

THE CLIPPER GROUP Navigator™



Published Since 1993

Report #TCG2013006

April 19, 2013

Resetting the Server Bar — Oracle Claims Database Performance Superiority

Analyst: David Reine

Management Summary

With the possible exception of Avis, nobody likes to claim to be #2. Whether you are in the rental car business or any other, being #1 is the goal, and every competitor vies for that position. This is especially true in sports, where only one team can win the final game of the season. Who remembers who came in second? No one cares. We currently find ourselves in the middle of the season for professional basketball. In the NBA, the Boston Celtics were #1 for the decade of the 1960s, winning nine out of ten titles. Who was #2? In the 1990s, the Chicago Bulls were the team of the decade, winning six championships. Who was #2? Organizations in the second slot are constantly trying to improve their performance in order to capture the top ranking, and the attention and respect of their competitors and the public at large. When they achieve that goal, everyone sits up and takes notice. The same thing can be said for those seeking the lion's share of the enterprise data center business.

The enterprise data center *always* is trying to improve the performance, security, and reliability of its mission-critical applications. The staff *always* is trying to improve the networking, in order to accelerate the response time for critical business workloads. They *always* are seeking to improve the scalability of each platform, in order to provide additional headroom while protecting the investments made in current platforms. In addition, as *always* is the case, the enterprise data center is trying to lower the total cost of ownership (TCO) of its IT infrastructure. This can be accomplished with the consolidation of mission- and business-critical applications and virtualization, in order to improve application density and reduce the size of the infrastructure. Consolidation and virtualization usually will enable the data center to reduce the administrative workload and lower the maintenance budget. An eternal question on the minds of enterprise data center staff is: **Who can provide the best solution for my data center?**

When it comes to critical business workloads, many data centers prefer the trusted behavior of applications running in a UNIX environment with, really, only three companies providing a viable solution – HP with its *Integrity* family, IBM with its *Power Systems*, and Oracle with its *SPARC*-based servers. Until now, the unquestioned leader for transactional performance was IBM with *Power Systems*. Until now! **With the announcement of Oracle's *SPARC T5* family of servers, Oracle has staked a solid claim for not only performance leadership for these high-end requirements, but also price/performance leadership as well.** Based upon an industry-standard transactional benchmark, Oracle finally has proven the veracity of their claims to performance superiority. To learn more about Oracle's *SPARC T5* family, please read on.

Critical Application Needs for the Data Center

In many instances, the success of any enterprise may depend upon the performance and continuous availability of IT services. Mainframe-

IN THIS ISSUE

➤ Critical Applications Needs for the Data Center	1
➤ Oracle SPARC High-Performance Processors.....	3
➤ Oracle T5 Servers.....	4
➤ Oracle M5 Server.....	6
➤ SPARC Integrated Operating Environment	6
➤ Conclusion.....	6

The Clipper Group, Inc. - Technology Acquisition Consultants ♦ Internet Publisher

One Forest Green Road ♦ Rye, New Hampshire 03870 ♦ U.S.A. ♦ 781-235-0085 ♦ 781-235-5454 FAX

Visit Clipper at clipper.com ♦ Send comments to editor@clipper.com

class reliability, security, and serviceability are essential throughout the enterprise, not just in the data center. A wide variety of binary-compatible servers, with the same overall features, are beneficial in supporting the data center, departments, and remote offices. **While reliability, performance, and security are important, the CFO of every enterprise will insist that the total cost of ownership (TCO) may be the gating factor.** With this in mind, your CIO probably is looking at more than just the compute capacity of the processor. He, or she, is seeking highly flexible servers with built-in virtualization and the ancillary tools to optimize the utilization of the infrastructure.

What are the critical needs for the mission-critical data center? Obviously, there are many! A breakdown in any one of them can cause irreparable harm to the enterprise. I will not attempt to rank them, as every data center will have its own unique priorities specific to its enterprise mission statement. However, they can be identified!!

