Opportunities in NASA’s Space Exploration Missions

• New Vision for NASA
• Program and Budget Changes
• Exploration Systems Mission and Project Constellation
• Technologies and Opportunities
• Spiral Acquisition Plan and Details
• Portal Familiarization
• Q&A

Matching interest & capability with opportunity
Implement a sustained and affordable human and robotic program to explore the solar system and beyond

Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;

Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and

Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

THE FUNDAMENTAL GOAL OF THIS VISION IS TO ADVANCE U.S. SCIENTIFIC, SECURITY, AND ECONOMIC INTEREST THROUGH A ROBUST SPACE EXPLORATION PROGRAM
The Nation’s Vision

1. Return the Shuttle to safe flight as soon as practical, based on CAIB recommendations
2. Use Shuttle to complete ISS assembly
3. Retire the Shuttle after assembly complete (2010 target)
4. **Focus ISS research to support exploration goals; understanding space environment and countermeasures**
5. Meet foreign commitments
6. **Undertake lunar exploration to support sustained human and robotic exploration of Mars and beyond**
7. **Series of robotic missions to Moon by 2008 to prepare for human exploration**
8. **Expedition to lunar surface as early as 2015 but no later than 2020**
9. **Use lunar activities to further science, and test approaches (including lunar resources) for exploration to Mars & beyond**
10. **Conduct robotic exploration of Mars to prepare for future expedition**
11. **Conduct robotic exploration across solar system to search for life, understand history of universe, search for resources**
12. **Conduct advanced telescope searches for habitable environments around other stars**
13. **Demonstrate power, propulsion, life support capabilities for long duration, more distant human and robotic missions**
14. **Conduct human expeditions to Mars after acquiring adequate knowledge and capability demonstrations**
15. **Develop a new Crew Exploration Vehicle; flight test before end of decade; human exploration capability by 2014**
16. **Separate cargo from crew as soon as practical to support ISS; acquire crew transport to ISS after Shuttle retirement**
17. **Pursue international participation**
18. **Pursue commercial opportunity for transportation and other services**
Key Elements of the Nation’s Vision

♦ Major Milestones

- 2008: Initial flight test of CEV
- 2008: Launch first lunar robotic orbiter
- 2009-2010: Robotic mission to lunar surface
- 2011 First Unmanned CEV flight
- 2014: First crewed CEV flight
- 2012-2015: Jupiter Icy Moon Orbiter (JIMO)/Prometheus
- 2015-2020: First human mission to the Moon
Strategy Based on Long-Term Affordability

NOTE: Exploration missions – Robotic and eventual human missions to Moon, Mars, and beyond
Human/Robotic Technology – Technologies to enable development of exploration space systems
Crew Exploration Vehicle – Transportation vehicle for human explorers
ISS Transport – US and foreign launch systems to support Space Station needs especially after Shuttle retirement
**Constellation Spirals**

**2005 - 2025**

- **Crewed Access to Low Earth Orbit**
- **Robotic Exploration, Lunar**

**2020 - 2025**

- **Crewed Exploration, Lunar Extended Duration**
- **Robotic Exploration, Mars**

**Other Potential Capabilities**

**- Crewed Exploration, Mars Surface**

**SPIRAL CAPABILITIES**

**PRE-ACQUISITION ACTIVITIES**

- HSRT: Exploration Systems Research & Technology
- PNST: Prometheus Nuclear Systems Technology
- HRST: Human System Research & Technology

**Technology Investment Line**

ESRT: Exploration Systems Research & Technology
PNST: Prometheus Nuclear Systems Technology
HRST: Human System Research & Technology
Exploration Mission Systems Programs

Development Programs Division

Strategic Analysis

Transition Programs

Human & Robotic Technology

Advanced Space Technology (TRL 2-5)

Technology Maturation (TRL 3-6)

SBIR

TRL 2-6

"Project Constellation" Exploration Transportation Systems

Robotic Lunar Orbiters/Landers

Crew Exploration Vehicle

Launch Vehicle(s)

Space Transportation Systems

Supporting In-Space Systems

Supporting Surface Systems

TRL ≥ 6

Advanced, Development, Demonstration & Studies

"Project Prometheus" Nuclear Systems Technology & Demo(s)

Power Systems

Propulsion Systems

Jupiter Icy Moons Orbiter (JIMO)

Mission Studies & Engineering Analysis

TRL 3-6

Coordination Responsibility with other Enterprises
$12B of R&D in Technology

$25B to get to human crewed spaceflight and do the robotic mission on lunar surface
### Pre-Acquisition Activities in Support of Spiral I

