National Aeronautics and Space Administration

NASA

Office of Chief Technologist - Space Technology Program

Dr. Prasun Desai
Office of the Chief Technologist
May 1, 2012

Office of the Chief Technologist

Serves as Advisor to Administration

Integrates Technology Investment Across the Agency

Direct Technology Management and Budget Authority for the Space Technology Program

Office of the Chief Technologist

Leads Tech Transfer, Partnerships and Commercialization Activities Across the Agency

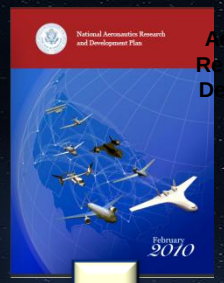
Advocates Externally NASA's R&D Programs

Demonstrates and Communicates Societal Impacts of NASA Technology Investments

NASA's Space Technology Portfolio

Top Down Driven Strategic Guidance

Strategic Space Technology Investment Plan



National Aeronautics Research and Development Plan

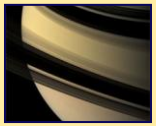
External Technology Portfolios & Partnerships

DoD
NRL
FAA
NRO
Space Command
DoE
AFRL
DARPA

Mission Directorate Requirements

ARMD

HEOMD



SMD

Technology Portfolio

SMD

HEOMD

Space Technology Program

ARMD

Bottom Up Driven Requirements

Guiding Principles of the Space Technology Program

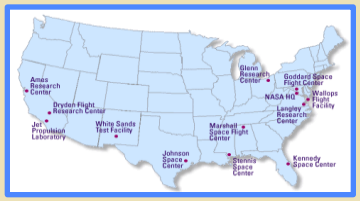
- **Strategic Guidance**
  - Agency Strategic Plan
  - Grand challenges
  - Technology roadmaps
- **Full spectrum of technology programs that provide an infusion path to advance innovative ideas from concept to flight**
- **Competitive peer-review and selection**
  - Competition of ideas building an open community of innovators for the Nation
- **Projectized approach to "Crosscutting" technology development**
  - Defined start and end dates
  - Project Managers with full authority and responsibility
  - Project focus in selected set of strategically defined capability areas
- **Overarching goal is to re-position NASA on the cutting-edge**
  - Technical rigor
  - Pushing the boundaries
  - Take informed risk; when we fail, fail fast and learn in the process
  - Seek disruptive innovation
  - Foster an emerging commercial space industry

The Ten Programs of Space Technology

Early Stage Innovation

Space Technology Research Grant Program

NASA Innovative Advanced Concepts (NIAC) Program



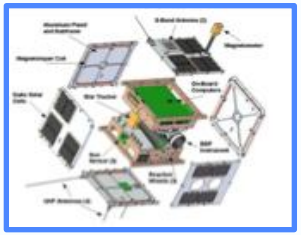
Center Innovation Fund Program

Centennial Challenges Prize Program

Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Program

Game Changing Technology

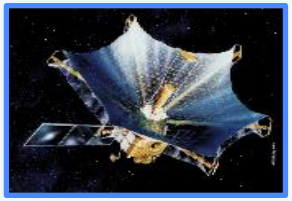
Game Changing Development



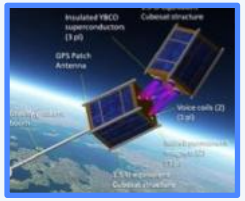
Franklin Small Satellite Subsystem Technology