- **Scalability** is one of the primary concerns. No enterprise wants to acquire a platform that does not have expandability to meet its needs, both today and tomorrow. The enterprise also needs to ensure that the architecture being deployed will survive and thrive. A look back can give the CIO a good vision as to what lies ahead. Scalability comes in many dimensions – processor, memory, and I/O to name a few.
- **Processor scalability** perhaps is most significant. Does the platform being considered have enough processor sockets, somewhere between four and eight, to handle more VMs and larger applications? A high processor count often provides increased compute density, which encourages consolidation while minimizing the required floor space. The ability to do everything faster and to make better decisions is critical in gaining immediate insight into both internal operations and customer needs, possibly via social media, or getting the latest financial or inventory data. What do “C” level executives prefer – getting their reports in days, hours, or perhaps, minutes? Processor scalability enhances the enterprise’s ability to make dynamic decisions on a minute-by-minute basis and, of course, is mandatory to achieve extreme performance.
- **Memory scalability** is another critical capability. Does the platform have enough memory capacity to support the number of virtual machines (VMs) that will be required to consolidate and virtualize anticipated applications, thus, reducing the number of servers needed? In many cases, existing servers are running at less than 50% utilization, often due to restrictions in the number of VMs allowed, thus wasting energy, space and administrative time.
- **Storage scalability** is important. In 2013, this includes not only the spinning media where the data center retains the majority of its online data, but also solid state devices (SSDs) that provide the fastest response time available. Mission-critical applications require a platform that can support both, with the capability for dynamic deployment of additional devices.
- **I/O scalability** is next on the list. I/O scalability can be measured by the ability of a server to add more I/O controllers. This will provide the bandwidth required by mission-critical applications. I/O expandability, in general, is required for all applications, but even more so for I/O-intensive applications. The efficiency of any multi-socket system can be destroyed by an inadequate I/O subsystem that forces high-performance processors to sit around and wait.
- **Administration** is another key need. What is involved in ordering, deploying, managing, and maintaining a network of these virtualized systems? Can all essential components be integrated before shipment, for ease-of-use when the new system arrives on-site? If this is not the case, the IT staff may be tied up for days (probably, weeks) putting together and testing a jigsaw puzzle of hardware and software.
- **Integrity of mission- and business-critical systems** is required, in a world that operates 7x24x365. In order to support this, these platforms must have the highest level of reliability, availability, and serviceability (RAS) available. This includes having sufficient redundancy deployed to provide business continuity, in the event of any critical component failure, which is inevitable for some mechanical components (power supplies, fans, etc.). Downtime is the bane of every data center IT staff.
- **Multiple threads** add to execution performance of data-intensive and mission-critical enterprise workloads. Multi-processor environments need to be optimized for multi-threaded application sets, while not losing sight of the need for extreme single-threaded performance, often required for compute-intensive environments.
- **Fitting within a constrained data center budget** rounds out the list. The IT staff cannot afford to make a mistake. They must ensure that the platforms that are installed today will do the job with increasing demands being placed upon them. The cost of every transaction within the data center will be measured and it must be as

low as possible.

Where can the IT staff look to find a platform with the features described above? In 2013, the answer may well be Oracle. With the latest announcement of their fifth generation of *Sun SPARC* servers, *SPARC T5*, Oracle has finally delivered a platform – an entire family of platforms – that backs up its claims. Before we look at the platforms, however, let's take an in depth view of the new processor inside these servers, the *SPARC T5*.

Oracle SPARC High-Performance Processors

Many IT executives do not care about what is inside their servers; it simply doesn't matter to them. For them, it is sufficient to understand that there is "Intel Inside" (or something sufficiently compatible). **For others, typically the information technologists among us, the infrastructure within their platforms is extremely important.** This infrastructure enables the IT staff with the knowledge they need to understand where to deploy their mission-critical applications, where to put their business-critical applications, and where to deploy their compute-intensive programs. **In order to get the best utilization of each server, the IT staff must assign the right application to the right server with the right architecture.**¹

Oracle SPARC T5 Processor

First, you need to understand the mission assigned to the Oracle engineering team – to improve upon *SPARC T4* in every way possible. This mission has been accomplished, satisfying the following goals.

