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Why Oracle Solaris is the Platform of Choice for Enterprise Databases

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Take the Enterprise to a New Level

Corporate managers are under tremendous pressure to succeed given the demands of today's complex and dynamic business environment. Challenged by the need to rapidly introduce new products and services, meet customer appeals for more information, conform to increasing regulatory requirements, and tighten security barriers against nefarious attacks, managers are looking for ways to increase revenue while needing to reduce expenses and freeze headcount. Often, the IT budget constitutes a significant portion of a company's capital and operating expenses, and as such, is coveted by finance managers looking for ways to cut costs.

Some line managers hope they can resolve spending problems by converting their systems to open source software, or running their applications on a cloud, or acquiring one big computer and running services in virtual machines. They might be right. These technologies are part of the reason why the IT industry is so dynamic and responsive to business needs. Open source software, cloud computing, and virtualization are powerful features that, when used appropriately, can bring significant advantages to organizations. However, none of them can solve every problem. To determine the right solution, the IT environment must be analyzed holistically. There is almost never one single factor that, when addressed, enables the system to meet customers' needs, make regulators happy, and cost less to operate. The solution requires an evaluation of the entire stack from the hardware platform to the applications.

The operating system is the heart and soul of the datacenter, and not all operating systems are created equal. They provide varying degrees of functionality in the keys areas of performance, manageability, availability, flexibility, security, and reliability. It is essential that business managers understand which features are most critical for their specific operation such as 24 x 7 availability of services, airtight protection from hackers, or reducing the cost of power and cooling. Then, working with the IT staff, they can determine which operating system provides the most appropriate environment based on its unique capabilities.

Corporate database environments are often mission-critical and as such need an especially robust platform on which to run or the business can suffer. Many datacenters pick Oracle Solaris as the platform for their corporate databases because its enterprise-class features offer corporations the level of services and capabilities dynamic businesses require. Whether an organization's environment is currently based on Oracle Database running on Oracle Solaris, or a transition to this infrastructure is under consideration, it is imperative that the organization evaluates the capabilities needed. Other popular operating systems such as Linux or Windows just don't offer the range of features and depth of functionality required by today's database applications.

Oracle Solaris is widely considered the most robust, reliable, and secure operating system available today and a comprehensive list of all its features would be a massive tome indeed. It has, however, a suite of advanced technologies, described in this paper, that make it an outstanding environment. To assist in the process of determining whether to stay with Oracle Solaris or choosing to upgrade to Oracle Solaris, this paper describes the key features of the Oracle Solaris operating system and the benefits they offer to businesses.

Leverage Oracle's Complete Stack

Many businesses attempt to create IT solutions utilizing a combination of independently developed and supported products. Frequently these aggregated infrastructures result in high-cost deployments and complicated systems that fail to provide the information needed for critical business decisions. There is another way—Oracle's integrated product stack approach. (See Figure 1.)

Oracle, the industry leader in database, middleware, and application software, offers an integrated, end-to-end solution stack that includes Oracle's Sun servers and storage, Oracle Solaris, and Oracle Database, middleware, and application software. Invented, integrated, and tested in-house, this stack helps make Oracle the premier vendor of comprehensive business solutions.

Figure 1. Oracle's hardware and software stack is optimized for creating and running databases and database applications

With this innovative strategy, Oracle applications, including Oracle's Siebel, PeopleSoft, Oracle E-Business Suite, and JD Edwards software, are pre-integrated with Oracle Database to provide a complete, integrated solution stack that offers better performance and reduced complexity. Since all the elements of a solution are designed, integrated, and tested to work together, Oracle's product stack approach provides immediate benefits to businesses. Total cost of ownership is lower because all the software is designed to work together, making it less complicated to deploy and manage. It is also easy

to reduce development and maintenance costs because IT staff no longer has to support numerous skills sets required to manage multi-vendor solutions.

Oracle's comprehensive product stack also simplifies database management because the applications, database, and operating system are pre-integrated across the entire stack. Users can easily leverage out-of-the-box features including intelligent resource management, best-in-class security, and advanced file management. And should they need help, service is much less cumbersome with the integrated product stack strategy, thanks to a single point of contact for complete customer support.

Oracle knows how to best deploy database solutions and optimize investments in Oracle products. With extensive expertise in deploying and optimizing every layer of the hardware and software stack, Oracle Consulting and Advanced Customer Services deliver the knowledge needed to help companies improve performance, increase availability, and reduce implementation and deployment times.

Optimize Database Environments

Oracle Solaris is the platform of choice for today's demanding enterprise. It delivers proven results running everything from mission-critical enterprise databases to large Web farms. Oracle Solaris is in a class by itself when compared to competing operating systems. It offers innovative technologies that fundamentally change the equation for organizations needing to reduce cost, complexity, and risk. These features make Oracle Solaris one of the leading platforms in terms of performance, availability, scalability, observability, manageability, flexibility, and security. Bringing an enterprise-level software environment to even the smallest single-processor servers, Oracle Solaris provides a stepping-stone to tomorrow's datacenter.

The Oracle Database has an established record as the industry leader for relational databases. Today, many successful businesses use the Oracle Database to deploy mission-critical applications. By utilizing Oracle Database 11g Release 2 within the IT infrastructure, business managers can leverage the power of the world's leading database to reduce server and storage costs, eliminate idle redundancy, and improve quality of service.

