Algorithm-Based Fault Tolerance for Numerical Subroutines

A software library implements a new methodology of detecting faults in numerical subroutines, thus enabling application programs that contain the subroutines to recover transparently from single-event upsets. The software library in question is fault-detecting middleware that is wrapped around the numerical subroutines, conventional serial versions (based on Lapack and FFTW) and a parallel version (based on ScalAPACK) exist. The source code of the application program that contains the numerical subroutines is not modified, and the middleware is transparent to the user.

The methodology used is a type of algorithm-based fault tolerance (ABFT). In ABFT, a checksum is computed before a computation and compared with the checksum of the computational result; an error is declared if the difference between the checksums exceeds some threshold. Novel normalization methods are used in the checksum comparison to ensure correct fault detections independent of algorithm inputs. In tests of this software reported in the peer-reviewed literature, this library was shown to enable detection of 99.9 percent of significant faults while generating no false alarms.

This program was written by Virgil Adumitroae, Hook Hua, William Lincoln, Gary Block, Joseph Mrozinski, Kacie Shelton, Charles Wesblin, Alberto Eljes, and Jeffrey Smith of Caltech for NASA’s Jet Propulsion Laboratory. This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-43771.

Distributed Operations Planning

Maestro software provides a secure and distributed mission planning system for long-term missions in general, and the Mars Exploration Rover Mission (MER) specifically. Maestro, the successor to the Science Activity Planner, has a heavy emphasis on portability and distributed operations, and requires no data replication or expensive hardware, instead relying on a set of services functioning on JPL institutional servers.

Maestro works on most current computers with network connections, including laptops. When browsing down-link data from a spacecraft, Maestro functions similarly to being on a Web browser. After authenticating the user, it connects to a database server to query an index of data products. It then contacts a Web server to download and display the actual data products. The software also includes collaboration support based upon a highly reliable messaging system. Modifications made to targets in one instance are quickly and securely transmitted to other instances of Maestro.

The back end that has been developed for Maestro could benefit many future missions by reducing the cost of centralized operations system architecture.

This program was written by Jason Fox, Jeffrey Norris, Mark Powell, Kenneth Rabe, and Khauvoa Shams of Caltech for NASA’s Jet Propulsion Laboratory. This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-4378.