Technology Roadmaps for Space Exploration (09)
Advancing Propulsion Technologies (4)

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TECHNOLOGY AREA ROADMAP FOR IN-SPACE PROPULSION TECHNOLOGIES

Abstract

During the summer of 2010, NASA's Office of Chief Technologist assembled fifteen civil service teams to support the creation of a NASA integrated technology roadmap. The "Aero-Space Technology Area Roadmap" (A-STAR) is an integrated set of technology area roadmaps, recommending the overall technology investment strategy and prioritization for NASA's technology programs. This paper describes the content and recommendations from TA02, In-Space Propulsion Systems Technology Area Roadmap.

With the exception of electric propulsion systems used for commercial communications satellite station-keeping and a handful of deep space science missions, all of the rocket engines in use today are chemical rockets; that is, they obtain the energy needed to generate thrust by combining reactive chemicals to create a hot gas that is expanded to produce thrust. A significant limitation of chemical propulsion is that it has a relatively low specific impulse (thrust per unit of mass flow rate of propellant). Numerous concepts for advanced propulsion technologies with significantly higher values of specific impulse have been developed over the past 50 years.

Advanced In-Space Propulsion technologies will enable much more effective exploration of our Solar System, near and far, and will permit mission designers to plan missions to "fly anytime, anywhere, and complete a host of science objectives at the destinations" with greater reliability and safety. With a wide range of possible missions and candidate propulsion technologies with very diverse characteristics, the question of which technologies are 'best' for future missions is a difficult one. A portfolio of technologies to allow optimum propulsion solutions for a diverse set of missions and destinations are described in the roadmap.

In-Space Propulsion is a category of technology where developments can benefit a number of critical Figures of Merit (metrics) for space exploration. Space exploration is about getting somewhere safely (mission enabling), getting there quickly (reduced transit times), getting a lot of mass there (increased payload mass), and getting there cheaply (lower cost).

Development of technologies within this roadmap will result in technical solutions with improvements in thrust levels, Isp, power, specific mass (or specific power), volume, system mass, system complexity, operational complexity, commonality with other spacecraft systems, manufacturability, durability, and of course, cost. These types of improvements will yield decreased transit times, increased payload mass,

safer spacecraft, and decreased costs. In some instances, development of technologies within this TA will result in mission enabling breakthroughs that will revolutionize space exploration.