Technology Capability Demonstrations

Flight Opportunities



Technology Demonstration Missions

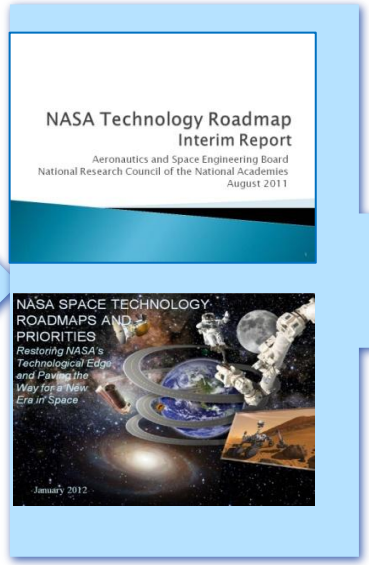


Edison Small Satellite Demonstration Missions

NASA's Space Technology Portfolio Perspectives and Process

Space Technology Roadmaps

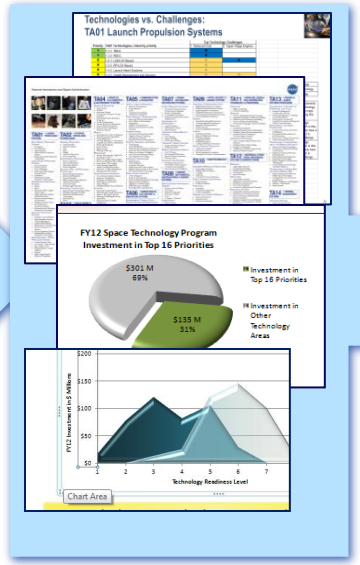
- 140 challenges (10 per roadmap)
- 320 technologies
- 20 year horizon



NRC Study

Gives priority to:

- 100 top technical challenges
- 83 high priority technologies (roadmap-specific)
- 16 highest of high technologies (looking across all roadmaps)
- Immediate 5 year horizon



Space Technology Investment Plan

Updated ST Roadmaps:

- Incorporate NRC Study Results

Developing a Strategic Space Technology Investment Plan:

- Identify current investments
- Identify current MD/Office priorities
- Identify opportunities for partnership
- Analyze gaps against current budget and capabilities
- Develop immediate 4-year horizon

Execution

Technology Portfolio Investments

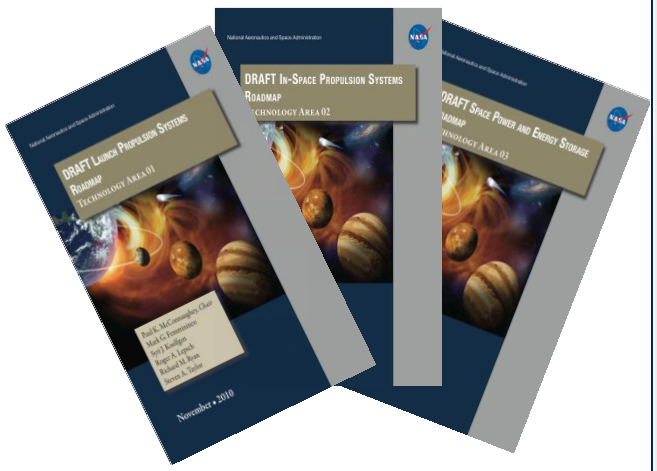
- Technology Developments (across full TRL spectrum)
- Flight Demonstrations

