New *Compaq AlphaServer* GS Series
Backgrounder

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COMPAQ NonStop™

The New *Compaq AlphaServer* GS Series:
The next generation of computing has arrived!

Preface
A History of Excellence, a Passion for Engineering

At certain times in history, the confluence of leadership companies—each with an outstanding technical heritage—creates an entity that is far greater than the sum of its parts.

Such is the case with Compaq Computer Corporation. A pioneer in the personal computer industry, Compaq is now the industry leader. Mergers with fault-tolerant leader Tandem Computers Incorporated, and 64-bit computing leader Digital Equipment Corporation have created an enterprise with unprecedented technical resources.

This combination brings an enormous capacity and capability to create competitive advantages for e-Business, enterprise and technical computing customers. The Compaq powerhouse is very good news for the marketplace.

Compaq is meeting the needs of the enterprise in the new Internet economy with available, scalable, secure and manageable *NonStop*™ e-Business solutions. Together with its partners, Compaq offers the world's most comprehensive—and complementary—set of computer hardware, systems software, application software and services for the creation of Internet-enabled solutions.

At the same time, Compaq continues to build upon its Tandem and Digital heritage with high-performance and supercomputing platforms for organizations pushing computing to its limits and beyond.

For both these markets, Compaq's newest server series will power revolutionary increases in availability and performance. The new *AlphaServer* GS Series is based on the new *Alpha* 21264 processor—the fastest on the planet—combined with advanced cross-bar switch and other systems technologies to set a new standard for application performance in a complete, proven 64-bit solution.

In the next few pages, we will take a closer look at how Compaq is turning its technological leadership in 64-bit computing into a true competitive advantage for its enterprise and high-performance customers.

The new *AlphaServer* GS Series systems are at the heart of the next generation of computing. With them, Compaq provides a significant business advantage to customers across a range of environments including e-commerce and the Internet, telecommunications, high performace technical computing and business intelligence/enterprise applications.

The *Alpha* Processor is Here to Stay

Compaq is totally committed to the *Alpha* processor. In fact, Compaq, in partnership with *Alpha* Processor Inc. (API), and Samsung Electronics Co. Ltd., is making a major technology contribution to expand *Alpha*'s opportunities in growing and emerging markets.

The three companies have signed a memorandum of understanding that will result in a US$500 million combined investment during 2000, to advance *Alpha* market opportunities and technologies. The investment commitment will further extend *Alpha*'s leadership in enterprise environments including a significant focus on *Compaq NonStop*™ e-Business solutions. It will also expand *Alpha* into new growth markets such as fixed-function servers, network appliances and Internet network infrastructure.

Compaq continues to build its worldwide Internet infrastructure leadership and *Alpha* technology is a strategic element in that effort. As the industry's most powerful 64-bit processor, *Alpha* is one of the essential technologies for e-Business and high-performance computing. With API and Samsung, we are jointly reinforcing our long-term commitment to *Alpha* and we are committed to expanding *Alpha* in target markets. And that expansion is made real with the introduction of the new *AlphaServer* GS Series systems.

Alpha 21264 EV67 Technical Attributes

Before discussing the new *AlphaServer* GS Series systems, let's take a quick look at the technical attributes of the heart of the system—the *Alpha* 21264 EV67 processor. Since their introduction in 1992, *Alpha* processors have been known for high performance. The *Alpha* processor is a full 64-bit processor, based on advanced RISC technology. Its combination of high clock speeds, excellent floating point performance, unprecedented memory bandwidth and the large memory support of 64-bit hardware and operating systems has made *Alpha* popular for running demanding applications. The newest generation of *Alpha*, the 21264, implements architectural enhancements that greatly improve on the already outstanding performance and contribute to the overall superiority of the new *AlphaServer* GS Series. Through "heroic parallelism" we deliver unprecedented performance to customers and their applications.