Oracle has a long history of optimizing and tuning software for the Oracle Solaris platform, making the OS an especially robust environment for Oracle databases and associated applications. The operating system takes advantage of many advanced features that enhance the implementation of Oracle Database and applications, including:

- **High-performance platform support.** Capabilities that leverage the compute, network, and encryption features of today's state-of-the-art processors

- **Oracle Solaris Containers.** Technology that provisions many secure, isolated runtime environments for individual applications using flexible, software-defined boundaries

- **Oracle Solaris ZFS.** A dramatic advance in data management with an innovative approach to data integrity and a powerful integration of file system and volume management capabilities

- **TCP/IP stack improvements.** Optimized TCP and IP layers providing improved network performance

- **Oracle Solaris Dynamic Tracing (DTrace).** Built-in observability technology that enables developers and administrators to safely monitor and troubleshoot the entire software stack on production systems
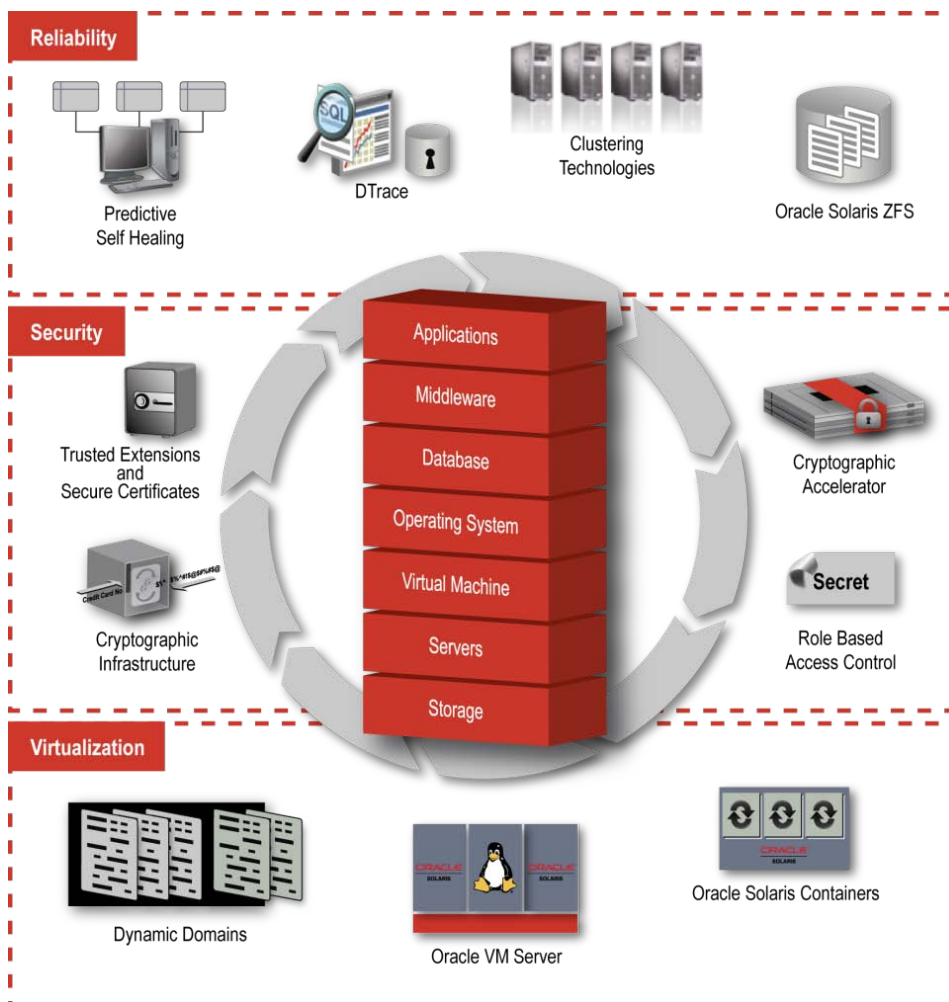

Figure 2. The advanced features of Oracle Solaris help optimize database environments

- **Oracle Solaris Predictive Self Healing.** Technology that automatically diagnoses, isolates, and aids system recovery from hardware and software faults including a standardized mechanism for control and management of application services

- **Process rights management facilities.** Fine-grained resource controls that reduce the risk of an application or user doing damage to a system

- **Oracle Solaris Cryptographic Framework.** Integrated application-level and kernel-level cryptographic facilities that help increase security and accelerate performance

IT organizations have found this unmatched set of features to be a key reason for retaining and expanding the use of Oracle Solaris in mission-critical environments. These capabilities dramatically enhance the functionality of business databases and applications, ultimately leading to increased revenue and lower costs.

Increase Performance with Oracle Servers

Every business manager wants their databases to run as fast as possible and their users' queries and processes to have the shortest possible response times. The factors that affect database and application performance are numerous. One of the key factors is the tight integration of system and storage architectures with the operating system. How the OS leverages the hardware performance features to coax the most out of the systems is critical to how applications perform in the real world. Oracle Solaris is supported on over 1,000 SPARC® and x86-based systems, ranging from single-board blade servers to large-scale symmetric multiprocessing (SMP) servers—from all the major computer vendors. Oracle's Sun SPARC Enterprise® mid-range and high-end servers are designed to meet the needs of complex, multi-tier applications requiring enterprise-class capacity and availability.

The high-end Sun SPARC Enterprise M9000 server is Oracle's highest performance and largest multiprocessor enterprise server delivering massive scalability, up to 64 processors (256 cores) and 4 TB of system memory to handle the largest workloads. Built on advanced SPARC64 VII quad-core or SPARC64 VI dual-core processors and with Oracle Solaris as its foundation, the Sun SPARC Enterprise M9000 server is optimized for large databases and enterprise-class applications such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Business Intelligence Data Warehousing (BIDW).

