation

Revitalized Program Architecture

Partnership / Shared Launches



- Increases launch opportunity
- Reduces “low tech” elements’ costs
- HQ’s help (commercial, government)

System / Subsystem Approaches with Frequent Flights

- Maximizes cost effectiveness of validation approach
- Balanced portfolio
- Flexible / adaptive / resilient

Flight Validation Criteria

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FACTORS	SUB-FACTORS	EXAMPLE EFFECTS	EXAMPLE JUSTIFICATION
1. MAJOR IMPLEMENTATION SHIFT (Never Flown Before)	1.1 **Fundamental Change** is a revolutionary way of designing, assembling, fabricating, testing, integrating, or operating.	Revolution in Design Procedures or Operations.	Multifunctional structures invoke new assembly, test and rework procedures that depart from existing practice and require flight validation to verify procedures and demonstrate flight worthiness.
	1.2 **Combined Effects** are complex interactions between advanced technology and different parts of the system or launch vehicle.	Contamination, Noise Sources, Survivability, Ionic Contamination, Launch Debris.	Contamination, deposited by thrusters or other sources, is difficult to predict; thus, flight validation needed to confirm contamination models.
2. SPACE ENVIRONMENT (Ground Test Inadequate)	2.1 **Persistent Effects** are steady space/planetary environments acting on the technology.	Zero Gravity, Radiation Effects, Noise Sources, Temperature cycling.	Large, light-weight deployable structures need zero G flight validation because an accurate ground test is impossible.
	2.2 **Transient Effects** are impulse space/planetary environments acting on technology.	Cosmic Rays, Temperature spike, Particle and Fields, Noise, Microphonics	System level faults, such as cosmic-ray induced single-event upsets in integrated circuits. Validation flight needed to confirm software error handlers.
	2.3 **External Interactions** are environments used by the technology to accomplish something.	Cometary Surfaces, Planetary Atmospheres, Solar Wind.	Aeroassist technologies using planetary atmospheres and solar sails using solar wind for propulsion. Both require flight validation to build an experience base and to determine the performance envelope and operating safety margins.
	2.4 **Reliability Hazards** are space/planetary environments that degrade performance.	Micrometeorite, Dust Accumulation, Atomic Oxygen, Radiation Effects.	Micrometeorite, orbital debris, dust accumulation, atomic oxygen, and radiation effects are difficult to predict and simulate.

Benefits of NMP Processes

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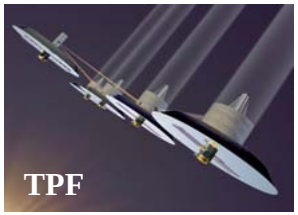
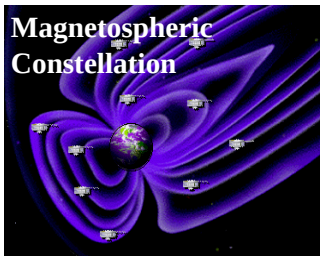
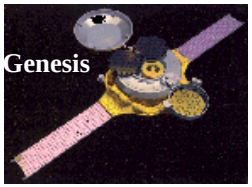
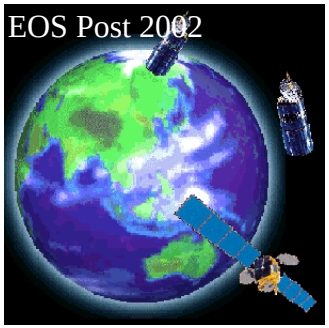
- Infusion into future science missions
  - Future strategic missions using NMP validated technologies
  - Technology available for NASA AOs
    - New capabilities enable new opportunities
    - MIDEX/SMEX/Discovery/ESSP

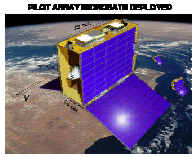


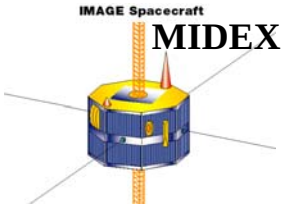


- Enhanced NASA's technology community through partnerships
  - Industry
  - Academia
  - Government Laboratories









