Enabling Exploration: NASA’s Technology Needs

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SPACE EXPLORATION: THE NEXT STEPS
The end of an era July 21, 2011: 30 years of Space Shuttle Exploration
NASA is changing its approach to Space Exploration

Strategy:
✧ Use the International Space Station as a research lab and test bed for new technologies
✧ Foster a commercial industry to take us to and from low Earth orbit
✧ Develop technologies to take humans to an asteroid and eventually to Mars
An incredible orbiting research lab

1.5 billion statute miles +
16 nations
202 astronauts
74 Russian vehicles, 37 space shuttles, two European and two Japanese vehicles
Foster U.S. Industry to Carry People and Cargo to/from Low Earth Orbit

Sierra Nevada
Dream Chaser

Boeing
CST-100

Space-X
Falcon 9 and Dragon

Blue Origin
Space Tourism: non-NASA Ventures

Virgin Galactic

XCOR Aerospace
NASA is Building the Capability to Go Further

- Near Earth Objects
- A Sustained Presence - Extending Human Frontiers
- Libration Points
- Geosynchronous
- LEO & ISS Vicinity
- New Knowledge in Science and Technology
- Economic Expansion
- Global Partnerships
- Inspiration and Education

Cycle B Draft July 12, 2011
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**Earth’s Moon**
- 382,500 km / 237,674 mi
- Witness to the birth of the Earth and inner planets
- Has critical resources to sustain humans
- Significant opportunities for commercial and international collaboration

**Mars and its Moons**
- 54,500,000 km / 33,900,000 mi
- A premier destination for discovery: Is there life beyond Earth? How did Mars evolve?
- True possibility for extended, even permanent, stays
- Significant opportunities for international collaboration
- Technological driver for space systems

**HEO/GEO/Lagrange Points**
- Microgravity destinations beyond LEO
- Opportunities for construction, fueling and repair of complex in-space systems
- Excellent locations for advanced space telescopes and Earth

**Near Earth Asteroids**
- Compelling science questions: How did the Solar System form? Where did Earth’s water and organic come from?
- Planetary defense: Understanding and mitigating the threat of impact resources
- Excellent stepping stone for Mars
Tomorrow’s missions are demanding more …

- More data processing
- More places
- More autonomy
WHAT TECHNOLOGIES ARE NEEDED?
# 14 Technology Areas

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<tr>
<th>TA01</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Launch Propulsion Systems" /></td>
<td><img src="image2.png" alt="In-Space Propulsion Technologies" /></td>
<td><img src="image3.png" alt="Space Power &amp; Energy Storage" /></td>
<td><img src="image4.png" alt="Robotics, Tele-robotics &amp; Autonomous Systems" /></td>
<td><img src="image5.png" alt="Communication &amp; Navigation" /></td>
<td><img src="image6.png" alt="Human Health, Life Support &amp; Habitation Systems" /></td>
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<td><img src="image8.png" alt="Science Instruments, Observatories &amp; Sensor Systems" /></td>
<td><img src="image9.png" alt="Entry, Descent &amp; Landing Systems" /></td>
<td><img src="image10.png" alt="Nanotechnology" /></td>
<td><img src="image11.png" alt="Modeling, Simulation, Information Technology &amp; Processing" /></td>
<td><img src="image12.png" alt="Materials, Structures, Mechanical Systems &amp; Manufacturing" /></td>
<td><img src="image13.png" alt="Ground &amp; Launch Systems Processing" /></td>
<td><img src="image14.png" alt="Thermal Management Systems" /></td>
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*What new capabilities can be created?*
Robotic Precursor Missions Pave the Way for Future Human Exploration Missions
Orion Multi-Purpose Crew Vehicle and Space Launch System
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Solar Electric Propulsion
In-Space Habitation
Planetary Transportation System
NASA Ames Overview

Technical Scope:
- Science (Earth-Life-Space)
- Astrobiology
- Science Missions
- Intelligent Systems
- High End Computing
- Human System Integration
- Small Satellites
- Aviation and Aeronautics
- Innovative Collaborations

- 2400 Employees
- $700+ M Annual Budget
Questions?
Thermal Protection Systems Research

- State of the art low density carbon ablators are used for current mission but have challenges
  - Low strain to failure
  - Brittle char
  - Needs strain isolation pads and gap fillers in tiled configurations
Thermal Protection Materials Research at Ames

Rigid Ablators
- Advanced PICA-like ablators
- Graded Ablators

Conformable Ablators
- Conformable PICA

Flexible Ablators
- Flexible PICA
- Flexible SIRCA

Woven TPS
- Mid density TPS
- Carbon phenolic replacement
SCIENCE HIGHLIGHTS
Water on the Moon - LCROSS

Changed our understanding of the moon
Destination Mars: Gale Crater
New Landing System: Mars Sky Crane
Curiosity – The Next Mars Rover

http://www.nasa.gov/mission_pages/msl
Kepler Mission

The determination of the frequency of Earth-size & larger planets in and near the habitable zone of solar-like stars
Kepler uses light curves to detect new planets
Locations of Kepler Planet Candidates
As of December 5, 2011

- **Earth-size**
- **Super-Earth size**
  1.25 - 2.0 Earth-size
- **Neptune-size**
  2.0 - 6.0 Earth-size
- **Giant-planet size**
  6.0 - 22 Earth-size
Real Life Tatooine?
First Planet with Two Suns:
Kepler 16-b
Another View of the “Tatooine” Planet: Kepler 16-b
Out of this world Solar System orbiting Kepler 11
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Looking Towards the Future

- ISS will be the centerpiece of human spaceflight activities until at least 2020
- Research and technology breakthroughs aboard ISS will facilitate travel to destinations beyond low Earth orbit
- Destinations for human exploration remain ambitious: the Moon, asteroids and Mars
- Continue to undertake world-class science missions to observe our planet, reach destinations throughout the solar system and peer even deeper into the universe
- Advance aeronautics research to create a safer, more environmentally friendly and efficient air travel network for the Next Generation Air Transportation System
- Continue to inspire the next generation of scientists, engineers and astronauts by focusing on STEM education initiatives
Student Opportunities: Many student internship, fellowship, and post-doc opportunities across NASA

http://intern.nasa.gov
http://eap.usra.edu
http://nasa.ora.org/postdoc
Questions?