The server is designed for 24 x 7 mission critical computing with mainframe-class RAS features, including automatic recovery with instruction retry, error- correction code (ECC) protection on memory, guaranteed data-path integrity, total SRAM and register protection, and configurable memory mirroring. What's more, major system components are redundant and hot-swappable, for increased availability and serviceability. With the unbroken binary application compatibility of Oracle Solaris minimizing IT obsolescence, these servers help businesses achieve outstanding database performance and application availability while lowering costs.

Reduce Memory Latency

A unique performance-enhancing feature of SPARC platforms is the larger quantity of CPU registers compared to their x86 counterparts. CPU registers are a great advantage to database operations executing complex computations. When there are not enough registers, applications spill register data to memory. Storing data to and fetching data from memory is time-consuming, causing the processor to stall while waiting for the memory operation to complete. Running the database on systems with more CPU registers reduces the likelihood of register spilling, resulting in increased performance and faster response times.

Optimize Threads

Another database performance-enhancing feature in Oracle Solaris is a built-in scheduling capability that gives compute threads the tendency to run on the same CPU as the one on which they last ran. The scheduler considers how long it has been since the thread ran, as well as the number of threads ahead in the run queue for that CPU. If the scheduler determines that it has not been too long and that the run queue is not too deep, then the thread is scheduled on the same CPU. The advantage is that the data needed by the thread is likely still loaded in the registers and caches. Consequently, the thread can continue to execute without having to wait to reload data from memory, thereby improving overall database and application performance.

Reduce Footprint and Cost with Virtualization Technologies

IT managers constantly seek capabilities that can lower the cost and complexity of managing ever-expanding compute environments. To accomplish this, managers need tools that help maximize the use of every IT asset and improve operational flexibility. At the same time, organizations are continually adjusting business plans and creating new income opportunities to help remain competitive. Managers avoid possible system security, availability, and performance conflicts by deploying only one application per server. Corresponding servers are then installed to support development, test, and disaster recovery initiatives. This often results in an out-of-control proliferation of inefficient systems that is both costly and unmanageable.

By enabling highly efficient consolidation, relocation, and replication of database environments, Oracle's virtualization technologies help eliminate the need for multiple separate systems, reducing both capital and operational costs. Oracle provides a range of high-performance, secure, and flexible virtualization options that can be used to consolidate systems and simplify datacenter management. With full stack virtualization and management, Oracle solutions help companies consolidate IT resources, gain greater efficiency, rapidly deploy solutions, and do it all with integrated support directly from Oracle. Oracle solutions enable every layer of the stack-—from applications to disk— to be virtualized.

Modern virtualization capabilities have moved beyond a simple hypervisor that allocates hardware resources among logical domains to more compelling and integrated solutions that manage sprawling environments. In fact, industry analysts believe the integration and management of physical and virtual infrastructure is rapidly becoming a best practice for enterprise datacenters. Understanding the need for accelerated application deployment and simplified management of the entire enterprise infrastructure, Oracle has developed the most complete portfolio of end-to-end virtualization solutions available today.

Oracle offers a comprehensive set of virtualization technologies including virtual machines, built-in operating system virtualization features, hard partitioning in servers, and storage virtualization solutions. These technologies are designed to work separately or together to affect better resource utilization and reduce infrastructure complexity and cost across the entire enterprise. Thousands of applications can be aggregated onto a single server while maintaining system, application, and data integrity. Multiple, diverse environments can run simultaneously on the same system, helping reduce

the cost of application creation, testing, and deployment. Tying these capabilities together, Oracle Enterprise Manager provides visibility into business transactions and user experiences, enabling IT staff to provision, deploy, and manage applications from a business perspective.
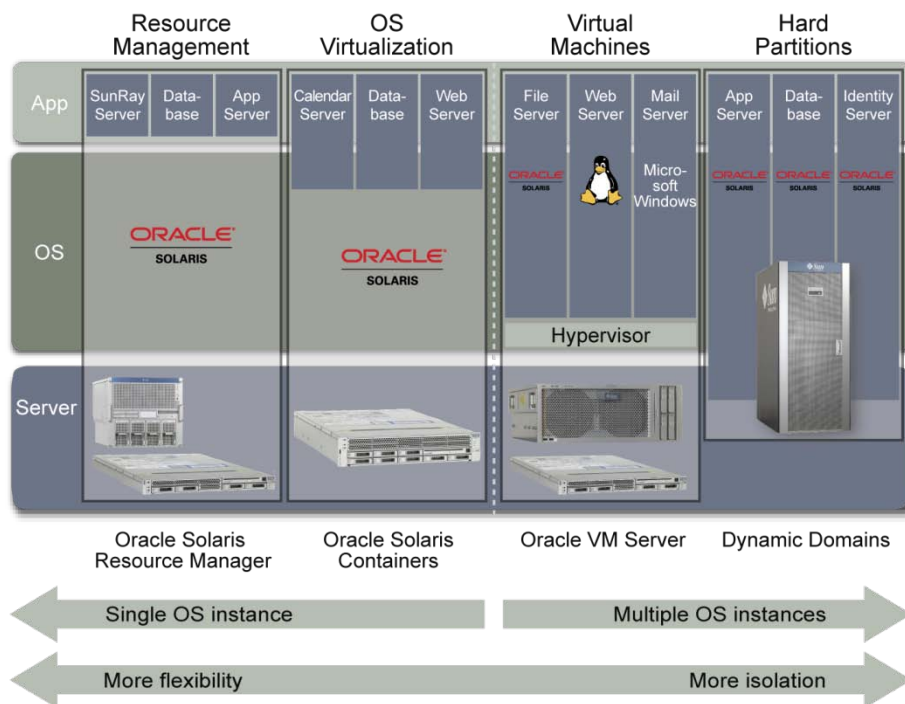

