Oracle Integrated Stack—
Complete, Trusted Enterprise Solutions
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Executive Summary

Oracle’s hardware and software products are designed and tested as an integrated, end-to-end stack in order to provide users with a complete, comprehensive solution, offering optimum functionality, top performance, and reduced complexity. As a complete systems provider, Oracle can offer the maximum level of integration of hardware and software components, delivering the best value in the industry. Oracle Integrated Stack Testing (OIST) strengthens Oracle’s position as a best-in-class technology provider, driving improvements in product stability, performance, scalability, reliability, and manageability.

This technical white paper describes the testing Oracle performs on a selection of widely-used hardware and software systems combined into several reference configurations. The systems are subjected to load testing and results monitoring while undergoing fault and error injection to ensure they function as designed. In addition, patches, software upgrades, and hardware upgrades are installed followed by another round of load testing, to ensure performance and availability levels are maintained or, in the case of a hardware upgrade, the added capacity provides an expected and commensurate increase in performance.
Oracle’s Complete Hardware and Software Stack

Many businesses attempt to create IT solutions utilizing a combination of independently developed and supported products. Frequently these in-house, aggregated infrastructures result in high-cost deployments and complicated systems that fail to perform as needed in business environments. There is another way—Oracle’s integrated product stack approach. See Figure 1.

Oracle’s complete hardware and software stack is optimized for creating and running comprehensive enterprise solutions.

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, the Oracle Solaris and Oracle Enterprise Linux operating systems, 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. Oracle applications including Oracle's Siebel, PeopleSoft, E-Business Suite, and JD Edwards software, are pre-integrated with Oracle Database to provide a complete, comprehensive solution stack that offers better performance and reduced complexity. In addition, Oracle's SPARC® and x86 processor-based systems offer a wide range of high-performance, scalable platforms designed to meet the needs of complex, multitier applications requiring enterprise-class capacity and availability.
Since Oracle’s products are designed and tested to work together, the solution stack provides immediate benefits to businesses. The integrated design of the elements makes them less complicated to deploy and manage, reducing total cost of ownership. 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. Furthermore, the stack helps reduce development and maintenance costs because IT staff no longer must maintain different skills sets to manage packages from multiple vendors.

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.

The Production Life Cycle

Processes and procedures for production deployment vary across different IT organizations once the vendor is selected, system performance and availability requirements are established, and the specific hardware and software configuration is determined. Prior to going into production, most systems should be tested for proper functionality and performance with all applicable software. Once in production, systems typically require:

- Updates and patches to all software layers
- Hardware updates, such as additional or next generation CPUs, memory, and I/O cards depending on demands for increased performance, capacity and availability
- Full system upgrades to meet growing business demands

Most production systems can tolerate zero downtime. Typically systems must be taken down during planned maintenance events, requiring the frequency and duration of these events to be minimized. Conversely, there is usually a much higher downtime cost associated with unexpected outages that proactive maintenance may have avoided. Consequently, many IT organizations invest in resources to test patches, software upgrades, and new hardware in a non-production environment prior to applying changes to production systems. Typically in pre-production testing, application specific stacks are validated to ensure they can function in a production environment.

The stress testing and induced maintenance events that solutions are subjected to at Oracle enable users to upgrade systems with significantly less costs associated with pre-production and maintenance testing. Testing at Oracle takes a full solution stack approach, reducing the risk of discovering issues with the integrated stack which could prove to be a roadblock to deployment. Oracle understands the issues involved with running and maintaining an enterprise datacenter. As the second largest software company in the world, Oracle knows how critical it is to operate businesses on a solid and secure IT infrastructure and to deploy IT services as quickly and trouble-free as possible. Oracle is expanding the use of Oracle Solaris platforms throughout the company. Due to the exhaustive testing done on the
product stack, Oracle is able to tune and optimize the user experience by resolving real-life deployment issues in-house.

**Oracle Test Programs**

Oracle has long provided a suite of tests and support for vendors to validate and certify the Oracle database software in their environments. Oracle Certification Environment (OCE) comprises a set of test kits for operating system certification, cluster software validation, installation validation, and more. OCE testing is a standard part of Oracle Solaris regression and patch verification and includes the Oracle Automated Stress Tool (OAST) that runs an Online Transaction Processing (OLTP) workload on the target platform. Oracle Integrated Stack Testing (OIST)—described in this paper—is not intended to replace OCE, rather it is a complementary program that extends the OCE testing.