Instruction execution
The 21264 is a superscalar microprocessor with out-of-order and speculative execution. Out-of-order execution allows for faster execution because critical path computations are started and completed as soon as possible. Speculative execution entails fetching and executing instructions even though it is not immediately known whether the instruction will be on the final execution path. This is particularly useful, for instance, when the 21264 predicts branch directions and speculatively executes down the predicated path. This sophisticated branch prediction coupled with speculative and dynamic execution extracts the most instruction parallelism from applications. Branch prediction and speculative and dynamic execution are part of the hardware run-time environment. Applications take advantage of these capabilities without modification or re-compilation.

Memory
The memory system is another enabler of the high performance levels of the 21264. On-chip and off-chip caches provide for very low latency data access. In addition, many memory references can be serviced in parallel to all caches in the 21264 as well as to the off-chip memory system. This allows for very-high-bandwidth data access supporting many in-flight memory references and out-of-order operation. The 21264 also has a fast interface that allows the memory system surrounding the microprocessor to provide data quickly, typically from DRAM, upon a cache miss.

The 21264 memory core logic supports up to 32 in-flight loads, 32 in-flight stores, 8 in-flight (64-byte) cache block fills, and 8 cache victims. This allows a high degree of parallel memory system activity to the cache and system interface. It translates into high memory system performance, even with many cache misses. For example, Compaq has measured a one GB/s sustained memory bandwidth on the STREAMS benchmark.

Core logic chipset
While most of the attention is given to the processor, the core logic chipset plays a critical role in the capabilities and performance of a system. The core logic chipset connects the processor to the outside world. It includes the memory controller, the interface to I/O subsystems such as PCI, and connection to mundane but critical components such as keyboard and mouse. In short, the core logic chipset has the responsibility of feeding data to the processor. Because modern processors have a voracious appetite for data, the demands on the core logic chipset have gone from bandwidths of tens of MB/s to hundreds of MB/s, and now to the *Alpha* 21264 which requires GB/s of data.

The 21272 chipset is a high-performance core logic chipset designed to work with the *Alpha* 21264 processor. It provides high bandwidth—up to 2.6 GB/s on uniprocessor systems and 5.2 GB/s on multiprocessor systems. It supports memory buses up to 256 bits wide, multiple banks of memory, and provides two independent 64-bit PCI buses.

Software development and optimization
One of the benefits of the *Alpha* 21264 is that it will run software developed and compiled for previous generations of *Alpha* processors and run it faster than the previous processors. Substantial advances have also been made in compilers and software development tools. Many of these improvements help all *Alpha* processors and others are focused on the 21264.

Some of the enhancements are incorporated into the compilers and are exploited simply by recompiling an application. New work has been done on Profile Directed Compilation allowing information obtained from running a program to be fed back into the compilation process. And, finally, analysis tools are available that enable software engineers to understand the behavior of their software and make source code changes to improve performance.

Attributes of the New *AlphaServer* GS Series Systems

The new *AlphaServer* GS Series systems are at the heart of the next generation of computing. With them, Compaq provides a significant business advantage to customers across a range of environments including e-commerce and the Internet, telecommunications, high-performance technical computing and business intelligence and enterprise applications. Let's take a look at the features that contribute to the leadership qualities of the new *AlphaServer* GS Series systems.

High-performance low-latency switching infrastructure
The new *AlphaServer* GS Series systems use an extremely low-latency, high-performance non-blocking switching infrastructure designed to provide the high CPU-count advantages of NUMA (Non Uniform Memory Access) system architectures while providing the benefits associated with SMP (Symmetric Multi-Processing) systems architectures.

These systems deliver unmatched scalability and application performance without requiring any optimizations from the application developer. Indeed, applications will move over without recompilation from other *Compaq AlphaServer* systems, run without modification and scale effectively to take advantage of even the largest 32-way configurations.