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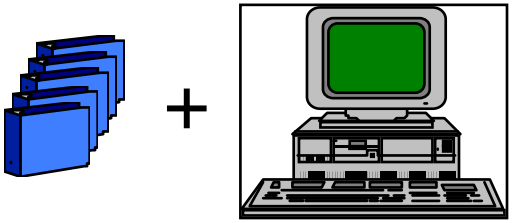
Technology Validation Information Dissemination Activities

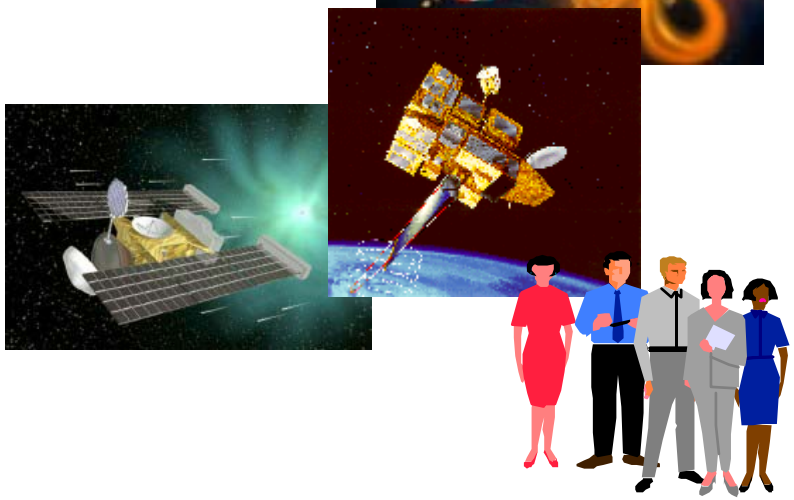
Web



Validation Reports

Validation Workshops

Support next set of Science AO's



User Community Contacts

Conferences

New Millennium Program Outreach

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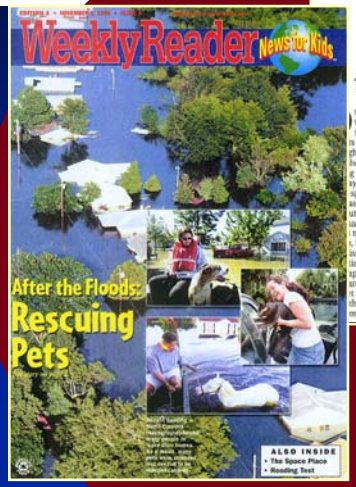
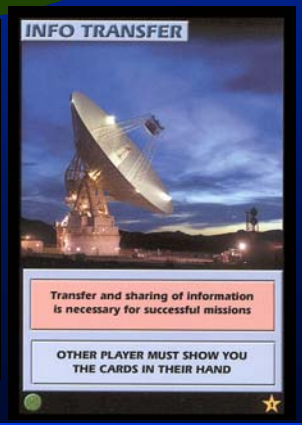
Print



Electronic

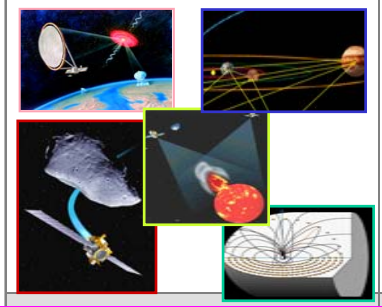
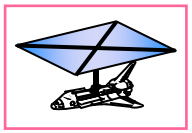
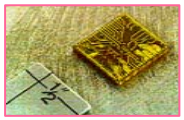
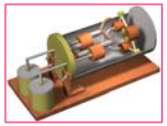
Museums & Libraries

Hands-on Activities



NMP

Revamped New Millennium Program Structure

	Approach	Project Attributes
System Validation 	Suites of new technologies to enable new system capabilities by performing critical system-level functions in a flight validation project	• Balanced mix of small and medium projects – Small (the normal): $50M class project with shared launches – Medium (occasional): $100-$150M class project • Yearly launches of system validation project
Subsystem Validation   	**Subsets or components of systems are flight validated as "stand-alone" technology subsystems on flights of opportunity and NMP technology carriers**	• **Yearly flight opportunities for several subsystems as technology items on flights of opportunities or technology carrier** • **$25M class technology subsystem projects (multiple subsystem items per project)** • **Partnership for flights of opportunity** • **NASA hosts technology carrier every 3 years** **- $15M-class carrier plus launch**