**Oracle Integrated Stack Testing**

OIST ensures the hardware and software components in an enterprise configuration interoperate and perform optimally throughout the system’s lifetime. For IT managers planning to purchase a new system, reference configurations documented by Oracle provide a starting point for solution architecture discussions. See Figure 2. Fully qualified by Oracle, these reference configurations reduce customer in-house testing, preparation, deployment, and maintenance times, thereby reducing overall operating costs.
OIST is a long-term, continuous effort to validate Oracle’s current technology and installed base in a dynamic, continually updated environment. Key reference configurations undergo constant upgrades to include the latest available software and hardware. New technology, complete hardware systems, hardware options, storage, and software are added to the environment as they become available.

With Oracle’s wide array of hardware and software platforms and solutions, the number of combinations of possible test configurations is massive, requiring a careful and well thought out selection of reference configurations. To benefit as many users as possible, Oracle chooses configurations that are representative of typical Oracle installations, combining hardware and software options used in volume production deployments.

Going beyond the performance and reliability testing of a configured system, OIST leverages existing infrastructure, resources, and expertise to subject the reference configurations to various events that are a standard part of production IT environments. Generated test and performance load metrics are monitored closely, ensuring that the system continues to meet expected levels of performance and availability.
OIST involves the building and configuration of several complete systems running volume enterprise software. The configurations are comprised of SPARC and x86 processor-based servers, Storage Area Network (SAN) and Network Attached Storage (NAS) based enterprise storage, and volume Oracle software packages. The Oracle servers fall into one of just a few classes, in terms of architectural commonality. Oracle Sun SPARC Enterprise M-Series servers share common processors, as well as other hardware components for memory interconnect and I/O. This is also true for Oracle Sun SPARC Enterprise T-Series servers, and the x86-based offerings. Although all SPARC processor-based systems run the Oracle Solaris OS, the x86-based servers run either Oracle Solaris or Oracle Enterprise Linux. By testing a relatively small number of representative systems, Oracle creates reference architectures that apply across their respective classes.

The reference architectures also span scaling dimensions, a critical component for meeting performance and capacity requirements. Oracle technology enables scaling systems both vertically and horizontally. Large SMP systems running a single instance of the operating system support vertical scaling by adding on CPUs, RAM, and I/O devices. Oracle Real Application Cluster (RAC) technology enables horizontal scaling, by adding more systems or virtual machines to the cluster, each running its own instance of the operating system. Again, a myriad of options exist, in terms of the number and types of nodes used in cluster configurations, as well as other key components, such as the cluster interconnect. The selected configurations enable the largest possible return on investment in terms of the broad applicability across a massive number of customer deployments.
Some of the current OIST platforms include the following configurations:

- Oracle Sun SPARC Enterprise M9000 server, with Oracle’s Sun Storage 7410C system, Oracle Solaris, Oracle 11g Release 1 (R1) Database, and Oracle PeopleSoft Enterprise Campus software (see Figure 3)

![Figure 3. An OIST test platform based on a single-node, large SMP server](image)

- Two-node Oracle Sun SPARC Enterprise T5440 server cluster, Oracle Solaris, Oracle RAC, Oracle Sun Storage 6780 arrays, Oracle 11g Release 2 (R2) Database, Oracle VM Server for SPARC (previously known as Sun Logical Domains), and Oracle Siebel Customer Relationship Management (CRM) 8 software

- Sun SPARC T3-1 server, Oracle Solaris, Sun Storage 7410C system, Oracle 11g R2 Database, Oracle WebLogic Server, and Java Enterprise Edition (Java EE) Application Server

- Two-node Oracle Sun Fire X4800 server cluster and Sun Fire X4450 server running Oracle Enterprise Linux 5.4, Oracle VM Server for x86, Oracle RAC, Oracle 11g R1 Database, Oracle PeopleSoft Human Capital Management (HCM) 9.1 with Sun Storage 6780 and Sun Storage 7410C systems (see Figure 4)
Figure 4. A test configuration including Oracle's Sun Fire x86-based servers running Oracle Enterprise Linux and Oracle VM Server for x86
• Two-node Oracle Sun SPARC T3-1 server cluster, Oracle Solaris, Oracle RAC, Sun Storage 6780 array, Oracle VM Server for SPARC, Oracle 11g R2 Database (see Figure 5)

Criteria for the tested configurations, including hardware options, are based on several key factors. Most importantly, the hardware and software selected represents volume products used by current and future Oracle users. Emerging technology, such as 10 Gigabit Ethernet network interfaces and Flash storage technology, that is in evaluation or being rolled into production by Oracle users must be considered.

