

## NASA Space Technologies and Roadmaps and Priorities **Restoring NASA's Technological Edge and Paving the Way for a New Era in Space**

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NASA's Office of the Chief Technologist (OCT) has begun to rebuild the advanced space technology program in the agency with plans laid out in 14 draft technology roadmaps. It has been years since NASA has had a vigorous, broad-based program in advanced space technology development and its technology base has been largely depleted. However, success in executing future NASA space missions will depend on advanced technology developments that should already be underway. Reaching out to involve the external technical community, the National Research Council (NRC) considered the 14 draft technology roadmaps prepared by OCT and ranked the top technical challenges and highest priority technologies that NASA should emphasize in the next 5 years. This report provides specific guidance and recommendations on how the effectiveness of the technology development program managed by OCT can be enhanced in the face of scarce resources.

### **Background and Introduction**

Technological breakthroughs have been the foundation of virtually every NASA success. In addition, technological advances have yielded benefits far beyond space itself in down-to-Earth applications. As the breadth of the country's space mission has expanded, the necessary technological developments have become less clear, and more effort is required to evaluate the best path for a forward-looking technology development program.

In late 2010, NASA developed a set of 14 draft roadmaps to guide the development of space technologies under OCT leadership. The roadmaps are intended to foster the development of advanced technologies and concepts that address NASA's needs and contribute to other aerospace and national needs. In February 2011, NASA issued an updated strategic plan outlining agency goals and plans for the achieving those goals in the 2011-2021 decade and beyond.

## **Overview of Technical Challenges and Priorities**

The NRC's Steering Committee for NASA's Technology Roadmaps and six subordinate panels examined the draft roadmaps, NASA's strategic goals, and public input they received regarding the roadmaps. The Steering Committee then identified the top ten technical challenges as well as the highest priority technologies for each of three main technology objectives (see table). These priorities are aligned with NASA missions that extend and sustain human activities beyond low Earth orbit, explore the evolution of the solar system and the potential for life elsewhere, and expand our understanding of Earth and the universe in which we live.

These objectives would lead to advancements that could enable humans to survive long voyages throughout the solar system, reach their chosen destination, work effectively, and return safely; allow humans and robots to perform measurements on Earth (astrobiology) and on other planetary bodies; and make remote measurements from platforms that orbit or fly by Earth and other planetary bodies and from other in-space and ground-based observatories.

## **Some Specific Recommendations for NASA's Technology Development**

### ***Technology Development Priorities***

During the next 5 years, NASA technology development efforts should focus on (1) the 16 identified high-priority technologies and associated top technical challenges; (2) a modest but significant investment in technologies at low technology readiness levels (TRLs), on the order of 10 percent of NASA's technology development budget; and (3) flight demonstrations for technologies that are at a high-TRL when there is sufficient interest and shared cost by the intended user.

### ***Managing the Progression of Technologies to Higher Technology Readiness Levels***

OCT should establish a rigorous process to down select among competing technologies at appropriate milestones and TRLs to assure that only the most promising technologies proceed to the next TRL.

### ***Cooperative Development of New Technologies***

OCT should pursue cooperative development of high-priority technologies with other organizations to leverage resources available for technology development.

## Final Prioritization of the Top Technologies, Categorized by Objective

Highest Priority Technologies for Technology Objective A Extend and sustain human activities beyond low Earth orbit	Highest Priority Technologies for Technology Objective B Explore the evolution of the solar system and the potential for life elsewhere	Highest Priority Technologies for Technology Objective C Expand understanding of the Earth and the universe
Radiation Mitigation for Human Spaceflight	GN&C	Optical Systems (Instruments and Sensors)
Long-Duration Crew Health	Solar Power Generation (Photovoltaic and Thermal)	High Contrast Imaging and Spectroscopy Technologies
Environmental Control and Life Support Systems (ECLSS)	Electric Propulsion	Detectors and Focal Planes
Guidance, Navigation and Control (GN&C)	Fission Power Generation	Lightweight and Multifunctional Materials and Structures
(Nuclear) Thermal Propulsion	EDL TPS	Active Thermal Control of Cryogenic Systems
Lightweight and Multifunctional Materials and Structures	In-Situ Instruments and Sensors	Electric Propulsion
Fission Power Generation	Lightweight and Multifunctional Materials and Structures	Solar Power Generation (Photovoltaic and Thermal)
Entry, Descent and Landing (EDL) Thermal Protection Systems (TPS)	Extreme Terrain Mobility	

## ***NASA Investments in Commercial Space Technology***

While OCT should focus primarily on developing advanced technologies of high value to NASA's own mission needs, OCT should also collaborate with the U.S. commercial space industry in the development of precompetitive technologies of interest to and sought by the commercial space industry.

## ***Industry Access to NASA Data***

OCT should make the engineering, scientific, and technical data that NASA has acquired from past and present space missions and technology development more readily available to U.S. industry, including companies that do not have an ongoing working relationship with NASA and that are pursuing their own commercial goals apart from NASA's science and exploration missions.

Through sustained progress in implementing the plans defined by the NASA technology roadmaps and shaped by the priorities recommended in this study, a foundation is formed that supports the breadth of NASA missions and national and commercial needs and provides the means to achieve the goals defined in NASA's 2011 Strategic Plan.

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