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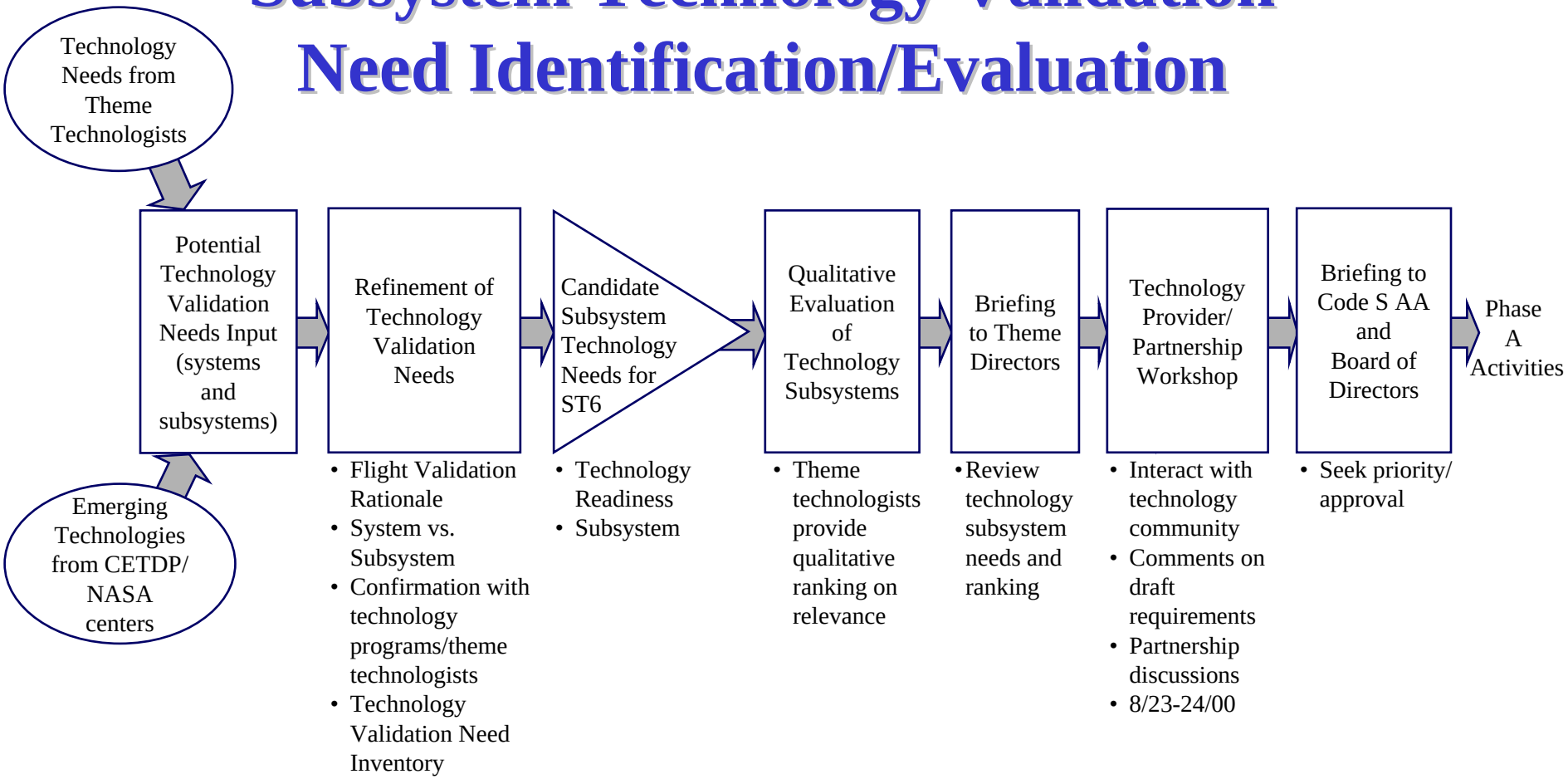
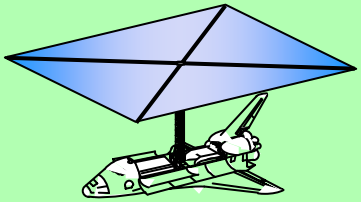
Subsystem Technology Validation Need Identification/Evaluation