These reference configurations are constantly being reconfigured and reintegrated in Oracle's testing labs. Selected software tools such as customer load generators and benchmarks stress the systems and determine performance baselines. OIST simulates the changes, events, and processes to which production systems are typically subjected, ensuring that Oracle technology continues to achieve designed availability and performance levels. Specifically, OIST includes:

• The installation and configuration of a selection of Oracle hardware and software technology that represents a volume cross-section of Oracle's installed base
• A documented snapshot of these reference configurations, including details of the hardware configuration, software versions, and applicable settings and parameters (see references on page 12)
• A series of performance load tests to establish baseline quality and performance
• Installing software upgrades and patches at all layers of the stack, validating quality and performance following each change including:
  • The use of Oracle Solaris Live Upgrade for upgrading to Oracle Solaris update releases
  • The installation of Oracle Solaris kernel and recommended patch clusters
  • The installation of Oracle patches and minor and major upgrades to all the software layers on each system (database, middleware, application)

The OIST environment enables incremental testing following each step of patch installations and software upgrades. By executing load and stress tests after each patch baseline/cluster installation or software upgrade, any variation of test results can be quickly identified, isolated, and fixed prior to the actual release of the modification. Integrated testing means that the entire stack, including patches and upgrades that have been previously applied, go through another round of load and stress tests to ensure the combinations of patches and upgrades work as expected.

Additional OIST tests include fault and error injection (destructive tests) while under load. Correctable errors are introduced to validate error diagnosis, reporting, and handling. Uncorrectable errors are inserted to validate diagnosis, reporting, recovery, and consistency. For systems with redundant components, such as Oracle RAC configurations, the testing verifies that surviving nodes continue to run as expected without service interruption.

Oracle is in a unique position to do this level of integration testing, not just by virtue of Oracle's broad technology portfolio, but also the breadth and depth of specialized tools and technologies available as part of the Sun acquisition. These include:
• Software for fault and error injection and diagnosis
• Fault handling and isolation through advanced diagnostic tools, including the Oracle Solaris Fault Management Architecture (FMA)
• Unparalleled observability with Oracle Solaris Dynamic Tracing (DTrace) and automated tools built using DTrace that enable fast and precise isolation of software failures

Several key benefits are derived from OIST. For new installations, the OIST configurations can serve as reference platforms for initial configuration and setup. Long-term users with production systems benefit from increased levels of quality and reduced test cycles to install patches or software updates, as well as performance optimizations resulting from additional tuning across the stack layers.

By publishing the specific details of the test configurations, including specific hardware components and software versions, customers can rapidly get answers to key questions such as:
• What software is best for a new production deployment?
• What are the best platform options for deploying a specific piece of Oracle Enterprise software?
• Which virtualization options are certified with which technologies?
• What are the optimal configuration settings for systems?
• Has the software needed been certified with the existing production stack?
• What is the risk of installing a given patch into an existing production environment?
• Should Oracle RAC be considered for redundancy or capacity?
• How will the system scale when the production environment is expanded?

User access is available to specific OIST information; configuration details, software versions, patches, and upgrades tested, and more. The ultimate value in OIST is in how it reduces risk and cost for customers. Enabling customers to quickly and easily access information is the shortest path to getting answers to the questions posed above, reducing the time and effort required to get from planning to deployment, and from planned maintenance to upgraded production systems.

Conclusion

Too often, businesses use a combination of independently developed and supported products in enterprise-wide application and database deployments. They grapple with high IT costs and complicated systems that fail to meet critical availability or performance requirements, while incurring substantial resource drains in terms of time, equipment, and manpower. Oracle's integrated product stack helps alleviate these issues.

OIST ensures that hardware and software components in a reference configuration interoperate and perform well together from initial deployment, through the production life of the systems. Oracle tests integrated technology stacks for real-world conditions with the latest hardware revisions and software patch baselines.

Since Oracle gained operational control of Sun Microsystems in February 2010, one of the major focus areas has been to bring together the various engineering groups from both companies to increase the value that we can deliver to our customers by ensuring the products integrate together. The full stack testing described in this paper is a significant part of these activities. This program is an ongoing part of the product development process, and it has already identified a small number of issues that fall into three major categories:

1. Bugs that were discovered because of the full stack testing. The scale and complexity of the OIST environment exposes some unique conditions that were not present in the standalone product testing or functional unit testing.
2. Issues where a problem in one part of the stack causes unintended operation in another part of the stack.
3. Usability concerns where the products are functioning as intended, however, the messaging to or the interaction with the user can be improved.

For the most recent stack testing results, please visit: www.oracle.com/technetwork/server-storage/solaris/documentation/oistwp-rev2-4-174767.pdf
For More Information

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

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