Figure 3. Multiple virtualization technologies are available with Oracle Solaris and Oracle's Sun servers

Configure Isolated Domains

In the ongoing effort to reduce costs, businesses are eager to consolidate applications onto fewer servers, but they must be careful to segregate these applications to provide adequate performance, security, and fault isolation. As one of the best virtualization platforms in the industry, Sun SPARC Enterprise M-Series servers are able to support as many as 24 electrically-isolated Dynamic Domains. Providing the ultimate in massive server consolidation as well as application isolation, these hard partitions support multiple OS instances without the overhead of a hypervisor. Unlike similar capabilities from other vendors, Dynamic Domains can be reconfigured while the system is operating—one system board (socket) at a time.

Hardware partitioning—such as Dynamic Domains—makes it possible to aggregate multiple isolated applications on one system with a very high degree of isolation, but is generally limited to high-end systems. In addition, the mechanism for allocating hardware components—adding a CPU/memory board to a domain or reconfiguring one to another domain—is relatively coarse-grained and sometimes less flexible than desired for today's application requirements.

Consequently, Oracle offers a choice of finer-grained, more flexible virtualization alternatives that help reduce the number of OS instances and increase asset sharing among multiple applications.
With Oracle Solaris virtualization, applications share a common infrastructure, lowering the number of resources required, simplifying administration, and reducing the total cost of ownership (TCO) for the applications.

Create Virtual Machines

Through the use of virtual machines (VMs), multiple instances and even different types of OSes can be supported on the same system. Each application can run in its own OS instance and a hypervisor gives each application the illusion that it owns a complete, dedicated set of hardware. With Oracle VM Server for SPARC (available for Sun SPARC Enterprise T-Series servers) it is possible to run up to 128 VMs on a server without paying for proprietary virtualization technologies, while dramatically increasing server use, efficiency, and ROI.

Partition Applications with Containers

An OS-level virtualization capability that enables multiple applications to share the same OS instance, Oracle Solaris Containers provides even finer-grained control of resources for each application—with very low overhead. Oracle Solaris Containers provides multiple virtualized environments on a single kernel instance, creating independently-managed entities that combine asset management and software partitioning for a solution that works on every server running Oracle Solaris. Up to hundreds of containers can be created on a domain, enabling a vast amount of server consolidation and overall cost savings.

Oracle Solaris Containers enable multiple applications to operate on a single server while maintaining desired quality of service (QoS) levels. Fixed resources such as processors and memory can be partitioned into pools, with different pools shared by different isolated application environments. Dynamic resource sharing allows different applications to be assigned different ratios of system resources. When resources such as CPUs and memory are dynamically allocated, resource capping controls can be used to set limits on the amount of resources used by a project. With all of these resource management capabilities, organizations can consolidate many applications onto one server, helping to reduce operational and administrative costs while increasing availability.

Increase Control and Manageability of Resources

Due to the dynamic nature of today's networked datacenters, systems are often alternately over-loaded or under-utilized. IT managers must find ways to gain control of system usage in order to improve resource efficiencies. In addition, applications are isolated only to the degree that OS-level security and resource management features keep them from interfering with each other. Although many system management tools provide the means to monitor the use of system components, they typically lack the means to control them. Indeed, to exert optimum control, system management needs to be tightly integrated with the operating environment.

Oracle Solaris Resource Manager is a powerful tool that enables organizations to consolidate multiple applications on a single server and deliver predictable service levels. Providing IT staff an extremely

high degree of control over allocating system and network components based on business priorities, Oracle Solaris Resource Manager simplifies the running of multiple applications on the same server and OS instance. With a finer granularity of control, administrators can ensure all workloads have access to the appropriate assets and that no workload consumes the entire system.

Oracle Solaris Resource Manager enables administrators to control system assets through the creation of pools—collections of resources, known as sets, such as CPUs, physical memory, or network I/O bandwidth, that are reserved for exclusive use by an application or set of applications. Resource pools enable system administrators to partition a system into a set of smaller virtual environments, each providing resources for a fixed workload consisting of one or more applications. These partitions provide fixed boundaries between workloads, ensuring each has access to a consistent set of resources regardless of usage on the rest of the machine. As a result, administrators can separate application workloads to eliminate the competition for resources, helping achieve predictable application and system performance.

Get a Handle on Data Growth

As file-level data (for example personnel documents, customer data, spreadsheets, email, articles, presentations, and video clips) consumes a rapidly growing portion of disk storage capacity, datacenter managers must allocate more planning and effort to the management and protection of large pools of file-based information. In fact, ensuring that files are stored, accessed, retained, and retrieved to meet user demand is becoming the primary task for storage administrators. With so many business databases growing exponentially, provisioning storage resources, retiring legacy storage, and archiving infrequently accessed information are essential elements of successful storage management.

File systems provide another way in which the features of Oracle Solaris can be leveraged to meet businesses' operational needs. The Oracle Solaris ZFS file system offers a dramatic advance in data management with an innovative approach to data integrity and a powerful integration of file system and volume management capabilities. Not only can Oracle Solaris ZFS manage traditional disk storage, it also seamlessly integrates enterprise solid state drives to improve application performance and operating efficiency.