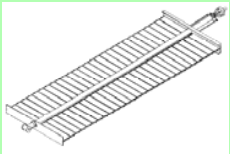
Candidate Technology Subsystem Areas for ST6

NMP

Lightweight Deployables

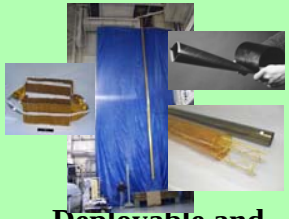


Solar Sail/Sunshade Deployment



Lightweight High Voltage Solar Array

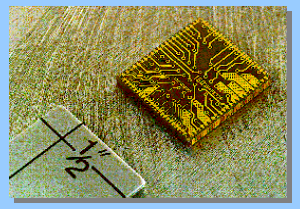
Membrane Optics Deployment



Deployable and Inflatable Booms

Spacecraft Miniaturization

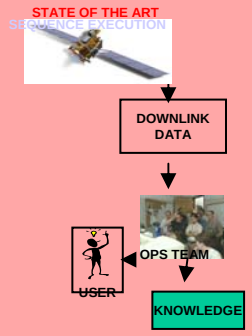
Acquisition, Tracking, and Pointing for Space-to-Space Interplanetary Optical Communications



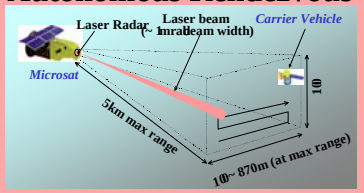
Ultra Low Power Advanced Electronics/ Avionics

Autonomy

On-board Data Processing to Enable Autonomous Operations and Reduce Downlink

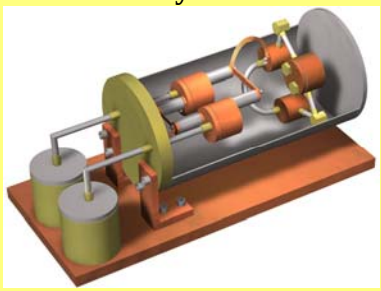


Autonomous Rendezvous



Cryogenics

Dilution Cryocoolers



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Subsystem Technology Solicitation/ Phase A Activities

- **ST6 planned to be ~$25M***
- **Recommend soliciting ~6-8 items for Phase A (average ~$500K/item Phase A studies)**
- **Recommend selecting ~3-5 items for Phase B**

ST6 Technology Solicitation → Peer Review led by NASA HQ → Technology Selection for Phase A Studies → Phase A Activities → Peer Review of Phase A Reports → Selection by NASA HQ of Subsystems to proceed to Phase B → Phase B Activities

ST6 Technology Solicitation
- Late Sept'00
- Proposals due mid Nov'00

Peer Review led by NASA HQ
- Nov'00-Jan'01

Technology Selection for Phase A Studies
- Feb'01

Phase A Activities
- Develop technology validation experiment plan, including Phase B/C/D/E activities
- Demonstrate with technology articles with TRL≥4
- Piggyback flight opportunities
- 6-month study

Peer Review of Phase A Reports
- 08/01

Selection by NASA HQ of Subsystems to proceed to Phase B
- 08/01

** Cost includes technology development, integration/test, technology validation and reporting. Does NOT include the cost for access-to-space.*

ST6 Relationship to STC

NMP

What the ST6 Technology Announcement said:

- For ST6, the NMP will focus on several technology subsystem areas that will be appropriate for flight validation in the 2003 to 2004 time frame.
- The ST6 technology selection process will be conducted in three steps: (1) selecting technologies for a six-month Technology Concept Definition Study Phase ("Study Phase"), (2) down-selecting technology concepts to continue into the Formulation Refinement Phase; and (3) approval for the Implementation Phase.
- NMP encourages partnerships in the technology development and/or approach for access-to-space.
- Low cost access-to-space for NMP subsystem flight validation experiments is an important area of the Study Phase.
- A key activity in the Study Phase is to define the resource requirements for a technology validation platform to accommodate the proposed technology validation experiment.
- As a primary means of low cost access-to-space, the experiment proposers are encouraged to seek commercial piggyback opportunities for the validation flights. If such opportunities are identified, they should be included in the proposal for evaluation.
- In addition to commercial piggyback opportunities that will be sought by the experimenters, the NMP is planning to conduct a Space Technology Carrier Study (New Millennium Carrier, NMC) in FY01 to examine a variety of cost effective access-to-space approaches, including internal government interagency opportunities for technologies which cannot obtain piggyback opportunities.

