Military Systems Get SMART

SKY Computers®, a subsidiary of Analogic Corporation, has been providing defense contractors and integrators with high-performance embedded computers for their mission-critical applications for nearly a quarter century. SKY's multiprocessing technology lies at the heart of many advanced military and defense systems, including surfaceship multi-function radars and target-acquisition systems, undersea warfare systems, airborne surveillance/reconnaissance systems, ground-based radars and more.

An early adopter of the COTS (Commercial Off The Shelf) philosophy for embedded servers, SKY leverages industry-standard computing hardware, software, development tools and interconnects to help reduce a defense customer's development, deployment and maintenance time, cost and risk. The latest offerings from SKY are based on the SMART Systems Architecture, a highly modular blade-server computing platform with unprecedented flexibility.

Many developers of defense systems have found that their applications naturally decompose into a front end for data acquisition and a back end for processing and analysis. The first members of the SMART Systems Architecture family, the SMARTpac™ 600 data acquisition server and the SMARTpac 1200 compute server, readily support this application partitioning.

SKY supplies the embedded compute systems for this Vetronics radar.

Creeping Complexity

With the relentless growth in performance and functional density of integrated circuits over the past few years, all types of computers are showing extraordinary advances in capabilities. In the defense arena in particular, the great leap forward in MIPS and GFLOPS is being accompanied by an explosion of data. Large volumes of sensor-based data for demanding applications are now generated at Megabit-to-Gigabit rates, which creates system complexity and stress. The high-performance embedded servers needed to process and analyze all that data typically contain 10's to 100's of processing elements.

Flexibility is Key

The critical factor for embedded servers in military applications today is flexibility, in addition to the traditional military system requirements of reliability, supportability, maintainability and affordability.

Flexibility enables a server platform to readily scale up to satisfy the needs of complex systems with extreme performance requirements, as well as to easily adapt in configuration for the particular application at hand. A truly flexible architecture must also elegantly scale up in bandwidth to make good use of that performance. Meeting these goals requires a highly capable switched-serial fabric interconnect.

The SMART Solution

SKY Computer's SMART Systems Architecture is based on the InfiniBand™ fabric, which was originally developed for the enterprise computing arena. Well thought out and well executed, it is being championed in the embedded computing community by such companies as SKY Computers, Mellanox Technologies and SBS Technologies. InfiniBand excels in delivering the ultimate scalability, throughput and robustness for the most demanding applications, and it is extremely well suited to distributing streams of incoming sensor data among large arrays of processors.

With InfiniBand's inherent scalability, upgrading a system in the field to satisfy evolving needs can be done at the blade or box level, rather

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than requiring the "forklift" upgrade of systems that have run out of steam. Whereas previous generations of embedded servers have had to rely on multiple interconnects, InfiniBand enables all the traffic to be consolidated into a single interconnect, thus solving what has been a serious systems management nightmare.

Military Configurability

With InfiniBand as its fabric interconnect, the SMART Systems Architecture scales all the way from a single blade server with between six and twenty-four processing elements to a whole rack of these servers with hundreds of processors and, indeed, even to very large multi-rack system implementations. The high-performance architecture readily adapts to a broad range of configurations from a simple daisy chain of blade servers to a complex full-mesh topology or any of the variations between.

Complex applications such as Synthetic Aperture Radar (SAR) readily map onto the SMART Systems Architecture. Here, multi-dimensional data is captured and routed through a number of distinct processing stages. That data – representing range, azimuth and possibly time (Doppler) – is quite highly correlated, which means that individual samples are dependent on many neighboring samples. CPUs, thus, share their data to quite a high degree, and a mesh is frequently the most efficient configuration.

Also, as the SAR data moves from one type of processing to the next, corner-turns are needed to maintain efficient memory access. The distributed corner-turn (mathematically a matrix transpose) requires a data array to be split into small strips so that each strip can be sent to its designated destination. Hence, a lot of relatively small transfers all occur at about the same time, placing very high loading on an interconnect fabric. This factor makes a mesh highly suitable also.

An airborne platform hosting a foliage penetrating SAR system by SKY.

SMARTpac Systems Architecture also readily adapt to many other defense-related applications such as Software Defined Radio (SDR), as well as shallow-water mine detectors in Navtronics, foliage-penetrating radars in Avionics and targeting radars in Vetronics.

A major defense contractor recently selected the SMARTpac 600 for a U.S. Navy tactical program that supports a weather analysis and forecasting system targeted for future deployment on surface ships. This system was based on a previous program, which supported a ground-based SKY-supported system installed at the National Weather Radar Testbed in Norman, Oklahoma (co-funded by the U.S. Navy).

A surface-ship Navtronics weather forecasting and analysis system uses SKY systems.

Getting the Job Done

SKY Computers has a quarter-century history of solving problems in mission-critical real-time applications by working closely with defense customers. SKY's signal processing experts are skilled at mapping algorithmic requirements onto high-performance multiprocessing architectures, as well as tailoring configurations to suit the application. Today and tomorrow, carefully tuned algorithms running on a scalable, flexible embedded server platform provide the ultimate in system performance.

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