

**National Space Transportation Policy
Coordinated Technology Plan**

**Department of Defense
Department of Commerce
Department of Transportation
National Aeronautics and Space Administration**

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Introduction

This document was prepared in response to the National Space Transportation Policy direction to the Secretaries of Defense, Commerce, and Transportation and the Administrator of the National Aeronautics and Space Administration (NASA) to provide a report that will include a common set of requirements and a coordinated technology plan that addresses the needs of the national security, civilian, and commercial space launch sectors. This plan documents current launch technology efforts, plans for future initiatives, and the overarching philosophy that links these interagency activities into an integrated national technology program.

The United States must ensure the pursuit of launch technologies that will lead to more modern space transportation systems with significantly lower costs, improved infrastructure, enhanced operability, greater system reliability, and environmental compatibility. A sustained and coordinated effort is essential to this technology development. Government investment in this research and development is critical. The Government agencies involved recognize the importance of joining forces for the benefit of the Nation's military, civilian, and commercial space transportation needs.

Requirements

A key element of national space policy stresses the need to develop and maintain assured access to space for United States national security, civilian, and commercial needs. To meet national security needs, the Department of Defense (DoD) requires low-cost, responsive, and flexible access to space, with a capability to augment available space assets during a crisis. Human operations in space may also have the potential to satisfy national security requirements.

Reliable and affordable delivery of humans and cargo to and from space is a continuing requirement for NASA's science and technology missions.

Historically, systems developed to satisfy DoD and NASA launch requirements provided the basis for commercial launch services. In an increasingly competitive world market, this approach is not acceptable if the United States is to have a viable commercial launch industry. Commercial space launch needs must be an integral part of this activity.

National Space Launch Architecture

Product improvements must continue for current space transportation systems to improve reliability, safety, operability, and to reduce costs. However, existing systems can benefit only to a limited extent from the latest technologies. Prudent investments must be made in the current launch fleet and infrastructure, until replacements are available.

Future space transportation requirements emphasize the attributes of reliability and cost effectiveness, with additional emphasis on operability.

Development of critical technologies and preliminary design work for Reusable Launch Vehicles (RLV's) to complement and subsequently replace the Space Shuttle are under way. RLV's have the potential capability to support military global reach/global access needs with on-demand launch. Significantly lower operating costs, combined with increased safety and reliability, are critical attributes for RLVs.

Technology Programs

Without making the necessary investments in technology today, there cannot be improved or new vehicles available in the next century. The highest priority should be placed on maturing the critical technologies required for both evolved expendable launch vehicles (ELV's) and a new reusable launch vehicle system.

At the technology discipline level, propulsion traditionally requires a substantial share of any technology investment effort, regardless of the specific launch vehicle concept. The DoD, NASA, and the commercial launch industry have also concurrently identified propulsion as a serious area of deficiency within the current technology base. Since propulsion systems typically account for a significant share of the acquisition and operations cost of every space transportation system, key technology initiatives are necessary to realize the propulsion system attributes critical to meeting the requirements of any evolved ELV or RLV development effort.

Similarly, critical vehicle-related (nonpropulsion) technologies have also been identified. Based on their inherent potential to provide significant improvements in overall vehicle system performance, operability, and reliability at lower costs, specific technology development efforts in structures, materials and manufacturing, operations and processing, avionics, aerothermodynamics and recovery, and systems analysis and design have been selected as merited by the focused goals of this plan.

Targeted space launch technology activities will support the following:

- Low cost propulsion systems for ELV's and RLV's,
- Highly reliable, readily maintainable, and cost effective reusable propulsion systems,
- Development of lightweight, high strength, high temperature materials,
- Low cost manufacturing and inspection techniques,
- Highly fault-tolerant avionics incorporating a high degree of adaptive on-board guidance, navigation, and control,
- Incorporation of system health monitoring and management and automation of ground processing and flight operations, and

- Significantly improved operations simulation capability designed to streamline mission planning and allow for rapid reconfiguration of missions.

Finally, the goals cited within this plan cannot be truly realized unless far reaching technology investments are made within our space launch operations infrastructure. Technologies for modernizing and developing new launch ranges and facilities are as important as the propulsion and vehicle-related technologies themselves in providing the kind of space access capabilities the United States seeks to attain. A new operational philosophy, incorporating innovative launch processing concepts (modular facilities and universal clean-pad design approaches), augmented by automation, health monitoring, and artificial intelligence, are critical toward any significant improvement in the operability and reliability of space launch activities, while at the same time realizing reduced overall costs.

Implementation

The involved agencies recognize the need for investment in specific propulsion, structures, materials, and manufacturing, operations and processing, avionics, aerothermodynamics and recovery, and systems analysis and design technologies. This plan sets forth the following technology investment priorities:

- Complete the critical technology investments embodied in the current ELV and RLV programs.
- Develop focused technologies that will enable cost effective launch systems.
- Continue to make investments in technology suitable for evolving the existing launch fleet.
- Increase the number of new concept testbeds and flight test demonstrations when needed.
- Increase the funding of nonpropulsion technologies, as future program options are implemented, especially in areas not sufficiently covered by the current focused programs.

Funding specifically allocated for technology development must coexist with the need to begin large systems development programs to evolve the current launch fleet and to introduce new launch systems. By definition, the technology effort must not only have the necessary level of funding, but must also be focused and accountable. Implementation of this plan, therefore, requires the cooperative assimilation of space technology resources and capabilities of both Government agencies and aerospace industry to meet the Nation's needs for a coordinated, cost effective space launch technology development effort.

To ensure a coordinated implementation process, it is anticipated that an oversight function will be provided by a coordination organization whose charter is to ensure a focused, orchestrated critical technology development effort within the framework of the intended goals of this Plan. Several coordination organizations already exist to focus both DoD and NASA technology development activities and, as such, there exists several viable options by which implementation oversight of this technology plan may be baselined.

The implementation strategy is to—

- Enhance our technology base to pursue the national strategy goals,
- Target funding to critical propulsion and nonpropulsion technology areas,
- Monitor funding distribution among technology disciplines,
- → Evaluate potential technology payoffs against desired system attributes, and
- Correct allocations where necessary.

Throughout the various joint interagency programs, Government/industry Independent Research and Development programs, and joint committees, there exists a high degree of information exchange at the technology working level. These exchanges will be exploited to avoid duplication of effort in the various space launch technology efforts, as well as to promote coordination planning activities that are instrumental in building successful cooperative relationships.

The Future

U.S. Government agencies will continue to pursue vigorous space transportation technology programs. Because of the ever-changing state of technology within and outside the United States (e.g., the hardware and technology currently available through the former Soviet Union), continued national-level attention and oversight are required. This will ensure that the Nation's space launch architecture and road maps for space transportation systems are current and properly focused. Future revisions of this plan will be accomplished through normal interagency processes to ensure a coordinated effort among all concerned entities.