ST6 Relationship to STC (cont)

NMP

- The proposers for those technologies should plan to interact with this study to define and assess the resource and interface requirements for the technology experiments.
- If the NMC is proposed as the primary access-to-space for the experiment, the NMP will provide an assessment of the degree of ease of accommodation in the down-selection process.
- Proposers were asked to provide an:
- Approach to secure any proposed technology development collaborations and access-to-space partnering arrangements; and
- Approach for access-to-space, including potential partnerships or desire to participate in the New Millennium Carrier study.

NMP Technology Carrier Options

NMP

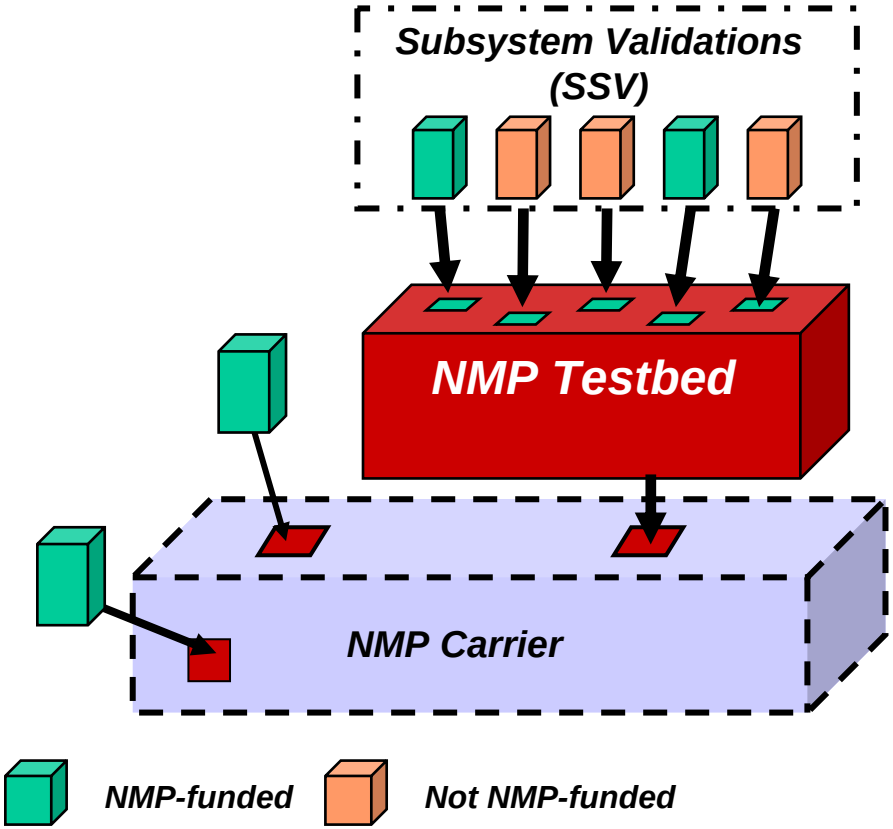
- Subsystem technologies require some form of “carrier” to support flight validation
- NMP expects three means of satisfying carrier requirements
  - Unique carrier proposed by the technology provider
  - A carrier derived from existing NASA program options (I.e. Spartan, small Shuttle payload, etc.)
  - An STC procured by NMP for a specific technology project through open solicitation

Future Subsystem-Level Flight Opportunities

NMP

- ST6 first Opportunity--2003-2004 timeframe
- Subsystem opportunities every other flight validation opportunity cycle
- One or more STC-type carriers are envisions at each subsystem technology flight validation opportunity

Testbeds for Sub-system Technology Validations



- Definition: Common support hardware & software to validate several subsystems or components
  - Facilitates harvesting subsystems & components developed in & outside space science
  - Outside space science = Industry, other NASA technology development programs, other government agencies

