Challenges for large-scale database tier infrastructures

Over the last decade, commercial activities such as classified advertising, recruitment, and shopping have started migrating from the physical world to the Web. Along with this movement comes the requirement to handle millions of users accessing billions of pieces of information in real time. Any downtime or delay could result in companies losing substantial amounts of revenue or ceding market share to a competitor with better infrastructure.

To satisfy these demands, companies host their business data and processes on massive databases with highly efficient online transaction processing systems. These systems enable activities such as credit checks, order processing, scheduling, inventory updates, online catalogs, and delivery routing. At the same time, they need to support real-time querying in order to get a snapshot of business conditions or to identify subsets of customers that meet certain defined criteria.

The OLTP system needs to be responsive and consistent even during periods of peak usage. In addition, it needs to scale easily and be optimized in every aspect—from throughput to memory latency—to provide the best possible customer experience.

Because of the vast amount of data that needs to be supported, large memory capacity on the OLTP host system is critical. High availability and serviceability are also key requirements, especially the ability to bring failing components offline without bringing the service down.

Finally, fast I/O access is needed to optimize data storage throughput, especially in the case of Web applications where responsiveness is measured in fractions of a second.

A better infrastructure for Web 2.0

In the face of these challenges, Sun’s database-tier offerings help you gain high compute density in a smaller footprint, with lower power and administrative overhead to streamline your database infrastructure. Through consolidation and optimization, you can benefit from:

- Greater throughput in less space
- Up to 60 percent fewer systems required
- As little as 1/4 the power consumption of competitive systems
- Greater security for the OLTP application infrastructure
- Secure consolidation of multiple database servers on a single system
- Reduced acquisition, licensing, and management costs with fewer systems and the use of automated tools
Sun's offering for the database tier includes a complete portfolio of hardware and software solutions, timesaving developer tools, and professional services designed to enhance datacenter efficiency. Sun's hardware offerings include both state-of-the-art rack servers and density-efficient blade servers:

- **Sun SPARC® Enterprise T5120 and T5220 servers**—based on the new UltraSPARC® T2 processor with up to 64 active execution threads and integrated dual 10 Gigabit Ethernet technology—provide a highly scalable platform for database-tier consolidation and offer blistering network performance.

- **Sun Fire™ T1000 and T2000 servers** (also called Sun SPARC Enterprise T1000 and T2000 servers) based on the UltraSPARC T1 processor, the world’s first eco-responsible servers, are the perfect fit for environments that demand the highest levels of price/performance.

- **Sun Blade™ modular systems**, including the Sun Blade T6320 server module based on the UltraSPARC T2 processor, are specifically designed for large server deployments. They’re able to maximize the energy and space efficiency offered by the Sun Blade 6000 chassis, with no compromise to performance. Other benefits of the Sun Blade architecture include faster installation and provisioning with improved serviceability, cabling, and systems management.

Sun servers and blades powered by the UltraSPARC T2 “system on a chip” processor come integrated with no-cost, open virtualization technologies, providing the ability to quickly consolidate multiple database services. With up to 8 cores and 64 threads per system, they provide the flexibility and power of 64 virtual systems in a single server. These systems can help you realize dramatic space savings, huge reductions in electricity costs, and simplified server administration—all while delivering much faster processing for each consolidated server.

**World-record performance**

The Sun SPARC Enterprise T5120 server running the Solaris™ 10 OS and Oracle 10g Database Server set a world record for performance and efficiency on the database tier of the SpecjAppserver2004 2-node benchmark. It outperformed all other competitive servers including systems based on the latest IBM Power 5+, Intel Xeon, and Intel Itanium 2 processors. In addition, the Sun SPARC Enterprise T5120 server delivered the highest overall performance per watt and the best per-socket performance in OLTP database serving.

