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AIAA
Shaping the Future of Aerospace

Computing advances push manufacturing, design, deep learning

BY RICK KWAN

The **Computer Systems Technical Committee** works on advancing the application of computing to aerospace programs.

If leadership in advanced design and manufacturing are predicated on high-performance computing, then China is clearly laying the groundwork; it continued to have the two fastest machines. Sunway TaihuLight led the Top500 supercomputer list published in June with a Linpack performance of 93.0 petaflops; the machine is built from 40,960 ShenWei SW26010 multicore computing chips. This was followed by China's Tianhe-2 (Milky Way-2) at 33.9 petaflops, which had been the fastest until June 2016. The third place position goes to Switzerland's Piz Daint, a Cray XC50 at 9.8 petaflops. It was previously held by Titan, a Cray XK7 at Oak Ridge National Laboratory in Tennessee. However, Oak Ridge has begun installation of pre-exascale Summit, a system comprised of IBM Power9 central processing units and NVIDIA Volta graphics process units. It is expected to reach peak performance above 200 petaflops and be available to scientific users in January 2019.

The NVIDIA Volta was announced in May and adds Tensor cores for artificial intelligence and deep learning to NVIDIA's CUDA cores for 3-D graphics and physics simulation. This provides new tools for applications like hazardous asteroid discovery, searching for life on exoplanets, autonomous air taxis and simply enabling image and speech recognition in computer-aided design systems.

The **International Space Station acquired its own supercomputer** in August when a SpaceX Dragon capsule delivered a pair of standard Linux-based HP Enterprise Apollo 40 machines as part of NASA's Spaceborne Computer experiment. The machines will provide over a teraflop of computing, an order of magnitude more than was previously available to the ISS. During high-radiation events, power and speed will be reduced to see if the machines continue to operate correctly, without housing them in bulky protective shielding. The machines use Haswell/Broadwell-class general purpose processors.

For its High Performance Spaceflight Computing effort, NASA issued a $26.6 million contract to Boeing in March to produce prototype chiplet devices. The chiplets will have eight general purpose ARM Cortex-A53 cores in a dual quad-core configuration and exploit radiation-hard by design techniques. They will support both real-time operating systems and Unix/Linux-based multiprocessing. They are intended for future deep space robotic missions, high redundancy on human missions and high bandwidth sensor data processing for U.S. Air Force missions.

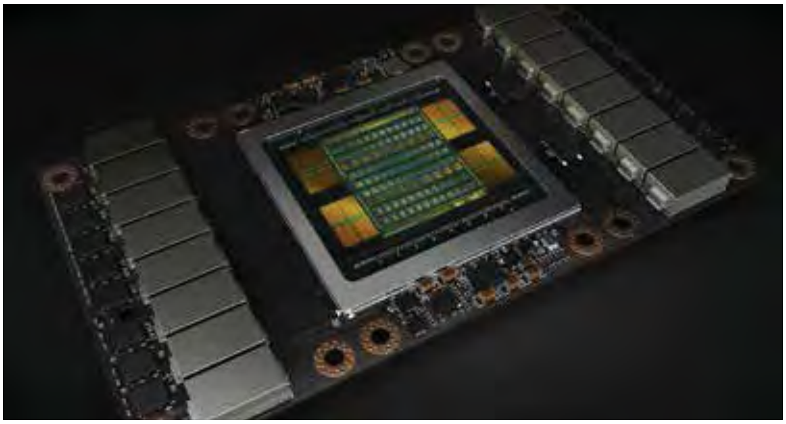
In August, BAE Systems announced availability of its RAD5545 single board computer, which replaces multiple cards used in earlier spacecraft and improves computational throughput, storage and bandwidth. This is intended to enable mission needs such as encryption, multiple operating systems, ultra-high resolution image processing and more. The **RAD5545 SBC provides a 10-times performance increase** over the company's RAD750 SBC, which is found anywhere from Earth orbit to the surface of Mars. It is built using the ANSI/VITA 78.00 SpaceVPX form factor, a flexible, scalable and interoperable standard for high performance space electronics modules.

Early space processor designs have been showing remarkable resilience. The Cassini spacecraft, which plunged into the Saturnian atmosphere in September, carried seven GVSC MIL-STD-1750A computers, designed around 1990 using technology developed in the Department of Defense's Very High Speed Integrated Circuit program a decade earlier. Each processor was capable of 3 million instructions per second. The Cassini spacecraft was launched 20 years ago.

Voyager 1 and 2, launched 40 years ago, have begun exploring interstellar space. They each have three kinds of computers with a total of 32,000 words (16 or 18 bits per word) per computer, running about 8,000 instructions per second. The spacecraft are still alive but on reduced power diets. The radioisotope thermoelectric generators feeding them have a half-life of 88 years. At their distances, they are transmitting 160 bits per second to the Deep Space Network. ★

Contributors: *Joe Marshall, Stan Posey*

▼**NVIDIA** unveiled the Tesla V100 with Volta GV100 GPU in May.



NVIDIA