The Global Switch in the larger *AlphaServer* GS Series systems is unique in the industry. It offers not only low latency and high bandwidth to support the most demanding applications, but maintains this low latency even under high load levels. This means that these systems can continue to provide exceptional interactive and batch performance even under the most demanding loads as well as those experienced through seasonal and irregular conditions.

System modularity
A second innovation is the modularity designed into the system. A customer can start with the smallest 8-way configuration and easily grow it to the largest 32-way configuration. Starting with the smallest *AlphaServer* GS Series system, most of the customer's investments in components such as CPUs, memory and I/O are preserved when they move to the larger 16- or 32-way systems. This growth is accomplished by the addition of cabinetry and system components and there is no disruption to application availability and performance while growing the system.

The modularity of the system allows customers to enter the product family at a surprisingly low price point (under $80,000), without having to pay for all of the inherent capacity and scalability of the system when it is originally acquired. This is unique to Compaq. High-end systems from other vendors require the customer to purchase the entire infrastructure "up front" whether used or not, and whether needed or not to meet the customer's current and projected performance requirements.

Quad Building Block (QBB)
The basic building block of the new GS Series of systems is the "Quad Building Block" or QBB, each of which supports four *Alpha* microprocessors, four memory boards supporting up to 32 GB of memory, and 8 PCI busses with 28 PCI slots. A high-performance switch is used to connect all of the system components, providing (individually) 1.6 GB/sec bandwidth between CPUs and memory or I/O and an aggregate bandwidth of over 6 GB/second within each building block.

System architecture
To create the new 8-way system, two QBBs are connected together, back to back, through a specialized high performance interconnect in a single cabinet. For larger systems, a second-level, high-performance, high-bandwidth, low-latency non-blocking switch is used. This switch connects up to four (16-way) or eight (32-way) QBBs creating larger systems with significantly more scalability and operational flexibility.

Reliability and availability
These systems have been designed for easy growth and easy replacement. CPUs and memory modules have been designed in small form factors with tracks with snap locks to facilitate very quick insertion or removal for maintenance or upgrades. They have also been designed to ensure "fool proof" connections into the QBB backplane without suffering issues of pin alignment or bending.

Many new high availability and reliability features have been designed in including: support for multiple redundant (and remote) consoles; hot-swap and hot-add of most system components; dual AC power sources; and extensive internal system monitoring and logging to ensure a worry-free computing environment. Error Correcting Code (ECC) memory is implemented through all of the data paths in the system, ensuring that single-bit errors never disrupt the application environment.

The Global Switch is designed to be ultra-reliable. Using conservative measurements, the predicted MTBF is around 10 to 15 years. This MTBF component has no measurable effect on either overall system reliability or availability. Other factors dominate these metrics. Should the switch experience a failure, the probability is 80% that it was transient in nature and a reboot is all that is necessary to recover the system.

With I/O multi-pathing and *Compaq StorageWorks* products like the RA8000 and ESA12000, customers can configure their storage subsystem or storage-area network (SAN) with no single point of failure. In addition, a fully redundant console subsystem with no single points of failure ensures that system failures will not be driven by failures "outside of the box."

Clustering
With clustering technologies, these new systems build on almost twenty years of experience and can handle loads that exceed that of a single system while at the same time providing very high availability, a common system view, better system utilization and easy systems administration. All applications and databases are available to all users from all systems.

As demand increases, customers can easily add systems and rebalance the client connections for optimal performance. Unique to Compaq, adding systems is virtually instantaneous (under 15 minutes) which means quick time to deployment for new resources. These additions are accomplished without requiring additional system management or operational staff (unlike other RISC/UNIX® systems) and without requiring redundant storage. These cost and resource savings are found only in *Compaq Tru64 UNIX* and *Compaq OpenVMS*. Automated load balancing with *Tru64 UNIX* and *OpenVMS* clusters is easy and seamless, thus ensuring optimal system resource utilization. Working in a solution with products like the *StorageWorks* Enterprise Backup Solution and Data Replication Manager, these systems illustrate Compaq's implementation of a SAN. These options make the new systems ideally suited to *Compaq NonStop*™ e-Business solutions and server consolidation applications.