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<table>
<thead>
<tr>
<th>Database Tier, SPECjAppServer2004 2-Node Comparison Table</th>
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<tbody>
<tr>
<td><strong>Space (RU)</strong></td>
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<tr>
<td>Sun SPARC Enterprise T5120</td>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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1 SPECjAppServer2004 Sun SPARC Enterprise T5220 (8 cores, 1 chip) and Sun SPARC Enterprise T5120 (8 cores, 1 chip) 2000.92 JOPS@Standard. SPECjAppServer2004 IBM p550 (4 cores, 2 chips) and IBM p5+550 (4 cores, 2 chips) 1,197.51 JOPS@Standard. SPECjAppServer2004 2 x Dell 2900 (4 cores, 2 chips) 652.95 JOPS@Standard. SPECjAppServer2004 2 x HP rx2660 (4 cores, 2 chips) 618.38 JOPS@Standard. IBM p5 power specifications calculated by applying 70% of the power numbers published in “Facts and Features Report”, 3/10/06, posted at http://www-03.ibm.com/servers/eserver/pseries/hardware/factsfeatures.html. All results from www.spec.org as of 10/10/07. Further details as well as calculations for performance per watt ratings are available at sun.com/servers/coolthreads/t5120/benchmarks.jsp?display=4#4.
These results confirm the Sun SPARC Enterprise T5120 server as the highest performing and most efficient platform available for deployment of secure application and OLTP database services.

In another benchmark, a Sun Fire T2000 server running Oracle Database 10g delivered 733.22 Java Operations Per Second (JOPS) when tested under the SPECjAppServer2004 benchmark. The database tier of the benchmark is representative of a high-concurrency OLTP database. These results show the highest performance of any single processor database server, along with the best performance per watt and leading database price/performance in its class. The comparison was against HP Itanium 2 and IBM System p5-based systems.

Compared to competitive servers, the Sun Fire T2000 server required 1/8 the number of database licenses and 1/8 the licensing cost, while consuming 1/13 the power and delivering eight times higher performance per watt.

### Improve performance and flexibility with the Solaris 10 OS.

Solaris 10 is the industry’s most innovative operating system, offering no-cost, open source licensing coupled with the enterprise-level support demanded by mission-critical enterprise environments. Future versions of the Solaris OS will be based on technology from the OpenSolaris™ project, a community-based open source initiative.

The strong industry reputation for reliability and scalability of the Solaris OS is based on many years of engineering investment from Sun. Solaris has been scaling to 64 threads since the introduction of the 64-way Sun Enterprise® 10000 server more than a decade ago. The Solaris OS is optimized to take advantage of the Chip Multithreading (CMT) capabilities of the UltraSPARC T2 processor, enabling database server instances to deliver excellent throughput.

Performance gains over competitive operating systems are also made possible through innovative features in the Solaris OS, such as enhanced multithreaded networking and drivers and DTrace for performance analysis.

### A highly reliable, integrated infrastructure

In addition to scalability and performance, the Solaris 10 OS also offers industry-leading reliability. Sun’s comprehensive Fault Management Architecture means that elements such as Solaris Predictive Self-Healing can communicate directly with the server hardware to help reduce downtime.

The server hardware itself offers greatly reduced part counts, providing commensurately higher levels of availability and serviceability. Many components of Sun CoolThreads servers are hot pluggable and field replaceable so that component failures can be corrected without downtime. In addition, lower power consumption greatly reduces generated heat loads and the associated issues they can cause.

### Comparison Table

<table>
<thead>
<tr>
<th></th>
<th>Sun Fire T2000</th>
<th>HP rx 8620</th>
<th>HP rx 4640</th>
<th>IBM p5+ 505</th>
</tr>
</thead>
<tbody>
<tr>
<td># of SPECjApp JOPS Supported</td>
<td>733.22</td>
<td>1266.42</td>
<td>618.22</td>
<td>404.88</td>
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<tr>
<td>Database Software</td>
<td>Oracle Database 10g</td>
<td>Oracle Database 10g</td>
<td>Oracle Database 10g</td>
<td>IBM DB2 V8.2</td>
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<tr>
<td># of Processors for Database</td>
<td>1 x UltraSPARC T1 Processor @ 1.2 GHz</td>
<td>16 x Itanium II Processors @ 1.6 GHz</td>
<td>4 x Itanium II Processors @ 1.6 GHz</td>
<td>2 x Dual Core Power 5 Processor @ 2.1 GHz</td>
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<tr>
<td># of Application Server Nodes</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># of Database Nodes</td>
<td>1</td>
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<tr>
<td>Size of Database Node</td>
<td>2RU</td>
<td>17RU</td>
<td>4RU</td>
<td>4RU</td>
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<tr>
<td>Power Consumption of Database Node (watts)</td>
<td>310</td>
<td>4103</td>
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<tr>
<td>Performance per Watt (Higher is Better)</td>
<td>2.37</td>
<td>0.31</td>
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<tr>
<td>Number of Database Licenses</td>
<td>2</td>
<td>16</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Database License Cost</td>
<td>$80,000</td>
<td>$640,000</td>
<td>$160,000</td>
<td>$145,600</td>
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<tr>
<td>Database Price/Performance</td>
<td>$105.11</td>
<td>$505.36</td>
<td>$258.81</td>
<td>$359.61</td>
</tr>
</tbody>
</table>

