Engineers building first space supercomputer

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HAL may soon be getting some company. But unlike the famous computer companion in Stanley Kubrick's "2001: A Space Odyssey," the first space-based supercomputer — so described because it will be by far the most powerful computer in space — is already nearing reality.

Engineering researchers at the University of Florida and Honeywell Aerospace are designing and building the computer projected to operate as much as 100 times faster than any computer in space today. Expected to be launched aboard a NASA rocket on a test mission in 2009, the computer is needed to process rapidly increasing amounts of data gathered by advanced scientific satellites. It is also needed to help space probes make more rapid decisions by themselves, independently of their Earth-bound minders.

"To explore space and to support Earth and space science, there is a great need for much more processing power in space," said Alan George, a professor of electrical and computer engineering and UF's principal investigator on the project.

Computers have become far more powerful and faster in recent decades, but these advances have been largely confined to Earth. That's because all computers sent into space must be "hardened" or protected against cosmic radiation prevalent outside the Earth's atmosphere, a process that slows their performance and increases their size and cost. The result is that even as satellites and space probes have become far better at gathering information, most of their data not has to be sent to ground stations on Earth for processing.

“Usually the downlinks have very limited bandwidth. There are only so many bits per second you can send down from a satellite,” said John Samson, the principal investigator for the project at project at Honeywell’s Clearwater facility. “That means scientists are very limited in how much science they can do.”

Today’s unmanned space probes also have restricted abilities to act independently, relying instead on relaying much of their command information back and forth from Earth. Because of the huge distances in space, that makes it impossible for mission controllers on Earth to respond in real time to short-lived or unexpected events. If probes had more sophisticated computers on board, they could make more of their own decisions, such as quickly selecting the best sensor or camera to record a momentary event of interest.

“To be autonomous is to require a lot of computation, and until now, conventional space processing technologies have been incapable of high-performance computing,” George said.

The UF-Honeywell computer aims to upgrade both satellites and probes with a novel design called the Dependable Multiprocessor. Funded by NASA’s New Millennium Program and the Florida High Technology Corridor Council, the goal is to cope with radiation from solar flares or other space events not through the physical hardening of components – but rather through software that allows the computer to survive radiation-caused flaws or errors.

As George put it, “when you know components are going to fail, you can design the system to automatically adapt and thereby mitigate the effects of that failure.”

A microwave-sized box full of circuit boards in a UF electrical and computer engineering laboratory has been ground zero for the project.

There, George and his team of graduate students develop and evaluate concepts and elements of the system. As per the project's requirements, they feature off-the-shelf components with no deliberate radiation hardening. Their methods involve strategies such as making the computer fault-tolerant, or able to make an instant switch from a temporarily failing board to a functioning one. They also use algorithm-based techniques to detect and correct processing errors. "If one board is failing because of radiation, we can automatically go to another," George said.

Samson said Honeywell is applying UF's basic research to build a high-performance computer capable of actually flying in space. Even with the radiation problem solved, that's a huge challenge because the system must be small, lightweight, capable of surviving the vibration of launch and the shock of the delivery vehicle separating from the booster rocket –and operate on relatively little precious electricity, among other challenges. "Space is a pretty tough operational environment," Samson said.

If plans go as intended, the completed computer is expected to fly aboard the unmanned ST8 rocket mission on a test mission in February 2009.

Source: University of Florida