"Lights Out" operations
The new *AlphaServer* GS Series has been specifically designed for a complete "lights out" operational environment. By "lights out" we mean that there is never any requirement for an operator to be physically present to manage and control the base system. This includes power off and power on, as well as all other system functions. Not only can cluster failover be completely and easily automated with *TruCluster* Server V5.0A or with *OpenVMS* clustering, but systems will "auto re-start" should there be a system failure. If the failure was due to a hardware component, the system will automatically bypass the failed component and return all applications to availability enabling systems management to diagnose and take appropriate actions for the failed components.

Dynamic partitioning
The new *AlphaServer* GS Series systems also support hardware partitioning and workload management with software partitioning. With either *Tru64 UNIX* or *OpenVMS* Galaxy software, fine-grained control of resource with dynamic partitions is available. Dynamic partitions enable system managers to make resource changes without affecting application availability. As we support hot-add and hot-swap of system components with the operating systems with minor releases through 2000, and early 2001, we will also be able to support completely dynamic hardware partitions so resource assignments can be changed without affecting application availability.

A system can be structured into as many as eight hardware partitions, each completely isolated from each other. An application, database, or operating system fault in one partition will have no effect on application performance or availability in other partitions. Not only can we run multiple instances of the same operating system, we can run different versions of the same operating system and even, uniquely, different operating systems in different partitions. This can be invaluable for customers engaged in server consolidation projects, or who have legacy applications that require older versions of operating systems, databases or applications. Partitions may also be used to support on-line maintenance and repair. If certain system components need attention, a new partition can be created for just those components. Then, while the system continues to run the applications, diagnosis and remedial actions can be taken without affecting application availability. These partitioning capabilities not only significantly reduce system management costs, but also further improve Compaq's advantage in Total Cost of Ownership.

System management
The new *AlphaServer* GS Series systems offer unprecedented flexibility for system management. Customers have the choice of deploying individual consoles for each system partition, using a single console for all system partitions within a single system, or using a single console for multiple systems. With local or remote console support, customers can manage systems distributed geographically from a single management center. Or they can establish a system management center to manage multiple systems in the same data center, the same building or office complex. The console subsystems have no single point of failure, so even the operational loss of a console connection does not affect systems operations. In the event of the loss of a master console itself, the remaining consoles "vote" to identify a new master console. The system itself is highly monitored, with the use of microprocessors throughout the entire physical environment. All physical activities in the system are reported both to the master console and to the console controlling a particular partition as well.

Multiple power sources
These systems support multiple power sources. The power is mixed together inside the system to run the entire environment. In the event of the failure of one of the power sources, virtually instantaneous failover to the remaining power source occurs, providing uninterrupted computing operations.

Customer Benefits

As we have seen, Compaq has engineered a technically innovative *Alpha* microprocessor—the EV67—and a new line of *AlphaServer* systems—the new GS Series. The EV67 is the fastest chip on the planet and the new *AlphaServer* GS Series servers are the most scalable and available servers on the market. The combination creates a computing environment unprecedented for its power, scalability and reliability.

The new *AlphaServer* GS Series systems will be at the heart of the next generation of infrastructures underpinning the next generation of e-Businesses. These e-Businesses require highly scalable and always available servers to deliver information quickly and securely across and beyond the enterprise. The new *AlphaServer* GS Series will be the core engine driving e-Business success. Both *Tru64 UNIX* and *OpenVMS* provide secure, evaluated environment solutions by securing the cluster, securing the department and securing Internet access. What's more, Compaq offers customers a full portfolio of end-to-end *NonStop*™ e-Business solutions to enhance their *AlphaServer* GS Series purchase including industry-leading storage, world-class services and best-in-breed partners.

