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Ice & Fire: Advanced Technologies Enable Lower Cost Missions to the Outer Solar System and Beyond

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Abstract

Missions to the outer Solar System are typically driven by factors which tend to increase cost, such as long life, high radiation exposure, high AV requirements, difficult telecommunications links, low solar illumination at the destination, and demanding science measurements. Advanced technology is a central part of responding to such challenges in a manner which permits the cost of development and operations to be an order of magnitude less than for prior outer planet missions. Managing the process of technology planning and advanced development versus the associated cost and mission risk is a formidable challenge. In meeting this challenge, outer Solar System mission development has been combined for a Europa Orbiter, Pluto Express, and Solar Probe (flying via Jupiter). In spite of the differing destinations and science objectives, these missions can be served by largely common avionics and software, which drive the largest portion of mission development costs, and they can be served by a shared operations approach.

Development activities are leveraging the latest products coming through the technology pipeline from industry, government labs, and academia. These products include software, low-power integrated microelectronics, low-mass, high-efficiency radioisotope power (in the event it is required), and telecommunications.

This paper summarizes the Europa/Pluto/Solar Probe mission set, the "X2000" flight and ground system development serving these missions and beyond, and the current technology development plan, which is tightly coupled to the New Millennium Program (NMP) Deep *Space 1* technology validation flight. Specific detail will be presented about advanced microelectronics technology. This technology will also be shown in the context of an on-going technology roadmap that extends beyond the Pluto Express mission. Other details focus on new technologies available for low-cost mission operations and the processes required to best develop and utilize these technologies. The development goal is to create an integrated flight and ground system with the functional simplicity necessary to achieve high reliability, operability, and a low total mission cost. The development process leverages the JPL Flight System Testbed and commercial off-the-shelf (COTS) products. A university partnership provides additional development support and is leading to a partnership for operations. Software technologies for spacecraft self-commanding and self-monitoring play a key role in meeting an operations vision called Deacon Monitoring. This approach is expected to decrease operations cost significantly by reducing the amount of routine interaction with the spacecraft. international cooperation is expected to be an element of some of these missions. The experience gathered may be valuable to Earth orbiting missions, the Mars Exploration Program, and Mission to Planet Earth.