



## TECHNOLOGY FORECAST: AN INTEGRATED APPROACH TO NASA TECHNOLOGY DEVELOPMENT

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The economic competitiveness and high standard of living in the United States are based on decades of investment in technology and innovation. NASA's focus on technology and innovation, that leverages the skills and expertise of industry, academia and other government partners, will provide the new knowledge and capabilities required to enable future NASA missions and address significant national needs.

NASA will employ a diversified portfolio approach toward technology development. This approach will span the Technology Readiness Level (TRL) spectrum and provide a balance between mission-focused ("pull") and transformational ("push") technology investments that enable revolutionary capabilities to meet NASA's goals. NASA technology development activities will span early stage conceptual studies, ground-based and laboratory testing, relevant environment flight demonstrations and technology test beds which include use of the International Space Station. NASA's Mission Directorates will continue to invest in "pull" technologies that lead to the evolutionary development of capabilities for specific NASA missions. The Space Technology Programs, implemented through the Office of the Chief Technologist, will focus on "push" technologies, designed to enable quantum leaps in technological capability.

To achieve the Agency's technology goals, NASA will sponsor relevant activities in academia and industry, at NASA Centers and in partnership with other government agencies. This approach will provide a balance between competed and strategically guided activities. NASA will use novel approaches to facilitate technology transfer, ensuring its technologies are infused into commercial applications, to promote the creation of new jobs and to advance new products and services.

NASA has worked steadily over the last several months toward development of an integrated technology plan. In the upcoming months, NASA will release several important products that define the Agency's strategy for innovation and technology development. These upcoming products are summarized as follows:

### **NASA Strategic Plan**

The NASA Strategic Plan will include one major goal related to technology development and specific outcomes that will drive NASA's innovation and technology activities. The NASA Strategic Plan provides the goals, outcomes, benefits, challenges and implementation methods that embody NASA's renewed focus on technologies that push the boundaries of scientific and engineering discovery.

### **Space Technology Roadmap**

NASA's integrated technology roadmap, including both technology pull and technology push strategies, will consider a wide range of pathways to advance the nation's current capabilities. The present state of this effort is documented in NASA's draft Space Technology Roadmap. This roadmap is an integrated set of fourteen technology area roadmaps, recommending the overall technology investment strategy and prioritization of NASA's space technology activities. NASA developed its draft Space Technology Roadmap for use by the National Research Council (NRC) as an initial point of departure. Through an open process of community engagement, the NRC will gather input, integrate it within the Space Technology Roadmap and provide NASA with recommendations on potential future technology investments.

### **Space Technology Grand Challenges**

The Space Technology Grand Challenges are an open call for cutting-edge technological solutions that solve important space-related problems, radically improve existing capabilities or deliver new space capabilities altogether. The challenges are centered on three key themes: (1) Expand human presence in space; (2) Manage in-space resources; and (3) Enable transformational space exploration and scientific discovery. These challenges are designed to facilitate communication and thought among our nation's innovators about future NASA missions and related national needs. The challenges will be continuously updated to serve as a reflection and long-term measure of our nation's technology capabilities. In the upcoming months, the public will have the opportunity to propose new challenges to the list of Space Technology Grand Challenges.



## **NASA ORGANIZATIONS INVOLVED IN TECHNOLOGY DEVELOPMENT:**

### **Office of the Chief Technologist**

NASA's Office of the Chief Technologist leads the Agency's technology and innovation activities. This office manages the ten Space Technology Programs and is responsible for integration and coordination of technology investments across the Agency. This office also leads the Agency's technology transfer and technology commercialization activities and is responsible for technology-oriented partnerships with a broad range of organizations, including other government agencies. The Space Technology Programs will use the Space Technology Grand Challenges and the Space Technology Roadmap as a resource for strategic guidance and to help frame the desired set of future technological capabilities. More than 70 percent of the Space Technology budget will be awarded competitively.

### **Aeronautics Research Mission Directorate**

NASA's Aeronautics Research Mission Directorate will continue to develop aeronautics technologies and innovations through cutting-edge fundamental research and by exploring and demonstrating the benefits of promising concepts and technologies at an integrated systems level. One of NASA's objectives is to advance U.S. technological leadership in aeronautics in partnership with industry, academia and other government agencies that conduct aeronautics-related research by increasing aviation safety, enhancing aircraft performance and enabling a more eco-friendly national airspace system with increased capacity, efficiency and flexibility. The National Aeronautics Research and Development Plan provides NASA with the high-priority challenges, goals and supporting objectives that guide our aeronautics research and technology development activities.

### **Exploration Systems Mission Directorate**

NASA's Exploration Systems Mission Directorate (ESMD) implements a number of technology development programs to facilitate NASA's future human exploration missions. ESMD holds conferences, workshops, meetings and focused studies to facilitate an open dialogue among Agency partners, academia and industry seeking to collaborate on future innovative technologies that support human space exploration. One result of such activities is the "Technology Frontiers: Breakthrough Capabilities for Space Exploration" report, which is expected to be released this win-

ter. The study was conducted to help identify areas of promising technology advancement for human exploration missions and was designed as a companion to an earlier report, "Technology Horizons: Game-Changing Technologies for the Lunar Architecture."

### **Science Mission Directorate**

NASA's Science Mission Directorate (SMD) relies on the NRC to provide consensus advice of the broad national science community on science goals and priorities. The directorate tasks the NRC with the creation of a decadal survey in each of its four science areas and uses the surveys as the starting point for strategic planning of its mission portfolio and to contribute to its technology needs and priorities. In addition to decadal surveys, the directorate tasks the NRC with performance of ad hoc studies on special topics, such as planetary protection, radioisotope power systems and suborbital science programs. These also contribute to mission portfolio and technology planning in SMD.

### **Space Operations Mission Directorate**

NASA's Space Operations Mission Directorate will continue to provide the foundation and platforms to ensure access to space and operation of the International Space Station. The directorate also will ensure NASA's capabilities to communicate return data and provide navigation on operational missions throughout the solar system. The directorate will continue to support research and development through enabling opportunities within programs including Space Communications and Navigation, Space Transportation, Processing and Operations and the International Space Station (ISS). The ISS represents an extraordinarily capable test bed from which to conduct research, development, test and evaluation of a broad range of technologies including robotics, communications, science instruments, spacecraft systems and components. Designated as a national laboratory by Congress, ISS resources are being utilized for non-NASA focused research by other government agencies, academia and private enterprises. The directorate will facilitate opportunities for NASA funded and non-NASA funded research and technology development through direct access to the International Space Station. The scope of participation will include development with NASA's international partners, academia and the commercial sector.