- In addition to the improvements to *SPARC T4*, radically increase the throughput computational capabilities over that of Oracle's *SPARC64 VII+* processor for workloads that require this level of performance.
- Provide networking performance to serve network-intensive workloads.
- Provide end-to-end data center encryption with significantly higher performance, as well as adding new ciphers implemented within hardware.
- Increase service levels and reduce planned and unplanned downtime.
- Improve data center scalability while reducing cost.

The SPARC T5 processor design recognizes that memory latency truly is the bottleneck to improving performance. Oracle has redesigned the cores within each processor, designed a new floating-point pipeline, and further increased

network bandwidth.

The SPARC T5 processor is a highly integrated chip that has eliminated the need for expensive custom hardware and software development by integrating computing, security, and I/O onto a single chip. It has maintained binary compatibility with earlier *SPARC* processors, delivering more performance in less space with less energy consumption. It enables organizations to rapidly scale the delivery of new network services with maximum efficiency and predictability.

With a 28 nanometer design, *T5* is not just another shrink of the *SPARC T4* architecture (at 40nm). **T5 is Oracle's latest, highest-performing processor, designed to accelerate critical business workloads with outstanding scalability and capacity.** A single *T5* processor has 16 *S3* cores, with a dual issue 16-stage integer pipeline, and 11-cycle floating point pipeline², both giving improvements over the previous *S2* core, used in the *SPARC T3* processor. The *S3* was introduced with the *SPARC T4* processor. *T5* has twice the number of cores in the *T4*, and double the memory channels, with 8MB of cache. It runs at 3.6GHz, compared to 2.85-to-3.0GHz for the *T4*. *SPARC T5* comes with 16 memory slots per processor, supporting up to 128 DDR3-1066 memory DIMMs in a *T5-8*. It is a well-balanced general purpose microprocessor that scales from the simplest task to the most complex and demanding workloads. It contains innovative technology that is a result of the commitment and investments that Oracle has made to the products acquired in the purchase of Sun Microsystems three years ago. Oracle's stated goal was to be able to deploy the best possible platform to deploy anything within the Oracle software stack by increasing CPU performance, throughput, memory bandwidth, I/O bandwidth, and socket scalability. As a result, Oracle has developed a superior engine on which to deploy a wide range of scalable data center workloads – from *JAVA*, to computer-intensive integer applications, and to mission-critical enterprise applications, such as *OLTP* and *ERP*, where heavily-threaded workloads often are being assigned dynamically.

Each S3 core comes with 8 threads per core to support multi-threaded workloads. Oracle also has improved the instruction pipeline, to help improve the performance of single-threaded workloads. Each core is configured with 128KB of L2 cache and 16KB of both L1 instruction cache and

¹ If you "don't care", you might skip the rest of this section and go right to the *SPARC Servers* section on the next page.

² The 11 stages are just the "execute" part of FP processing; there are more stages involved.

