Throughput Computing Emerges as a Key Data Center Strategy

New Workloads Drive Innovative Processor Architecture

Moore's Law states that transistor densities—and therefore processor speeds—double every two years, while memory speeds double every six years. This disparity is why ever-faster processor clock speeds fail to translate into correspondingly faster system performance. Today's gigahertz processors spend as much as 75 percent of the time waiting for memory to obtain required data. Such large latencies, or memory delays, result in inefficiency and wasted time rather than in useful work. It's like driving a Porsche through the teeming streets of Calcutta. Throughput Computing addresses the need to cope with this widening gap between processor core speeds and memory interfaces.

At the same time, network computing fundamentally changed the nature of data center workloads. With constant, pervasive use of the Internet today, network-based applications such as online transaction processing, videoconferencing, decision support, enterprise resource planning and Web services make up the bulk of thread-rich data center workloads. These applications depend less on the execution of a single thread (a set of software instructions that executes independently) than on overall throughput.

Chip Multithreading Enables Huge Increases in Application Throughput

Sun found a way to radically reduce the cost and complexity of network computing while simultaneously increasing the throughput of real-world applications and workloads. Throughput Computing increases aggregate work done by a processor executing multiple threads simultaneously in a highly thread-rich computing environment.

Throughput Computing is made possible by Sun's chip multithreading (CMT) technology, by which a microprocessor concurrently executes several threads. To work successfully, a CMT processor must be combined with a hardware platform that can supply the necessary memory capacity—as provided by 64-bit addressing capability—and an operating system like Solaris that can efficiently handle and schedule a heavily threaded environment. The results are orders of magnitude increases in application throughput or aggregate useful work done by the processor.

How CMT Works

Sun is designing new UltraSPARC® processors specifically to maximize throughput for network computing workloads. These processors support multithreading at the chip level by processing multiple threads simultaneously. A CMT processor could implement its multithreaded capability by having multiple cores on a single chip, executing multiple threads on a single core, or combining both.

Through this threading model, Sun tackles latency, or memory delay, in a very positive way. When one thread waits for memory to deliver data, the processor switches to another thread ready to run, and so on for several threads. The processor then switches back to the first thread when that thread receives its data and is ready to execute. The cycle then begins all over again.

Using CMT, a single processor can process tens of threads simultaneously, considerably increasing the amount of data processed in a given amount of time.

Sun's First-Generation CMT Processor

When it hits the market in the first half of 2004, Sun's first CMT processor family, the UltraSPARC IV, will potentially double the throughput of Sun's high-end and midrange systems. The UltraSPARC IV is a dual-threaded processor consisting of two UltraSPARC III cores on a single silicon die. Built with 130 nanometer (nm) process technology, the processor will operate at an initial frequency of 1.2 GHz, moving higher over time in later family members.

Depending on customers' application workloads, performance improvements will range from 1.6 to 2.0 times the throughput of today's 1.2 GHz UltraSPARC III processor. Future UltraSPARC IV processors, to be built with 90-nm technology, will offer throughput that's three to four times faster than today's UltraSPARC III processors. The UltraSPARC IV maintains Sun's tradition of binary compatibility, preserving customer investments in development tools and application software.

Enabled by 90-nm process technology, Sun will roll out a more radical CMT design that will first appear in Sun's blade platform in 2006. This second-generation CMT processor will increase the throughput of today's UltraSPARC IIIi systems by up to 15 times by running tens of threads simultaneously. Still later, Sun's third generation CMT processors will provide as much as a 30-fold throughput improvement over the current 1.2 GHz UltraSPARC III.

Sun Uniquely Positioned to Deliver CMT

Where SMP (symmetric multiprocessing) delivers Throughput Computing at the system level, CMT does so at the processor level, providing a quantum reduction in the cost of network computing. Because many Sun customers already use multithreaded SMP-based systems, they will not have to change their software model. Throughput Computing is highly applicable to their software-installed base, and no recompiling or reprogramming is necessary. The Solaris Operating System (supporting threads since 1992) and Java technology are already designed to support multithreading.

Since a large amount of memory is needed to support this computational capacity and to scale with the power of the CPU, 64-bit addressability by the processor is required, as opposed to limited address space imposed by 32-bit addressing.

Most important, an operating system is needed that can efficiently handle and schedule such a heavily threaded environment. Neither Windows nor Linux has this capability. Solaris is considered to have the best threading model among commercial operating systems today. Using the UltraSPARC IV processor, Solaris can run more than 200 simultaneous threads on an SMP system.

Benefits of Throughput Computing

Its innovative CMT processors give Sun a price/performance advantage by significantly increasing throughput performance without increasing chip costs. Since CPU costs are normally based on volume and die size, CMT chip costs will be comparable to those of traditional processors.

Sun's UltraSPARC processors will offer customers a compelling value proposition: very high levels of service at very low cost of acquisition and operation. Among their landmark business benefits are:

- Increased chip utilization, dramatically boosting application performance by factors of 10.
- More efficient systems, lowering TCO through reduced space, power and maintenance requirements.
- Higher-throughput systems to manage, increasing system reliability and availability.
- Applications run unchanged because CMT processors continue Sun's binary compatibility of the UltraSPARC and Solaris Operating System.

The next few years will see a revolution in application throughput made possible by Sun's CMT UltraSPARC processors running on the thread-friendly Solaris OS in low-end, midrange and high-end Sun servers. With this achievement, Sun will radically reduce the cost and complexity of network computing while simultaneously increasing application throughput—and significantly lower TCO.

For more information, go to sun.com/ultrasparc/throughput. ■