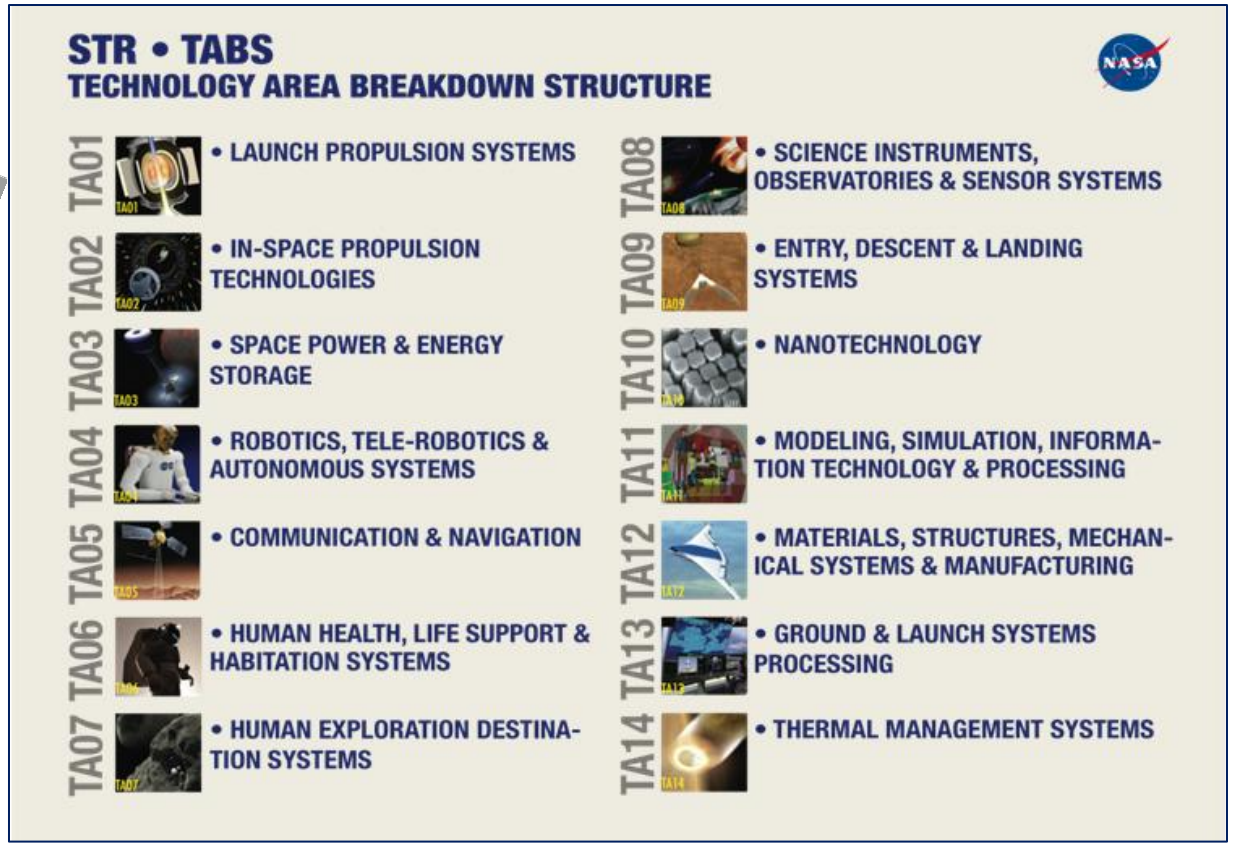
Must reflect:

- Affordability
- Technical Progress and Performance
- Mission Needs and Commitments
- Stakeholder Guidance

NRC Report on NASA's Space Technology Roadmaps

- At the end of 2010 NASA drafted roadmaps to guide Agency-wide technology investment. The National Research Council (NRC) led a year-long study to assess these roadmaps, prioritizing prospective technology-investment opportunities in terms of their value to NASA's future and the Nation as a whole.





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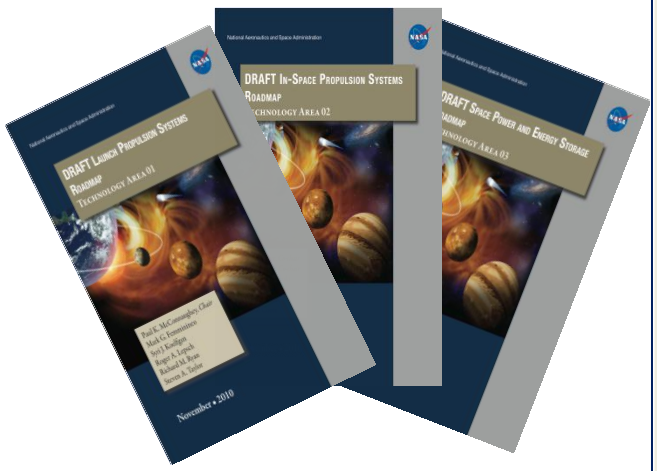

Planetary Protection (PP) technologies are within these highlighted technological areas

The National Research Council (NRC) Recommendations – Three Technology Objectives and 10 Associated Technical Challenges

