JPL spacecraft incorporates a general-purpose "Safe Mode" response algorithm that configures the spacecraft in a lower-power state that is safe and predictable, thereby facilitating diagnosis of more complex faults by a team of human experts on Earth.

This work was done by Paula Morgan of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42900.

⚙ Algorithm Optimally Allocates Actuation of a Spacecraft

A report presents an algorithm that solves the following problem: Allocate the force and/or torque to be exerted by each thruster and reaction-wheel assembly on a spacecraft for best performance, defined as minimizing the error between (1) the total force and torque commanded by the spacecraft control system and (2) the total of forces and torques actually exerted by all the thrusters and reaction wheels. The algorithm incorporates the matrix·vector relationship between (1) the total applied force and torque and (2) the individual actuator force and torque values. It takes account of such constraints as lower and upper limits on the force or torque that can be applied by a given actuator. The algorithm divides the aforementioned problem into two optimization problems that it solves sequentially. These problems are of a type, known in the art as semi-definite programming problems, that involve linear matrix inequalities. The algorithm incorporates, as subalgorithms, prior algorithms that solve such optimization problems very efficiently. The algorithm

affords the additional advantage that the solution requires the minimum rate of consumption of fuel for the given best performance.

This work was done by Behçet Açikmeşe and Shui Motaghedi of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42301.

◎ Radar Interferometer for Topographic Mapping of Glaciers and Ice Sheets

A report discusses Ka-band (35-GHz) radar for mapping the surface topography of glaciers and ice sheets at high spatial resolution and high vertical accuracy, independent of cloud cover, with a swath-width of 70 km. The system is a single-pass, single-platform interferometric synthetic aperture radar (InSAR) with an 8-mm wavelength, which minimizes snow penetration while remaining relatively impervious to atmospheric attenuation.

As exhibited by the lower frequency SRTM (Shuttle Radar Topography Mission) AirSAR and GeoSAR systems, an InSAR measures topography using two antennas separated by a baseline in the cross-track direction, to view the same region on the ground. The interferometric combination of data received allows the system to resolve the path-length difference from the illuminated area to the antennas to a fraction of a wavelength. From the interferometric phase, the height of the target area can be estimated. This means an InSAR system is capable of providing not only the position of each image point in along-track and slant range as with a traditional SAR but also the height of that point through interferometry.

Although the evolution of InSAR to a millimeter-wave center frequency maximizes the interferometric accuracy from a given baseline length, the high frequency also creates a fundamental problem of swath coverage versus signal-to-noise ratio. While the length of SAR antennas is typically fixed by mass and stowage or deployment constraints, the width is constrained by the desired illuminated swath width. As the across-track beam width which sets the swath size is proportional to the wavelength, a fixed swath size equates to a smaller antenna as the frequency is increased. This loss of antenna size reduces the two-way antenna gain to the second power, drastically reducing the signal-to-noise ratio of the SAR system. This fundamental constraint of high-frequency SAR systems is addressed by applying digital beam-forming (DBF) techniques to synthesize multiple simultaneous receive beams in elevation while maintaining a broad transmit illumination. Through this technique, a high antenna gain on receive is preserved, thereby reducing the required transmit power and thus enabling high-frequency SARs and high-precision InSAR from a single spacecraft.

The Ka-band digital beam-forming interferometric mapper will provide critical data on the mass changes of the Earth's ice cover and contribute data to improved estimates of ice sheet contribution to sea-level rise, as outlined in the Climate Variability and Change road map. The comprehensive measurements will come from the swath, temporal sampling capability, variable resolution, and accuracies unique to this system.

This work was done by Delwyn K. Moller, Gregory A. Sadowy, Eric J. Rignot, and Soren N. Madsen of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-43962