data cache, the same as SPARC T4. Oracle has doubled the amount of shared L3 cache to 8MB, and increased the memory bandwidth by a factor of 2.5, to almost 80GBs, by increasing the number of memory controllers to four. Each core has a 16-stage integer pipeline in support of out-of-order execution. SPARC T5 also has on-die accelerators for encryption and random number generation, enabling the IT staff to deploy a secure environment from one end to the other. In addition, *Solaris* has been "Engineered Together" with SPARC hardware to integrate *Solaris* tightly with the T5 feature set, including high core and thread count and on-chip security, without interfering with the binary compatibility with all previous versions, from *SPARC T1* to SPARC T4. SPARC T5 has eliminated the requirement for an outboard chipset and additional circuitry. Oracle has replaced the I/O with PCI-Express 3.0 for the on-chip peripheral controllers. In addition, Oracle has developed a processor that can grow with near-linear scalability for up to eight sockets in most workloads, by moving to a directory-based protocol, eliminating unnecessary coherence chatter, and reducing memory latency. Oracle T5 has 1.2 times the single-thread performance of T4, and enables a two-times improvement in throughput, with plans to add on-chip accelerators for database activity to a future SPARC CPU. All of this contributes to the configurability and performance of Oracle SPARC T5 servers, from the *SPARC T5-1B* to the *T5-8*.

Oracle SPARC M5 Processor

The SPARC M5 uses the same S3 cores as the SPARC T5, thus sharing all of the features mentioned above, but is more powerful. However, unlike the T5 processor, the *SPARC M5* has six S3 cores per socket (ten less than the T5). The M5, however, shares an extra-large 48MB of L3 cache among the six cores, significantly higher than the 8MB of L3 cache shared by 16 T5 cores, for exceptional per-core performance and system throughput.

Oracle T5 Servers

Oracle has not only rolled out a family of servers based on SPARC T5, but also introduced a high-end platform for the largest enterprise workloads based upon the SPARC M5. Oracle claims that they have the fastest systems in the world, and that may well be true. By running a variety of workloads based upon industry-standard benchmarks, Oracle has been able to determine database performance over a variety of configurations, enabling them to assist clients in determining the right configuration for their environment. For example,

the Oracle T5-8 server has leaped to the top of the heap in transaction-processing benchmarking³, exceeding the previous leader, IBM and its *Power 780 System*, based on the *POWER7* processor. No IBM benchmarks for Systems with *POWER7+* installed have been published. *Is this important?* It is, if the ability to do everything faster, gaining insight into customer needs, is important. It is important if your CxO desires the ability to postpone reports until the last minute, enabling better decision making. This is especially true for the enterprise that relies upon the performance of *Oracle Database 11g* for their mission-critical workload requirements.

Furthermore, Oracle has publicly stated that they are continuing to invest heavily in SPARC processors and systems, announcing a roadmap into 2015, identifying a follow-on *M6*, with a goal to continue doubling application performance every year. They intend to do this by continuing to move software functionality into the silicon. Ultimately, they intend to put database and JAVA accelerators right on the SPARC processor.

All Oracle servers are designed from the ground up by Oracle engineering, from silicon to application, to run smoothly and efficiently with *Solaris 11* or *Solaris 10*. They are configured with full-function server management at no extra charge. This includes *Oracle Integrated Lights Out Manager (ILOM)*⁴ for both local and remote management, including power management, monitoring, fault detection, and notification.

Oracle SPARC T5-1B

The SPARC T5-1B is a single-socket SPARC T5 server running at 3.6GHz and supporting up to 256GB of DDR3 memory. Designed for the Sun Blade 6000 chassis for efficiency and high reliability, it takes advantage of the chassis' flexible, modular network infrastructure to be a data-intensive and enterprise workhorse that produces the highest levels of performance, reliability, and security.

With its high single-thread and multi-thread performance, along with improved throughput, the T5-1B is ideal for a wide range of enterprise data

³ See *TPC-C* ratings of the Transaction Performance Processing Council at http://www.tpc.org/tpcc/results/tpcc_perf_results.asp (as of 15-Apr-2013 12:28 PM [GMT]).