Furthermore, many storage management tasks are carried out infrequently and consequently are prone to operator errors that can damage the system. Oracle Solaris ZFS benefits IT staff by automating both common and less-frequent tasks. Managing storage with Oracle Solaris ZFS is extremely easy, because it enables administrators to simply describe the intent of storage policies, rather than all the details needed to implement them. Creating a file system or performing other administrative activities is fast— just a matter of a few seconds—regardless of size. There is no need to configure (or reconfigure) underlying storage devices or volumes, because this is handled automatically when they are added to a pool. Oracle Solaris ZFS also enables administrators to guarantee a minimum capacity for file systems, or set quotas to limit maximum sizes. Administrators can delegate fine-grained permissions to accomplish file system administration tasks to nonprivileged users, making the system easy to quickly deploy.

Oracle Solaris ZFS helps businesses keep data secure. It provides unmatched data integrity, automated error correction, and integrated data services that include unlimited snapshots and file compression. With self-healing diagnostic and recovery features built-in, Oracle Solaris ZFS reduces the risk of data loss from hardware, software, and administrator errors. Using the Oracle Solaris ZFS file system helps reduce the cost and complexity of managing data and storage devices as well as maximizing performance on Oracle's reliable storage systems.

Find and Fix Potential Problems

When a database is up and running, every connected process is either busy working or waiting to work. A process that is waiting may mean nothing, or it can be an indicator that a database bottleneck exists. Database administrators use response time analysis to determine if perceived bottlenecks in a database are contributing to a performance problem. This analysis is an essential method of measuring the effectiveness of a process because it helps track where a database has been spending its time.

Observe Database Behavior

Oracle Solaris Dynamic Tracing (DTrace) is a framework that helps to simplify the process of identifying and resolving intermittent and/or sustained application performance problems. DTrace is designed to safely instrument applications, even in production environments. It collects operational data at specific points of interest in the OS kernel and user processes, called probes. With improved visibility into application operation, administrators are better able to identify trouble spots, determine where applications are spending too much time, and focus development and debugging efforts.

With DTrace, administrators and application developers can instrument running applications as well as the OS kernel without rebooting, recompiling, or even restarting the applications. DTrace adds very little overhead when in use. Individual probes have minimal impact on the system and can be shared for even more efficiency. DTrace automatically terminates any tracing operation that uses excessive resources and generates no application overhead when tracing is switched off.

The characteristics and features of Oracle Solaris DTrace help to ease adoption of this performance troubleshooting approach. DTrace scripts are written in a language similar to C, simplifying the learning process for most system and database administrators. Within DTrace scripts, probes record data and set timestamps at locations of interest throughout application execution. Oracle Solaris includes tens of thousands of built-in instrumentation points depending on the platform.

Many applications include specific DTrace probe points to supplement the built-in probes, enabling administrators and developers to see interactions between the system and applications. In addition, users can examine information relating to a particular application and correlate that with other probes, using a single analysis framework. To accelerate problem identification and analysis, DTrace scripts also can collect information in a table and return aggregated values such as the average, minimum, maximum, or sum of a specific variable.

Using custom and embedded DTrace probes significantly improves database observability and helps developers and administrators speed the process of identifying the root cause of performance issues. Powerful DTrace probes can help an administrator determine the amount of time spent on each aspect

of a database operation, including the time spent processing a query, waiting on locks, and executing disk I/O. Custom DTrace probes can be created to delve more deeply into an application and measure the cost of individual processing steps.

Handle Faults

For companies today, most applications and services that utilize databases are critical to the business's operation and revenue stream. In fact, services that require continuous 24 x 7 operations are common. Thus, it is essential that the infrastructure upon which the databases run are as reliable as possible. The predictive self healing feature in Oracle Solaris is designed to maximize the availability of the system, databases, and application services by automatically diagnosing, isolating, and recovering from faults. This helps to reduce not only hardware failures but also the impact of application failures, leading to increased system and service availability.

Oracle Solaris Predictive Self Healing provides both hardware and software resiliency through automatic component retirement and software restart. Rather than providing a stream of error messages that can be difficult to decipher, Oracle Solaris Predictive Self Healing automatically initiates appropriate responses such as dynamically taking a CPU, a region of memory, or an I/O device offline before the component can cause a system failure.

Oracle Solaris Service Management Facility (SMF)—an integral capability in Oracle Predictive Self Healing—is designed to simplify the management of system and application services by creating a supported, unified model for services and service management. It assists administrators in controlling services, including restarting failed services automatically. If an application should fail, a built-in mechanism automatically restarts the application. SMF allows IT staff to define the relationships between services—for example, a dependent service will not run unless the other services that it requires are already running.

Through a set of interfaces, SMF enables administrators to easily configure, enable, and control services, while enhancing visibility of and debugging of errors. All these capabilities are made possible by treating services more than just user-executed software to the OS. They are designated as having special status that enables finer control and permits monitoring and probing for diagnosing software failures—rather than just having the service killed and restarted.

Also part of the Oracle Predictive Self Healing software is Oracle Solaris Fault Manager. This software isolates and disables faulty components—even before administrators know that a problem exists—helping ensure uninterrupted service, while simultaneously remote service agents are collecting information to assist administrators in diagnosing the root cause of the failure. In addition, the kernel memory scrubber constantly scans physical memory, correcting any single-bit errors that it finds so that it can reduce the chance of those problems turning into uncorrectable double-bit errors.

The Oracle Solaris Fault Manager provides a fault management architecture that can be updated with increasingly sophisticated diagnostic modules as they become available—without having to reboot the system. A stream of binary telemetry data regarding the system's health is fed to a set of dynamically loadable diagnosis engines that examine incoming events related to their particular function, for example memory or CPU faults. The diagnosis engine logs detected errors and produces a fault

diagnosis once it has observed discernible patterns from the stream of incoming errors. A specific fault diagnosis is determined using root-cause analysis and by making inferences on the incoming events.