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Activity</th>
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<tbody>
<tr>
<td>FY 04</td>
<td><strong>Spiral I Technology Infusion</strong></td>
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<tr>
<td></td>
<td>• Content Determined by Gap Analysis of Capabilities Against Requirements</td>
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<td></td>
<td>• Technologies Targeted for Transition at CEV PDR</td>
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<tr>
<td>FY 06</td>
<td><strong>Safety Net</strong></td>
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<tr>
<td></td>
<td>• Final Adjustment in Portfolio</td>
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<td></td>
<td>• Fill Technology Areas Left Uncovered by Previous Competitions</td>
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<tr>
<td>FY 08</td>
<td><strong>System Integrator</strong></td>
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<td></td>
<td>• Strategy Still in Development</td>
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<td>• Planning for RFP in Late FY05</td>
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#### Phase A: Study
- SRR
- Design
- Risk Reduction 2008 Demo

#### Phase B: Design
- CDR
- Build, Test, Launch
- Design

#### Phase C: Build, Test, Launch
- CEV un-crewed Flight
- Build, Test

### Non Traditional Approach
- RFP
- Pre-Acquisition Activities in Support of Spiral I
- Technology Infusion BAA
- Safety Net
- ETO

### System Engineering and Integration
- Study
- Design
- Build, Test

### Potential Commercial Service
- Operate (SOMD)

#### Pre-Acquisition Activities in Support of Spiral I
- Phase A: Study
- Phase B: Design
- Phase C: Build, Test, Launch
Exploration Systems Research & Technology
Strategic Technical Challenges

Sustainable
Vision for Space Exploration

Affordable
Systems & Operations
(Development, Ownership, Missions)

Reliable/Safe
Systems & Operations
“ASARA”

Effective
Missions & Systems

Flexible
Robust in terms of Policy, Adaptive to Events

Margins and Redundancy

Autonomy
Human Presence in Deep Space
(as safe as reasonably achievable)

Modularity

Reusability

Robotic Networks

Access to Surface Targets
Precise, Repeatable

Energy-Rich
Systems and Missions

Data-Rich Virtual Presence

Space Resources Utilization

In-Space Assembly

Re-configurability
(H/W, S/W, Systems)

Affordable Pre-Positioning of Logistics
• Margins and redundancy
  - in diverse subsystems, systems and systems-of-systems—but particularly those that must execute mission critical operations (such as transportation or life support) with the prospect of significant improvements in robustness in operations, reliability and safety.

• Reusability
  - using vehicles and systems during multiple phases of a single mission, and/or over multiple missions instead of ‘throwing away’ crew transportation, service modules, propulsion stages, and/or excursion systems after only a single mission.

• Modularity
  - employing common, redundant components, subsystems and/or systems that can improve reliability and support multiple vehicles, applications and/or destinations—with the potential for significant reductions in cost per kilogram.

• Autonomy
  - making vehicles and other systems more intelligent to enable less ground support and infrastructure, including the goal of accelerating application of ‘COTS’ and COTS-like computing and electronics in space.

• “ASARA” Human Presence in Deep Space
  - making it possible for humans to operate affordably and effectively in deep space and on lunar/planetary/other surfaces for sustainable periods of operations—while assuring that they are ‘as safe as reasonably achievable’.
Exploration Systems Research & Technology
Strategic Technical Challenges (2)

- **In-Space Assembly**
  - docking vehicles and systems together on orbit instead of launching pre-integrated exploration missions from Earth using very heavy launch vehicles, and including in space maintenance, servicing, reconfiguration, evolution, etc., for exceptionally long-duration deep space operations.

- **Reconfigurability**
  - deploying systems that can be reconfigured following initial deployment, to enable adaptation to new circumstances, evolution at the systems-of-systems level as new elements are added, or to support high level system options.

- **Robotic Networks**
  - enabling ‘networks’ of cooperating robotic systems to be deployed that can work cooperatively to prepare landing sites, habitation, and/or resources and to extend the reach of human explorers.

- **Affordable Logistics Pre-positioning**
  - sending spares, equipment, propellants and/or other consumables ahead of planned exploration missions to enable more flexible and efficient mission architectures.
• **Energy-Rich Systems and Missions**
  - including both cost-effective generation of substantial power, as well as the storage, management and transfer of energy and fuels to enable the wide range of other systems-of-systems level challenges identified here.

• **Space Resource Utilization**
  - manufacturing propellants, other consumables and/or spare parts at the destination, rather than transporting all of these from Earth.

• **Data-rich virtual presence**
  - locally & remotely, for both real-time & asynchronous virtual presence to enable effective science and robust operations (including tele-presence and tele-supervision; tele-science; etc.).