⁴ Oracle Integrated Lights Out Manager (ILOM) is the system management firmware used to monitor, manage, and configure a variety of Oracle server platforms. It provides advanced service processor hardware and software that you can use to manage and monitor your SPARC servers. ILOM's dedicated hardware and software is preinstalled on a variety of Oracle SPARC and x64-based servers. It is a vital management tool in the data center and can be used to integrate with other data center management tools already installed on your systems.

center workloads, from front-end Oracle applications to back-end database workloads, consolidation, and virtualization, including previous iterations of SPARC platforms. With 16 S3 cores, twice as many as the T4-1B plus a higher clock speed, the T5-1B provides significant performance gains for data centers that have deployed the T4-1B. In addition, the T5-1B can be configured with two hot-pluggable 2.5” drives, with an integrated 10GbE network connection and built-in PCI-Express expansion. Pricing for the SPARC T5-1B starts at \$25,862.

Oracle SPARC T5-2

The SPARC T5-2 server has been optimized for the small-to-mid-sized Web-tier workloads and database applications, along with an ideal environment for consolidation and virtualization, supporting up to 128 VMs. It is ideal for departmental business applications, such as billing, supply chain, engineering, and manufacturing. As with the SPARC T5-1B, the SPARC T5-2 server delivers 2.3 times the throughput of the T4-2, with 20% more single-threaded performance, and twice the I/O bandwidth.

It is deployed with two SPARC T5 processors, with a total of 32 S3 cores and 256 threads, delivered in a 3U configuration, with each core running at 3.6GHz; with up to 512GB of DDR3 memory, double the core count and memory of the SPARC T4-2. It has eight PCIe 3.0 slots and six bays to support 2.5” HDD or SSD drives. Four 10Gb Ethernet ports are built-in. The T5-2 also has multiple RAS features to ensure 7x24x365 availability (See Exhibit 1, at the top of the next column). Pricing for the T5-2 starts at \$53,948.

Oracle SPARC T5-4

The SPARC T5-4 has been combined with Solaris to optimize extreme performance on a highly scalable, secure, and integrated platform for large-scale application workloads and database applications. In addition the T5-4 is ideal as an enterprise-wide consolidation and virtualization vehicle, with the flexibility to support up to 128 VMs with a built-in (at no extra cost) *Oracle VM Server for SPARC* and *Oracle Solaris Zones*, formerly *Oracle Containers*. The SPARC T5-4 server delivers twice the throughput of the T4-4, with 20% more single-threaded performance, and twice the I/O bandwidth. As such, the SPARC T5-4 is ideal for such enterprise applications as *Oracle E-Business Suite*, *Oracle Siebel CRM*, and *Oracle PeopleSoft*, among others. In addition, the T5-4 may be used for middleware products such as *Oracle Weblogic Server*, *Oracle WebCenter Suite*, and *IBM WebSphere*, etc. Finally, the T5-4 can run multiple

Exhibit 1 – SPARC T5-2 RAS Features

- Two redundant, hot-swappable power supplies and fans;
- Hot-pluggable disk drives;
- Environmental monitoring;
- Extended ECC, error correction, and parity checking memory;
- Two integrated disk controllers with RAID 0, 1, and 1E;
- Electronic prognostics; and
- Fault management, including predictive self-healing from Solaris.

Source: Oracle

database products such as *Oracle Database 11g* and *IBM DB2*.

It is a four-socket platform, with 64 cores, running at 3.6 GHz with 16 memory slots per CPU for up to 2TB of DDR3 memory, all in a 5U chassis. It utilizes up to 128 threads per processor up to a maximum of 512 threads for a T5-4 system. The expansion bus has 16 low-profile PCIe 3.0 slots to accommodate hot-plug PCIe cards with a PCIe hot-plug carrier, and eight bays to support 2.5” HDD or SSD drives. It has four external USB 3.0 ports, along with additional internal ports for administration and management. Four 10Gb Ethernet ports are built-in. The T5-4 also has multiple RAS features to ensure 7x24x365 availability (See Exhibit 1 for additional features). Prices for the SPARC T5-4 start at \$147,992.