2 SPECjAppServer2004: 1 Sun Fire T2000’s (8 cores, 1 chip) and 1 Sun Fire T2000 (8 cores, 1 chip) 733.22 SPECjAppServer2004 JOPS@Standard. 1 HP rx6600 (8 cores, 4 chips) and HP rx8620 (16 cores, 16 chips) 1266.42 JOPS@Standard. 1 HP rx3600 (4 cores, 2 chip) and 1 HP rx4640 (4 cores, 4 chips) 618.22 JOPS@Standard. 1 IBM p5 560 (2 cores, 1chip) and 1 p5 550 (4 cores, 2chips) 404.881 JOPS@Standard.
The combination of the highly reliable Solaris 10 OS and the availability features built into Sun CoolThreads servers can be further extended by using Sun Cluster software to deploy redundant database servers. When deployed in a cluster configuration along with Sun Cluster software, the database servers can provide automatic failover in case of a critical fault.

The Solaris™ ZFS file system can also be used with OLTP applications to offer high reliability through built-in features such as copy-on-write and end-to-end checksumming. Solaris ZFS is based on the concept of a virtual storage pool that decouples the file system from physical storage in the same way that virtual memory abstracts the address space from physical memory, allowing for much more efficient use of storage devices. In terms of scalability, Solaris ZFS is a 128-bit file system. Its theoretical limits are truly mind-boggling—2^128 bytes of storage, and 2^64 for everything else such as file systems, snapshots, directory entries, and devices.

Secure isolation with Logical Domains technology
Sun’s Logical Domains (LDoms) technology comes standard on Sun systems based on the UltraSPARC T1 and T2 processors, allowing you to deploy one of the industry’s most open virtualization solutions with no additional licensing costs. LDoms let you consolidate your database tier by dividing Sun CoolThreads servers into multiple logical servers so you can securely isolate database server instances. You can replace your older, less efficient hardware servers and simply move the OS, data, and applications to a domain within a Sun CoolThreads server. Each logical server’s OS, data, and applications are partitioned to run independently of each other while sharing the processing and storage resources of the Sun CoolThreads server. You can even run multiple operating systems simultaneously, combining multiple UNIX® and Linux servers onto a single Sun CoolThreads server.

Cool Tools for easy adoption
No matter how compelling new hardware or OS platforms may be, organizations must be assured that the costs and risks of adoption are in line with the rewards. In particular, IT departments want to continue to leverage the considerable advantages of popular commercial and open source software. Developers want to use familiar compilers and basic development tools. And administrators can’t afford to spend extra time getting applications to run effectively in a new environment.

Sun Cool Tools are designed specifically to enable you to seamlessly optimize your database-tier environment and quickly deploy applications that take advantage of the high performance of multiple threads with CoolThreads technology. Cool Tools can help you with porting or performance optimization through the all stages of the development lifecycle.

A key element of the Cool Tools offering, Cool Stack provides an optimized open source software stack for the Solaris OS. Cool Stack has been preconfigured to deliver the most popular applications working seamlessly out of the box. It includes the 32-bit MySQL package, which has been configured with client-side (PHP) support. For the database server, the 64-bit binary is available and recommended because it allows the use of larger caches to improve performance. Most applications in Cool Stack have been recompiled to deliver a 30 percent to 200 percent performance improvement over standard binaries compiled with the GNU Compiler Collection (GCC). DTrace probes have also been added for enhanced observability.
Sun’s three-step approach to greening the datacenter

Sun has gone beyond providing hardware and software solutions for database-tier efficiency and has created the Sun Eco Innovation Initiative, which defines a clear and actionable approach that can guide you through the steps that will lead you to greater energy efficiency in your database tier. The program includes online information about Sun’s approach that you can use to help save time and reduce risk. You can also take advantage of Sun Services offerings, based on a proven, straightforward process with three simple steps:

• **Assess** – Let Sun help measure the current efficiency and environmental impact of your database tier and recommend ways to optimize space, power, and cooling for better efficiency.