The scalable architecture of Oracle Solaris Predictive Self Healing can be rapidly evolved to new problems and updated as new diagnosis and availability technologies are added to the system. Most future updates can be loaded and unloaded from the system while it is running and can be upgraded on the fly without requiring downtime or losing previous diagnosis data. The higher uptime of Oracle systems that can be achieved by running on Oracle Solaris with predictive self healing translates to reduced loss of business, improved resource utilization, and reduced administration costs.

Improve Network Performance

Network performance plays a critical role in the performance of databases and related applications as more business services go online. An enhanced TCP/IP stack in Oracle Solaris lowers overhead by requiring fewer instructions to process network packets. By optimizing the Internet Protocol stack and making it easier to develop drivers supporting new hardware technologies, users have seen speed increases of as much as 50 percent when moving network-based applications to Oracle Solaris. The TCP and IP layers in Oracle Solaris are much more tightly integrated and optimized, resulting in significantly improved network performance for online applications. The threading and queuing code in the TCP/IP stack is streamlined to process a single packet through both layers, improving processor locality, increasing processor cache performance, and reducing context switch overhead.

The enhanced network stack not only reduces CPU overhead when processing packets, it also improves scalability, interrupt handling, and Secure Sockets Layer (SSL) traffic. More network connections can be supported, and throughput can scale linearly with the number of CPUs and interface cards, helping enable the latest 10 Gigabit Ethernet adapters to deliver throughput converging on wire speed. The result is the network throughput levels that today's enterprise environments demand.

Achieve Higher Availability with Clusters

As businesses depend more and more on database applications, managers increasingly focus on the availability of the services in addition to controlling the total cost to the organization. Although many features of Oracle Database help to protect a business from common causes of unplanned downtime, additional capabilities in the operating system can improve the availability and reliability of the system. Many businesses need to be online 24 x 7 and risk losing revenue, dissatisfying customers, and tarnishing reputations if critical applications or data become unavailable. The stability of the hardware platform and operating system is critical to achieving high levels of database availability.

Oracle Solaris Cluster is a high availability (HA) solution that meets the challenges of delivering 24 x 7 availability, maintaining continuous business operations, and reducing costs through hardware consolidation. It delivers availability and continuous business operations regardless of local or global disaster, planned or unplanned outages. Providing up to 99.999 % availability plus up to 15 times faster

failure detection and 2 times faster recovery than HA systems from other vendors, Oracle Solaris Cluster is seamlessly integrated with Oracle Solaris.
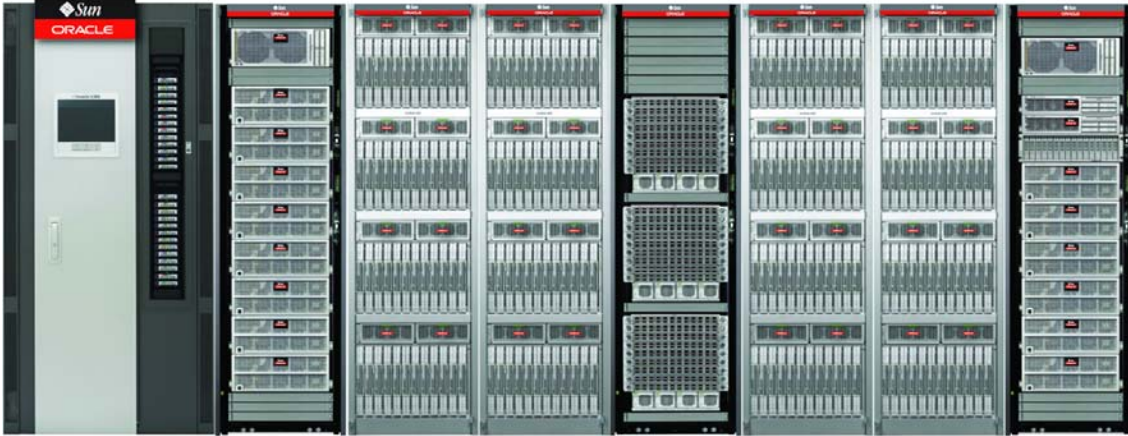

Figure 4. Oracle Solaris Cluster unleashes the combined power of high availability and virtualization

Oracle Solaris Cluster provides for the creation of virtual clusters based on Oracle Solaris Containers, enabling consolidation of multitier applications and databases in a shared cluster of hardware. Each application runs in a fully isolated virtual cluster that can be configured to cap CPU usage, reducing the number of database and application licenses required while providing highly available consolidated services. Oracle Solaris Cluster also manages domains both as cluster nodes and as assets in the nodes by combining the domain's migration capability with HA features to provide robust and reliable deployments in consolidated environments. With no need for hot stand-by servers, Oracle Solaris Cluster saves costs by optimizing hardware utilization and significantly reducing software expenses. This single, end-to-end, integrated virtualization and HA platform helps enable resilient database services with security isolation, resource management, and fault isolation for mission-critical business applications despite large scale infrastructure failures.

Shield the Datacenter with Advanced Security

Most modern corporate IT infrastructures are widely distributed networks linked to the internet. The hyperconnected nature of today's datacenters, with virtually unlimited points of access, leaves businesses vulnerable to a wide variety of security threats—from unintentional acts that compromise security to targeted violations that expose sensitive information and corrupt data. The need for bulletproof security is increasingly necessary in order to maintain continuous system operation and data integrity in the face of malicious attacks and intruders.