The new *AlphaServer* GS Series will significantly benefit customers in the following areas:

E-Commerce/Internet
The new *AlphaServer* GS Series are

- The best e-Business application servers for Oracle® applications
- The best Web servers for high-volume, secure e-Business transactions
- The best Web servers acting as integration "eHubs" for building matrix systems to connect and process Business-to-Customer and Business-to-Business transactions
- The best Web servers for high-volume content management
- Better than the competition—an ideal solution for dot-coms who require UNIX servers that are:
  - Highly scalable to accommodate growth and varying traffic patterns
  - Faster, to provide customers with quick response times even under heavy loads, including those that require encryption
  - More secure with security features embedded on chip
  - More affordable over the entire technology cycle with the lowest Total Cost of Ownership
- The ability to deploy solutions today to meet short-term needs and then scale the system over time to meet explosive growth
- Solution deployment with very low entry costs due to the modularity and growth built into the systems architecture
- System, operating environment and I/O flexibility to meet the ever-changing and frequently changing needs of Internet portal-based applications and telecommunications customers

Telecommunications
As the industry moves to wireless-everything, telcos will need the capabilities that only the new *AlphaServer* GS Series can offer

- Supports and runs with ease in *Tru64 UNIX* and *OpenVMS* environments enabling telco customers to run legacy billing applications as they begin to migrate to more open environments
- Gives telcos the performance they need to handle demanding customer transactions with ample time left to complete billing and CDRs by the end of the day
- "Extreme CRM" and immediate access to information will differentiate the most successful telcos and Compaq Zero Latency Enterprise (ZLE) capabilities with the new *AlphaServer* GS Series and will deliver a significant competitive advantage

High performance technical computing
Compaq is committed to working with HPTC customers to deliver products that match the demands of their industry and lines of research/investigation. And with the new *AlphaServer* GS Series, Compaq will provide:

- The fastest microprocessor in the industry, by a factor of two, backed up by incredible memory bandwidth, delivering the highest computational performance for all technical applications
- The fastest single-system scientific computing platform, with the fastest floating point performance of any RISC/UNIX system in the world
- Scientific computing clusters initially capable of delivering over 3Tflops of scientific performance and growing over time with speed improvements and new generations of *Alpha* microprocessors

Business Intelligence/Enterprise Applications
The new *AlphaServer* GS Series systems are ideal for supporting the massive amounts of data that Business Intelligence and Enterprise Application customers input, store and access. The new *AlphaServer* GS Series offers:

- Continuous computing delivered through leadership single-system availability and reliability features including hot-swap of most system components and subsystems and support for complete "lights out" operations
- The lowest Total Cost of Ownership and significantly reduced system management costs and overhead with Compaq clustering, *StorageWorks*, and Compaq services including Customer Services, Professional Services, and CustomSystems & Solutions
- System, operating environment and configuration flexibility to support mixed-operating environments, server consolidation and cost-effective use of system resources for development, test and production deployment
- Fast and effective execution of batch jobs

Conclusion: The Next Generation of Computing Has Arrived!

The new *Compaq AlphaServer* GS Series is at the heart of the next generation of computing. We've taken the *AlphaServer* qualities that have driven productivity to new heights in mission-critical environments and applied them to the new world of e-Business. And those qualities map perfectly for customers seeking ultra-high availability with incredible scalability, unmatched investment protection and unstoppable performance with price/performance leadership.

Moreover, Compaq's total commitment includes a complete services offering that can be tailored to unique customer environments. From uptime guarantees to upgrades to custom systems to storage to networking and so much more, Compaq delivers unrivaled service and support with over 27,000 professionals in over 100 countries.

It all adds up. There is no question. The new *AlphaServer* GS Series systems provide an incredible foundation for e-Business and mission-critical computing solutions today—and for years to come. The next generation of computing has arrived!

To learn more about the *AlphaServer* GS Series systems, visit **www.compaq.com/alphaserver**.

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