National Aeronautics and Space Administration

NASAfacts

Space Technology
Game Changing Development
High Performance Spaceflight Computing

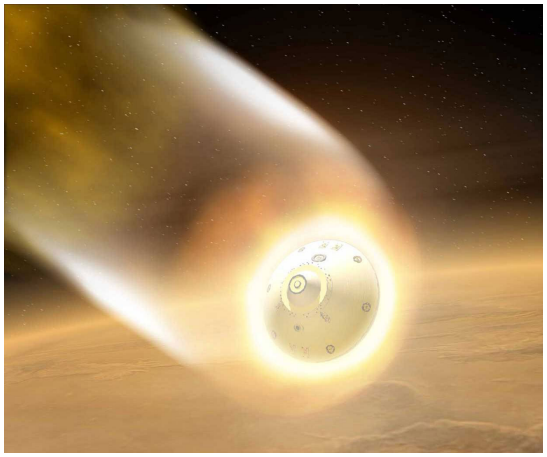
Reinventing the Role of Computing in Space

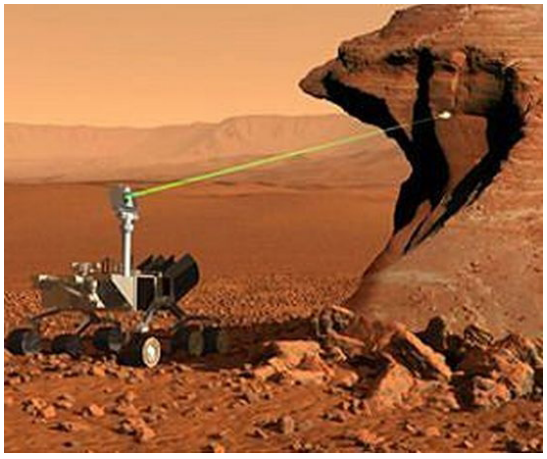
Spaceflight computing is a key resource in NASA space missions and a core determining factor of spacecraft, end-to-end system, and mission capability.

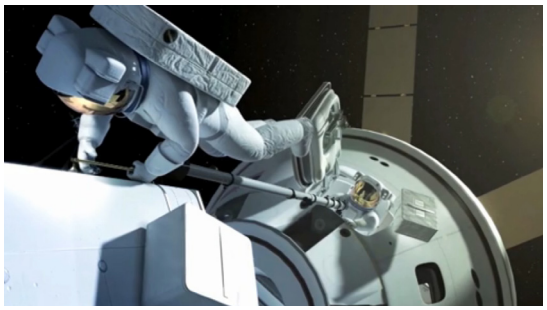
Onboard computing can be viewed as a "technology multiplier" in that any advance provides for direct improvements in flight functions and capabilities across the NASA mission classes and enables new flight-based capabilities and mission scenarios, increasing science and exploration return.

However, space-qualified computing technology has not advanced significantly in over 15 years, and the current state-of-the-practice fails to meet the near- to midterm needs of NASA missions.

Recognizing this gap, NASA Space Technology's Game Changing Development Program commissioned a study on space-based computing needs for the next 10-20 years. To identify cases for future flight computing needs, NASA held a series of workshops with mission designers, scientists and engineers from NASA's Johnson Space Center, Goddard Space Flight Center and Jet Propulsion Laboratory. Both robotic and human spaceflight mission applications were examined.







Future NASA human spaceflight and robotic science missions will require more powerful space-based computing for autonomony, high-data-rate instruments, and human-robotic interactions.

The workshops identified the range and types of future NASA mission flight applications through the 2030 timeframe. A total of 19 generic applications were identified that required significantly higher performance computing than currently available with current or planned space-qualified computers.

The study concluded with a recommendation to pursue an investment for a next-generation flight computer for future NASA missions.

Rad-hard general-purpose multicore was identified as the most promising architecture for a future NASA flight computer for the following reasons:

- Rad-hard general-purpose multicore has the best overall fit to application requirements—provides both general purpose and some digital signal processing capability as well as interoperability with specialized coprocessors.
- Rad-hard general-purpose multicore is conducive to power scaling at the level of individual cores or processors, and the power dissipation issues to address appeared to fit within the available investment resource envelope.
- Rad-hard general-purpose multicore is conducive to thread-based fault tolerance—the ability to segregate failed cores from the pool of available cores in support of graceful degradation.

These architectural features together will allow for unprecedented flexibility in flight computing: choosing the operating point dynamically, trading among performance, energy management and fault tolerance needs as the mission unfolds and science, engineering and exploration objectives evolve.

A series of discussions with the Air Force Research Lab (AFRL) at Kirtland revealed similar interests and objectives concerning future flight computing capability. As part of the decision meeting in December 2012 to proceed with High Performance Spaceflight Computing implementation, AFRL and NASA entered into partnership and issued a joint Broad Agency Announcement in April 2013 to solicit, under a study phase, architectural designs for a rad-hard general-purpose multicore flight computer with the following features:

- 100X performance of the RAD750
- <7W power budget, scalable
- Support for a range of fault tolerance methods
- Interoperable with coprocessors

It has been more than 15 years since the previous investment at NASA in a flight computer. A next-generation flight computing capability will be a necessary and timely ingredient for future mission success. Partnered with AFRL, we are taking steps toward realizing that investment.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit
http://gameon.nasa.gov/

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