Oracle SPARC T5-8

SPARC T5-8 provides the largest data centers with an ideal platform for data-intensive and enterprise workloads that require the highest levels of performance, reliability, scalability, and security in its class. It can be used for the most demanding, I/O intensive applications and to consolidate and virtualize workloads for the expanding enterprise, with Oracle Solaris 11 and Oracle VM Server for SPARC included in the basic platform to enable the enterprise to extract maximum value from its IT assets.

The SPARC T5-8 has been designed with symmetric multiprocessing (SMP) scalability from one to 8 processors, with up to 128 cores, and up to 4TB of memory, for the enterprise data center in search of superior performance, outstanding I/O expandability, along with enterprise-level RAS features. The SPARC T5 processors in the T5-8 are directly attached to each other in a glueless, 1-hop configuration to lower latency and increase workload performance. It is configured to fit into an 8U rack space and has been optimized for data-intensive and enterprise workloads that require the highest levels of performance, scalability, and RAS

feature availability (as shown in Exhibit 1).

It has extensive I/O flexibility with 16 hot-plug, low-profile PCIe 3.0 slots and a choice of network connections. It also has four integrated 10Gb Ethernet ports for additional I/O bandwidth and is capable of supporting up to eight internal 2.5” HDDs or SSDs. The already-published transactional benchmark indicates that the SPARC T5-8 has the best price/performance ratio in its class at \$0.55 per transaction. As noted above, the T5-8 has industry leading performance for transactional workloads. Pricing for the Oracle SPARC T5-8 starts at \$268,314.

Oracle M5 Server

Oracle’s M5 server is a highly reliable, easy-to-manage, vertically scalable system with many of the benefits of traditional mainframes—without the associated cost or complexity. This server delivers a mainframe-class system architecture at open-systems prices. With SMP scalability to 32 processors, memory capacity up to 32 TB, and a high-throughput I/O architecture, the SPARC M5-32 easily satisfies the most demanding workloads. Furthermore, the M5-32 runs the powerful Oracle Solaris 10 and Oracle Solaris 11 operating systems that include leading virtualization technologies. By offering *Dynamic Domains*, Oracle VM Server for SPARC, and Oracle Solaris Zones technology⁵, this server brings sophisticated mainframe-class resource control to any enterprise environment.

As with the SPARC T5-8, the Oracle SPARC M5-32 is a world-class performer. With up to 32 processors, 192 cores, 1,536 threads, and up to 32TBs of memory and 32 SAS drives, the M5-32 is a performance powerhouse with class-leading performance in the two-tier SAP Sales and Distribution Standard Application benchmark. The M5-32 may be configured with up to 64x8 PCIe Generation 3 low-profile I/O controllers, and with up to 12 power supplies, and 18 fans to power and cool the environment.

SPARC Integrated Operating Environment

Oracle Solaris 11 is a proven and feature-rich enterprise operating system, providing the data center with continuing binary compatibility to enable the IT staff to migrate legacy Solaris applications to even more powerful platforms. With Oracle *VM Server for SPARC*, Solaris enables enterprises to extract the maximum possible value from IT resources, creating an infrastructure capable of adapting to today’s dynamically-changing enter-

prise requirements. Oracle *Solaris Zones*, previously known as *Solaris Containers*, isolate software applications and services, using flexible software-defined boundaries. Zones enable private execution environments within a single instance of Oracle Solaris 11. Each zone has its own identity that is distinct from the SPARC hardware and behaves independently, as if running on its own system, making consolidation simple, safe, and secure.

Oracle *Enterprise Manager* consolidates the enterprise-wide management of traditional and virtualized IT deployments, providing views into Oracle applications, middleware, database, Oracle Solaris, and virtualization technologies on Oracle servers, network and storage infrastructure. Enterprise Manager has been optimized with Oracle SPARC systems. Enterprise Manager monitors application network performance and identifies network bandwidth issues so system administrators can set network bandwidth priorities with Oracle Solaris 11 and restore network resources to critical applications.