Since a database is only as secure as the operating system it is running on, most IT managers are well aware that a properly secured OS provides minimal opportunities for attack. To be effective, data security features must be designed into the heart of an OS, rather than simply wrapped around its core components. Oracle Solaris combines multiple security technologies that allow it to monitor file

integrity, verify user and process rights, and retain a detailed audit trail of all events, significantly reducing the system's risk of exposure.

Manage User and Process Access

Oracle Solaris's rights management features help to harden systems against attacks by preventing unauthorized access to data and applications. The software limits—and selectively allows—both users and applications to access just those system resources necessary to perform their function. This capability dramatically reduces the possibility of attack from a poorly written application by eliminating inappropriate access to the system. Even if hackers gain access to an application, they are unable to raise its privileges, thus limiting the opportunity to inject malicious code or otherwise damage data.

For example, low-numbered ports are privileged, and on traditional UNIX systems only processes with root privileges are allowed to bind to them. This provides a huge opportunity for security breaches, since a web-facing application must have root-level access in order to bind to the necessary port. With Oracle Solaris, however, the application can be given *only* the specific right to bind to the privileged port. By limiting the privileges granted to just this one function, Oracle Solaris significantly limits the scope of potential security exposure. This feature is integrated with process rights management through Oracle Solaris role-based access control (RBAC).

In addition, Oracle Solaris offers an extensive system event audit trail facility to assist administrators in tracking users on the system by recording all access granted to files, devices, roles, system services, and applications. This audit trail is exportable into an open XML format or can be automatically transported to another system.

Encrypt Communications

Database solutions are at the heart of a wide range of corporate applications, such as CRM and order processing, that collect personal and financial customer information. At the same time, database environments must satisfy very demanding security requirements imposed by regulations such as Health Insurance Portability and Accountability Act (HIPAA) of 1996 and the Sarbanes-Oxley Act of 2002 in the U.S, and the European Union Data Protection Directive of 1995 in Europe. Consequently, it is critical that as these applications interact with users and communicate with one another to get a job done, the communications that take place must be secure and protect that private information.

On most systems, encryption is accomplished with add-on cryptographic accelerator cards that typically slow down the system since the option is not tightly integrated into the system. Oracle Solaris builds cryptography into the environment, and provides a framework for accessing the cryptographic capabilities built into Oracle servers. The result is faster, more secure communication.

Oracle Solaris adds a standards-based common API that provides a single point of administration for cryptographic routines and digital certificate lifecycle management. Oracle Solaris' cryptographic frameworks provide a single set of administrative commands for digital certificate creation requests, manipulation, and loading. These pluggable frameworks balance loads across hardware accelerators and software implementations, increasing encrypted network traffic throughput. They're available to applications written to use the PKCS #11, OpenSSL, and Java Cryptography Extension APIs.

Management of corporate datacenters is often accomplished remotely. Using a shell, IT staff can access systems no matter where they are located. Logging into systems over an insecure network that transmits sensitive data such as passwords in plain text, exposes communications to packet analysis. The Secure Shell service in Oracle Solaris enables data to be exchanged over a secure channel. Providing a method to protect against threats such as session eavesdropping, password theft, and session hijacking, the Secure Shell encrypts all network traffic, delivers stronger authentication, and monitors the integrity of network sessions. Because it is integrated into the Oracle Solaris 10 operating system, the Secure Shell environment can leverage the cryptographic framework in Oracle Solaris for even greater security. The IPsec/IKE and secure shell protocols in Oracle Solaris comply with industry standards to provide data encryption between two or more systems over the network, without any application modification. The secure shell protocol is a specific set of utilities modified to allow for encrypted remote access and file transfer between two systems. These technologies help ensure the overall security of the system, safe guarding users' proprietary information with the least amount of cost and effort.

Control Access

Many corporate customers demand explicit controls over how database information is disseminated. In addition, regulatory requirements for certain industries stipulate stringent data security policies. Integrated into Oracle Solaris, Trusted Extensions is an advanced security feature that provides a layer of secure label technology, enabling Mandatory Access Control (MAC) security policies. It implements labels to protect data and applications based on their security level, not just on who owns or runs them. Credit card information, classified data, and personal records remain secure, and can't be accessed by unauthorized sources. Trusted Extensions enforces multilevel security (MLS) policies and provides for the secure, controlled environment required by regulatory agencies and financial institutions without sacrificing hardware and application compatibility.

Oracle Solaris with Trusted Extensions MAC policy creates an explicit relationship among labeled objects, preventing an application with a different security label from accessing unauthorized data. (Applications are allowed read or write the data if they have appropriate authorizations.) The MAC policy applies to all aspects of the OS, including file, print, networking, window management, and device access, and even system administrators can't violate the policy inadvertently

Oracle Solaris is widely regarded as one of the most secure operating systems on the planet. With its advanced security features and open standards approach that allows third-party security solutions to be integrated into the security architecture, Oracle Solaris offers unmatched protection of business interests and intellectual property.

Keep Running with Oracle's Support Programs

Oracle's support services help protect technology investments and keep business operations running effectively and efficiently. Providing a single vendor solution for enterprises running the Oracle Database and applications on Oracle Solaris platforms, Oracle support expertise guarantees fast, accurate resolution enabling IT staff to focus on the business. Proactive, preventive services from

Oracle help organizations avoid business disruption and enhance security, taking the risk out of the operating environment. Highly personalized services that leverage Oracle expertise and IP help improve business efficiencies and lower TCO.