Technology Objective A Extend and sustain human activities beyond LEO	**Technology Objective B** Explore the evolution of the solar system and the potential for life elsewhere (in-situ measurements)	**Technology Objective C** Expand understanding of the Earth and the universe (remote measurements)
A1. Improved Access to Space	B1. Improved Access to Space	C1. Improved Access to Space
A2. Space Radiation Health Effects	B2. Precision Landing	C2. New Astronomical Telescopes
A3. Long Duration Health Effects	B3. Robotic Maneuvering	C3. Lightweight Space Structures
A4. Long Duration ECLSS	B4. Life Detection	C4. Increase Available Power
A5. Rapid Crew Transit	B5. High Power Electric Propulsion	C5. Higher Data Rates
A6. Lightweight Space Structures	B6. Autonomous Rendezvous and Dock	C6. High Power Electric Propulsion
A7. Increase Available Power	B7. Increase Available Power	C7. Design Software
A8. Mass to Surface	B8. Mass to Surface	C8. Structural Monitoring
A9. Precision Landing	B9. Lightweight Space Structures	C9. Improved Flight Computers
A10. Autonomous Rendezvous and Dock	B10. Higher Data Rates	C10. Cryogenic Storage and Transfer

The National Research Council (NRC) Recommendations – List of Highest Priority Technologies

Technology Objective A Extend and sustain human activities beyond LEO	**Technology Objective B** Explore the evolution of the solar system and the potential for life elsewhere (in-situ measurements)	**Technology Objective C** Expand understanding of the Earth and the universe (remote measurements)
1. Radiation Mitigation for Human Spaceflight (X.1)	1. GN&C (X.4)	1. Optical Systems (Instruments and Sensors) (8.1.3)
2. Long-Duration Crew Health (6.3.2)	2. Solar Power Generation (Photovoltaic and Thermal) (3.1.3)	2. High Contrast Imaging and Spectroscopy Technologies (8.2.4)
3. ECLSS (X.3)	3. Electric Propulsion (2.2.1)	3. Detectors and Focal Planes (8.1.1)
4. GN&C (X.4)	4. Fission Power Generation (3.1.5)	4. Lightweight and Multifunctional Materials and Structures (X.2)
5. (Nuclear) Thermal Propulsion (2.2.3)	5. EDL TPS (X.5)	5. Active Thermal Control of Cryogenic Systems (14.1.2)
6. Lightweight and Multifunctional Materials and Structures (X.2)	6. In-Situ Instruments and Sensors (8.3.3)	6. Electric Propulsion (2.2.1)
7. Fission Power Generation (3.1.5)	7. Lightweight and Multifunctional Materials and Structures (X.2)	7. Solar Power Generation (Photovoltaic and Thermal) (3.1.3)
8. EDL TPS (X.5)	8. Extreme Terrain Mobility (4.2.1)	

NRC Recommended 83 High Priority Technologies

TA01 Launch Propulsion Systems
1.3.1 Turbine Based Combined Cycle (TBCC)
1.3.2 Rocket Based Combined Cycle (RBCC)

TA02 In-Space Propulsion Technologies
2.2.1 Electric Propulsion
2.4.2 Propellant Storage and Transfer
2.2.3 (Nuclear) Thermal Propulsion
2.1.7 Micro-Propulsion

TA03 Space Power and Energy Storage
3.1.3 Solar Power Generation (Photovoltaic and Thermal)
3.1.5 Fission Power Generation
3.3.3 Power Distribution and Transmission
3.3.5 Power Conversion and Regulation
3.2.1 Batteries
3.1.4 Radioisotope Power Generation

TA04 Robotics, TeleRobotics, and Autonomous Systems
4.6.2 Relative Guidance Algorithms
4.6.3 Docking and Capture Mechanisms/Interfaces
4.5.1 Vehicle System Management and FDIR
4.3.2 Dexterous Manipulation
4.4.2 Supervisory Control
4.2.1 Extreme Terrain Mobility
4.3.6 Robotic Drilling and Sample Processing
4.2.4 Small Body/Microgravity Mobility

TA05 Communication and Navigation
5.4.3 Onboard Autonomous Navigation and Maneuvering
5.4.1 Timekeeping and Time Distribution
5.3.2 Adaptive Network Topology
5.5.1 Radio Systems

NRC Recommended 83 High Priority Technologies (continued)