Space Technology Carrier Study

Dick Turner

California Institute of Technology, JPL

January 17, 2001

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STC Study Details

- Study Contacts:
  - John T. Davis Contracts **john.t.davis@jpl.nasa.gov 818-354-2055**
  - Dick Turner CTM **philip.r.turner@jpl.nasa.gov 818-354-5643**
- Schedule
  - **Feasibility Study**
    - **Kickoff Meeting 01/17/01**
    - **ST6 Selections 02/01/01**
    - **ST6 Phase A Kickoff Meeting 02/16/01**
    - **STC Study Result delivery/presentation 03/09/01**
  - **Concept Definition Study (Phase A)**
    - **Down-selection of Contractors 03/20/01**
    - **Study Initiated 03/23/01**
    - **Study Completed 10/05/01**
- Deliverable for Feasibility Study
  - **Oral presentation of result**
  - **View graph hard copies of presentation**

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STC Study Rationale

- Goal: Evaluate feasible, low cost options for implementing Subsystem-level projects
- Examine a range of accommodation approaches studied through Concept Definition Phase (Phase A)
- Allow potential industry providers to suggest innovative, low cost solutions for a wide range of potential technology flight validation projects
- Establish a potential supplier base for future NMP open calls for technologies without a defined implementation or “ride”

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STC Study Process

STC Feasibility Study Start → ST6 Selected Technologies Kickoff → STC Feasibility Study Report → Down-select for STC Concept Definition Study → STC Concept Definition Study → Future Procurement of STC TBD

- Jan'01
- Feb16, '01
- Mar 9, '01
- Mid Mar '01
- Mar-Aug'01

ST6 Technology Solicitation → Peer Review led by NASA HQ → Technology Selection for Phase A Studies → ST6 Phase A Activities → •Peer Review of Phase A Reports •NASA HQ Selection of Subsystems to proceed to Phase B

- Late Sept'00
- Proposals due mid Nov'00

- Nov'00-Jan'01

- Feb'01

- Develop technology validation experiment plan, including Phase B/C/D/E activities
- Demonstrate with technology articles with TRL≥4
- Piggyback flight opportunities
- 6-month study

- Aug'01

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Feasibility Study Report Content

- Viewgraph presentation ~ ≤ 30 pages
- 5 Topical Sections:

A. Summary of options studied and rationale for feasibility

B. Descriptive detail for each concept
  - Technical approach description and heritage
  - Technology payload accommodation capability
  - Applicability to ST6 Candidate technology projects
  - Cost and schedule issues

C. Applicable access to space options

D. Management/teaming requirements

E. Proposed work for Concept Definition Study

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Downselect Process/Criteria

- Downselect for up to 3 Concept Definition Studies based on Feasibility Study reports

- The degree to which the concepts of the Feasibility Study Report fit NMP's flight experiment budget, schedule, access to space, and technical performance needs for ST6 and/or future subsystem-level validation experiments, The following factors for consideration are of equal importance:

  – Factor A Unique capabilities to accommodate a range of technology validation experiments.

  – Factor B Degree of innovation of the technical design of the STC.

  – Factor C Feasibility of the design and implementation of the STC.

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Concept Definition Phase Study

- STC study in parallel with ST6 Concept Definition (Phase A) Study
  - Detailed technology mission definitions provide examples for STC concepts
  - Additional prospective technology mission requirements will be available as developed
- Concept Definition will be requested for 3 examples
  - Two ST6-related technologies will be addressed for applicable STC concept/s
  - One technology opportunity to be proposed by the study
- Detailed mission, hardware design information for each example
  - Mission definition, including orbit, access to space, ground support, etc.
  - STC flight system hardware description and heritage
  - Management and organizational structure assumed
  - Proposed schedule and lead times for deliverables
  - ROM cost estimate for STC and estimate for other parts of the project (other than technology payload)

Future STC Mission Options

NMP

- ST6 is first opportunity for a possible STC flight opportunity
- Current candidates are a good example of possible future STx projects
  - NMP will be identifying other future candidates in the period of the Concept Definition Study
- Should NMP select an ST6 or future STx project which could utilize an STC concept, NMP would issue an open solicitation for an STC for that flight validation opportunity

STC Contract Management

John Davis

California Institute of Technology, JPL

January 17, 2001

NMP

STC JPL Points of Contract

Contract Technical Manager: Dick Turner
(818) 345-5643
FAX (818) 393-6871
E-Mail: Philip.R.Turner@jpl.nasa.gov

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