• **Access to Surface Targets**
  - that is precise, reliable, repeatable and global for small bodies, the Moon, Mars and other destinations—including both access from orbit and access from other locations on a planetary surface through the use of advanced mobility systems.
How Do I Evaluate These Opportunities for Myself?

♦ Read the Exploration Systems Mission Vision and Plan
  • http://exploration.nasa.gov/documents/documents.html#vision

♦ Become familiar with the Project Constellation Spiral Acquisition Program and Strategic Technical Challenges that come from the requirements process http://exploration.nasa.gov/documents/cev_rfp_schedule1.ppt#2

♦ Know what NASA considers to be technology gaps
  • http://exploration.nasa.gov/programs/

♦ See what they consider gaps and technologies needed:
  • http://exploration.nasa.gov/documents/nova_29july04b.pdf

♦ Learn what they have already invested in:
  • Who won technology awards within the NASA centers and for what: http://exploration.nasa.gov/documents/04aug1hrt_icp_awards.pdf
  • Who won technology awards outside NASA and for what: http://exploration.nasa.gov/acquisition/hrtbaa_092004_awards.pdf

♦ Become familiar with the concept studies and their architectures
  • http://exploration.nasa.gov/acquisition/cev_procurement.html

♦ Decide if your interest and capability aligns with the STC’s and fills a gap (must be requirements driven!)
  • www.soulsearch.org; www.cryystalball.org (kidding)

♦ Determine your best partnering arrangement:
  • With key NASA Centers
  • Within PSU
  • With outside (see Concept Exploration and Refinement Contractors)

♦ Follow the Portal for updates
  • http://exploration.nasa.gov/acquisition/index.html
NASA Systems Engineering Tools for SBA-RFI

Key areas that this tool will support include requirements management (to include development, analysis and documentation), logical systems design (to include system concept analysis, system and/or architecture diagramming and trade tree documentation), architecture and technology analyses (to include functional allocation and analysis), and management of the supporting trade studies and corresponding results. This SE tool must enable the engagement of a large multi-organization, distributed team that will be working in the previously mentioned key areas.

An example use case of this tool would involve: 1) an engineer or team of engineers utilizing the tool to perform a conceptual logical system design; 2) the "final" conceptual reference system design being captured in the tool, via DODAF-like architecture models/views; 3) a central repository providing access to that reference system design; 4) the tool being used by the requirements analysis team to decompose the system functions into requirements; 5) an engineer's "new" idea being modeled and analyzed based upon the reference design; 6) the alternative design placed into the SE tool repository for comment and critique; 7) resulting changes, based upon a well-documented ESMD change control process resulting in a new reference design.

http://prod.nais.nasa.gov/cgi-bin/eps/bizops.cgi?gr=D&pin=04#114158
Relevant Information & Hints

♦ President’s budget request for FY’06 increased 2.2%
♦ Greater emphasis on outsourcing then in the past
♦ DoD-like business processes with Spiral Acquisition
♦ NASA, as an organization, in midst of massive change
  • Centers must focus on core competencies
  • Realignment, reductions, shifting, ongoing in FY’05:
  • Especially Langley, Ames, Glenn, Marshall, Dryden

♦ Map to the requirements!
♦ Pick your partners carefully!
  • have already been awarded from intra- and extra mural awards
  • Does the “center” have the core competency
♦ Pick your conferences and meetings carefully
  • “partnering” conferences being held routinely by centers
♦ Stay tuned to HQ and their directions.
Summary

♦ CEV RFP-
  • Team with primes
    — ?? (Lockmart, Denver); Boeing/Northrup Grumman ElSegundo

♦ Systems Engineering Tools RFI

♦ ES R&T
  • Gap Filling/ Tech Infusion BAA (March ’05???)
  • Safety Net BAA (Fall ’05)

♦ Posture yourself for participation on:
  • CEV Launch Systems
  • Ground Systems
  • In-Space Systems
• Mission oriented
• Medium to large space programs
• Aids concept development & proposal submission
• Helps with implementation (e.g. program management, systems engineering, co-share of facilities)
• Increases external awareness of PSU

www.csrp.org
Critical Activity
Coordination with Concept Exploration & Refinement

- Andrews Space
- Boeing
- Draper Lab - MIT
- Lockheed Martin
- Northrop Grumman
- Orbital Sciences
- Raytheon
- SAIC
- Schafer & Boeing/Phantomworks
- SpaceHab
- tSpace

Your likely team members and partners for CEV

Technical Interchange Meeting being planned for December