Conclusion

Despite the claims of some that I.T. does not matter, the enterprise depends more than ever upon better technology as the differentiator between themselves and their competition. It depends even more on the vendor that can deliver that better technology. It certainly takes more than one iteration of a technology to be able to claim technological leadership in any area, let alone processor development. With this generation of SPARC innovation, SPARC T5 and M5, Oracle has been able to do just that, by taking a giant step toward processor superiority. Years of investment since acquiring Sun have proven Oracle’s intent relative to developing the hardware required to take their software stack to the top of the enterprise systems’ hierarchy.

By doubling application performance with each successive generation, Oracle has established that headroom still exists for their mission-critical technology. As discussed, it takes more than just a CPU to satisfy the total systems needs of the enterprise data center. With their unique combination of hardware, operating system, and application solutions, Oracle now is providing enterprises with the integrated systems required for success. If your data center is looking to grow, you need to revisit Oracle to see the giant strides it has taken on behalf of its customers.



⁵ Also available in with the Oracle T5 processor.

About The Clipper Group, Inc.

The Clipper Group, Inc., now in its twenty-first year, is an independent publishing and consulting firm specializing in acquisition decisions and strategic advice regarding complex, enterprise-class information technologies. Our team of industry professionals averages more than 25 years of real-world experience. A team of staff consultants augments our capabilities, with significant experience across a broad spectrum of applications and environments.

- ***The Clipper Group can be reached at 781-235-0085 and found on the web at www.clipper.com.***

About the Author

David Reine is a Senior Contributing Analyst for The Clipper Group. Mr. Reine specializes in enterprise servers, storage, and software, strategic business solutions, and trends in open systems architectures. In 2002, he joined The Clipper Group after three decades in server and storage product marketing and program management for Groupe Bull, Zenith Data Systems, and Honeywell Information Systems. Mr. Reine earned a Bachelor of Arts degree from Tufts University, and an MBA from Northeastern University.

- ***Reach David Reine via e-mail at dave.reine@clipper.com or at 781-235-0085 Ext. 123. (Please dial “123” when you hear the automated attendant.)***

Regarding Trademarks and Service Marks

The Clipper Group Navigator, The Clipper Group Explorer, The Clipper Group Observer, The Clipper Group Captain's Log, The Clipper Group Voyager, Clipper Notes, and “*clipper.com*” are trademarks of The Clipper Group, Inc., and the clipper ship drawings, “*Navigating Information Technology Horizons*”, and “*teraproductivity*” are service marks of The Clipper Group, Inc. The Clipper Group, Inc., reserves all rights regarding its trademarks and service marks. All other trademarks, etc., belong to their respective owners.

Disclosures

Officers and/or employees of The Clipper Group may own as individuals, directly or indirectly, shares in one or more companies discussed in this bulletin. Company policy prohibits any officer or employee from holding more than one percent of the outstanding shares of any company covered by The Clipper Group. The Clipper Group, Inc., has no such equity holdings.

After publication of a bulletin on *clipper.com*, The Clipper Group offers all vendors and users the opportunity to license its publications for a fee, since linking to Clipper's web pages, posting of Clipper documents on other's websites, and printing of hard-copy reprints is not allowed without payment of related fee(s). Less than half of our publications are licensed in this way. In addition, analysts regularly receive briefings from many vendors. Occasionally, Clipper analysts' travel and/or lodging expenses and/or conference fees have been subsidized by a vendor, in order to participate in briefings. The Clipper Group does not charge any professional fees to participate in these information-gathering events. In addition, some vendors sometime provide binders, USB drives containing presentations, and other conference-related paraphernalia to Clipper's analysts.

Regarding the Information in this Issue

The Clipper Group believes the information included in this report to be accurate. Data has been received from a variety of sources, which we believe to be reliable, including manufacturers, distributors, or users of the products discussed herein. The Clipper Group, Inc., cannot be held responsible for any consequential damages resulting from the application of information or opinions contained in this report.