As a broad-based IT solutions provider, Oracle offers comprehensive training and certification services for virtually every member of the IT staff. From installation to setting up a database to migrating applications, Oracle provides a broad portfolio of support and service offerings to help maximize the stability of Oracle Database and Oracle Solaris environments.

Sail with Oracle Solaris

Based in Victoria, British Columbia, BC Ferry Services Inc. (BC Ferries), one of the largest ferry operators in the world, provides year-round transportation services to the west coast of Canada. The company is a key participant in the development of coastal communities through its unique role of maintaining a constant flow of goods and services to linking families and friends and attracting tourists from throughout the world. The company's 4,500 employees provide transportation services to more than 21 million passengers and 8.5 million vehicles each year.

Figure 5. BC Ferries is an essential transportation link connecting communities throughout coastal British Columbia.

The BC Ferries infrastructure includes a data network that supports the company's databases and applications for reservations, scheduling, personnel, and sales data. For the past several years, BC Ferries has outsourced the management of these resources. The company needed to update its infrastructure to be able to respond faster to customer demands for online services, such as real-time

schedule information. "We were falling behind in meeting our business needs, and we were negotiating new terms for the existing IT outsourced services model," says Mike Chanin, Director of Business Support Services for IT.

Ultimately, the organization decided to assume greater internal control of its infrastructure and chose to standardize its IT architecture and operating systems. "We had several different operating systems and a mix of hardware in place," says Paul Bartle, Senior Manager of Technical Services. The organization also sought to optimize its datacenter footprint. "At our old datacenter, we were maxed out on power and AC, and we could not continue to grow the way we had in the past," says Bartle. "We needed to move to a virtual environment and we wanted to reduce our utility costs."

BC Ferries chose a solution that includes Sun SPARC Enterprise servers, Oracle's StorageTek storage systems and tape library, and Oracle Solaris. With the deployment of its new solution, the company has reduced the number of servers in its datacenter while increasing employee productivity, system availability, and flexibility. "Increased system reliability and scalability are things we previously would not have been able to do without investing a lot of money into hardware and software," Bartle remarks. "We now have a standardized platform and operating system, rather than different systems and pieces of hardware, resulting in reduced cost and complexity and increased employee productivity."

BC Ferries is also leveraging Oracle's virtualization capabilities. "We're making use of container virtualization in Oracle Solaris and embedded virtualization features of the StorageTek 9985V array, so we can actually expand our IT infrastructure without having to physically grow the datacenter space," Bartle says. "The time it takes for us to build up new servers has dropped from days or months to just a few hours," Bartle says.

Since, BC Ferries reduced the number of physical servers and installed energy-efficient technology from Oracle, the organization has greatly reduced its power consumption. "We can now run multiple database servers on a smaller server footprint," Bartle adds. "As a result, we have reduced a lot of power, cooling, and space requirements at our new datacenter."

Oracle Services helped BC Ferries achieve these results through installation, implementation, and backup and restore services. "Support was a big part of our success on this project," says Afzal Chaudhry, Manager of Data Services, BC Ferries. "They took the time to understand our unique business needs, and they also spent a lot of time testing and making sure that the solution would work for us."

Optimize Database Operations

The combination of a dynamic, competitive environment, added database complexity, more data, and less headcount has become a real challenge for database managers who work hard to maintain high database availability and performance. Choosing an operating environment on which to run business solutions is a complex process. Oracle Solaris can help. It includes Oracle Solaris ZFS, Dynamic Tracing (DTrace), Predictive Self Healing, built-in virtualization, and advanced security— unique and innovative technologies that are uncommon to other operating systems. When faced with maintaining

mission-critical systems that need to be reliable, meet performance expectations, and are secure, IT managers choose to stay with the proven Oracle Database on Oracle Solaris solution.

The Oracle Solaris operating system continues to be trusted by thousands of business managers around the world. Developers and IT staff depend on the performance, availability, scalability, observability, manageability, flexibility, and security features of Oracle Solaris to help ensure that applications just work. These capabilities, combined with the world-class support for and corporate commitment to both Oracle Solaris and Oracle Database, give managers the confidence to base their IT strategy on these innovative and industry-leading technologies.

For More Information

Information on the products and technologies discussed in this paper can be found at the following sources.

TABLE 1. LIST OF SOURCES FOR ADDITIONAL INFORMATION

TOPIC	SOURCE
Oracle Solaris operating system	www.oracle.com/solaris
Oracle's Sun Servers	www.oracle.com/servers
Oracle Solaris: Virtualization	www.oracle.com/virtualization
Oracle Solaris: Reliability	www.oracle.com/us/products/servers-storage/solaris/reliability-066071.html
Oracle Solaris: Security	www.oracle.com/security
White Paper: Configuring Oracle Solaris ZFS for an Oracle Database	developers.sun.com/solaris/docs/wp-oraclezfsconfig-0510_ds_ac2.pdf
White Paper: Best Practices for Running Oracle Databases in Oracle Solaris Containers	developers.sun.com/solaris/docs/oracle_containers.pdf
Oracle Solaris and Sun SPARC Systems—Integrated and Optimized for Enterprise Computing	http://developers.sun.com/solaris/docs/solaris-sparc-061110.pdf
Oracle Solaris Operating System: Optimized for Sun x86 Systems in the Enterprise	http://developers.sun.com/solaris/docs/oracle-solaris-intel-xeon.pdf
Oracle Services	www.oracle.com/services
SPARC processors	www.oracle.com/us/products/servers-storage/microelectronics www.sparc.com/
BC Ferry Services Inc	www.bcferries.com

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Why Oracle Solaris is the Platform of Choice for
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