• **Optimize** – Sun can help you optimize your existing Web servers and upgrade your infrastructure with Sun’s Eco products to realize improved performance, space, power, and cooling efficiencies while delivering greater throughput.

• **Virtualize** – Sun Services experts can help you get the most out of our virtualization solutions, help increase system utilization and ROI, and overcome your power and space limitations.

**CoolThreads technology in action**

Sun’s server solutions are helping many organizations around the world improve the efficiency and scalability of their database-tier infrastructure.

PTK Centertel is the first mobile phone operator to have started business in Poland, and it currently supports more than 7 million customers. The company runs its Oracle database, Web server, mail server, and Weblogic application server all on a Sun SPARC Enterprise T5220 server based on the UltraSPARC T2 processor. Radoslaw Korzeniewski, the IT manager overseeing the installation, found that the performance scaled linearly with the available 64 threads, resulting in over twice the throughput and much better performance than the company’s previous x86-based rack and blade servers. He particularly noticed the ease of installation and reliability, factors that were instrumental in the decision to deploy more Sun SPARC Enterprise servers to keep pace with his company’s expanding customer base.

Ebay, the world’s largest online marketplace, has also benefited from Sun CoolThreads servers in its database infrastructure. On a typical day, more than 100 million items are listed on its website, in tens of thousands of categories. Recent listings have included a tunnel boring machine from the Chunnel project, a cup of water that once belonged to Elvis, and the Volkswagen that Pope Benedict XVI owned before he moved up to the Popemobile. The items available range from the massive to the mundane.

Using the Sun Fire T2000 “Niagara” server and upgrading to the Solaris 10 operating system for its database servers has enabled EBay to deliver a 20 percent performance gain across the board. Just as importantly, the IT staff has instant visibility into the performance of its applications with Solaris’ DTrace capability. “Niagaras run much cooler than our previous servers, plus they are scary fast,” says Heather Peck, Infrastructure Manager at EBay. “They have cut our total cost of operations through lower acquisition and management costs. The Sun Fire T2000 is our database platform of choice in 2007.”

Another Web 2.0 company, DigiTar, is using Sun CoolThreads servers to deliver sophisticated Web services. DigiTar’s services enhance existing messaging systems with next-generation capabilities such as “DNA-based” spam filtering that uses deep contextual analysis to block spam with an unprecedented accuracy rate of 99+ percent.

In 2006, DigiTar COO and CTO Jason Williams decided on a risk-free trial run of the Sun Fire T2000 servers based on CoolThreads technology through Sun’s Try and Buy program. The primary test was the ability to run the MySQL database component of the company’s messaging services and comparing performance to DigiTar’s existing HP ProLiant DL345 G2 database servers. Eight HP servers in four paired clusters were consolidated into a single pair of Sun Fire T2000 servers.

DigiTar’s tests showed that the two Sun servers could deliver performance equal to 10-20 of the HP servers. The company estimates a 4.5X performance improvement per server, a doubling of its database processing capacity, and a 75 percent reduction in operating costs for its MySQL applications.

DigiTar is using the open source Solaris 10 operating system to run multiple instances of the MySQL database on the same server. In addition, the Solaris ZFS file system in Solaris 10 automates and simplifies database storage administration, drastically reducing the administration time required for tasks such as identifying and fixing database corruption. “We improved performance so much and reduced costs in so many ways with the [Sun Fire] T2000 that it represents a 10X improvement in price-performance for our entire architecture,” says Williams.
Get started now with a risk-free trial

Take the first step toward a more efficient database tier now. You can try world’s first eco-responsible servers, the Sun Fire T1000 and T2000 servers or Sun SPARC Enterprise T5120 and T5220 servers—risk-free for 60 days and then buy at 25-45% off. Visit sun.com/tryandbuy/ to apply for your free trial system.

You can also download and run trial versions of Oracle Database 10g and 11g, along with MySQL and PostgreSQL, as part of the Try and Buy program. See sun.com/tryandbuy/specialoffers.jsp for more details.