TA06 Human Health, Life Support, and Habitation Systems

6.5.5 Radiation Monitoring Technology
6.5.3 Radiation Protection Systems
6.5.1 Radiation Risk Assessment Modeling
6.1.4 Habitation
6.1.3 Environmental Control and Life Support System (ECLSS) Waste Management
6.3.2 Long-Duration Crew Health
6.1.2 ECLSS Water Recovery and Management
6.2.1 Extravehicular Activity (EVA) Pressure Garment
6.5.4 Radiation Prediction
6.5.2 Radiation Mitigation
6.4.2 Fire Detection and Suppression
6.1.1 Air Revitalization
6.2.2 EVA Portable Life Support System
6.4.4 Fire Remediation

TA07 Human Exploration Destination Systems

7.1.3 In-Situ Resource Utilization (ISRU) Products/Production
7.2.1 Autonomous Logistics Management
7.6.2 Construction and Assembly
7.6.3 Dust Prevention and Mitigation
7.1.4 ISRU Manufacturing/ Infrastructure etc.
7.1.2 ISRU Resource Acquisition
7.3.2 Surface Mobility
7.2.4 Food Production, Processing, and Preservation
7.4.2 Habitation Evolution
7.4.3 Smart Habitats
7.2.2 Maintenance Systems

TA08 Science Instruments, Observatories, and Sensor Systems

8.2.4 High-Contrast Imaging and Spectroscopy Technologies
8.1.3 Optical Systems (Instruments and Sensors)
8.1.1 Detectors and Focal Planes
8.3.3 In Situ Instruments and Sensors
8.2.5 Wireless Spacecraft Technology
8.1.5 Lasers for Instruments and Sensors
8.1.2 Electronics for Instruments and Sensors

NRC Recommended 83 High Priority Technologies (continued)

TA09 Entry, Descent, and Landing (EDL) Systems
9.4.7 GN&C Sensors and Systems (EDL)
9.1.1 Rigid Thermal Protection Systems
9.1.2 Flexible Thermal Protection Systems
9.1.4 Deployment Hypersonic Decelerators
9.4.5 EDL Modeling and Simulation
9.4.6 EDL Instrumentation and Health Monitoring
9.4.4 Atmospheric and Surface Characterization
9.4.3 EDL System Integration and Analysis

TA10 Nanotechnology
10.1.1 (Nano) Lightweight Materials and Structures
10.2.1 (Nano) Energy Generation
10.3.1 Nanopropellants
10.4.1 (Nano) Sensors and Actuators

TA11 Modeling, Simulation, Information Technology, and Processing
11.1.1 Flight Computing
11.1.2 Ground Computing
11.2.4a Science Modeling and Simulation
11.3.1 Distributed Simulation

TA12 Materials, Structures, Mechanical Systems, and Manufacturing
12.2.5 Structures: Innovative, Multifunctional Concepts
12.2.1 Structures: Lightweight Concepts
12.1.1 Materials: Lightweight Structure
12.2.2 Structures: Design and Certification Methods
12.5.1 Nondestructive Evaluation and Sensors
12.3.4 Mechanisms: Design and Analysis Tools and Methods
12.3.1 Deployables, Docking, and Interfaces
12.3.5 Mechanisms: Reliability/Life Assessment/Health Monitoring
12.4.2 Intelligent Integrated Manufacturing and Cyber Physical Systems

TA13: Ground and Launch Systems Processing
none

TA14 Thermal Management Systems
14.3.1 Ascent/Entry Thermal Protection Systems
14.1.2 Active Thermal Control of Cryogenic Systems

Summary

- The NRC report does not explicitly call out PP technologies, but states they are important and would need to be part of the overall activities
- OCT's current direct investment in PP technologies is supporting development of thermal protection systems that would be necessary for safely returning samples
- OCT would look to Mission Directorates for their lead on their Planetary Protection needs to drive our crosscutting investment
- Two programs within OCT could be utilized for PP technology development now
  - NIAC Program currently has solicitation for proposals (open topic areas)
  - STTR/SBIR subtopic areas can be defined for PP technology development if deemed priority
- To bridge this current gap, the subcommittee may choose to recommend a program focusing on the maturation of promising crosscutting PP technologies