An Oracle Technical White Paper
October 2013

# Oracle Internal Testing Overview: Understanding How Rigorous Oracle Testing Saves Time and Effort During Deployment

# Introduction

The complexity that surrounds modern computing infrastructures is massive and constantly changing. Setting up technical infrastructures correctly from the start can help to save significant time and reduce the amount of complexity-exacerbated problems downstream. Problems that can be avoided can range from impacting a company's ability to respond to new business directions (at best) or to manage day-to-day operations (at worst). Designed with interoperability in mind, the Oracle software and hardware stack goes through intensive testing and multistage validation before seeing deployment in customer environments. This whitepaper highlights the ways that the many groups within Oracle Engineering work to pretest and validate software and hardware configurations in order to save customers from having to do these tests themselves.

Oracle Engineering puts massive amounts of work into delivering any product into the hands of customers, including synthesizing issues that Oracle has seen in the past to improve output for other customers. The purpose of this paper is to describe how the Oracle Engineering organization tests products both individually and within complex multicomponent environments. The end goal is to allow the consumers of these products the freedom to concentrate more on their own applications and use cases, rather than retesting what Oracle has already examined and validated.

## Install-Time Choices Can Lead to Complex Problems

With the ability to see into complex customer configurations and to be an essential part of product design and definition, Oracle Engineering has established a rigorous internal test and feedback framework. Based not only on internal testing, but also on decades of experience in customer deployments, this framework tests various components (both hardware and software) in many dimensions to help ensure the best product for Oracle's customers. Some common examples of configuration issues Oracle Engineering has seen:

A good example of the integrated approach to infrastructure testing resides in Oracle's engineered systems. Engineered systems are pretested hardware and software setups that help reduce troubleshooting dramatically, while offering the utmost in performance based on a known set of hardware. See the blog posting here to read about a specific case where troubleshooting in a normal fashion would have taken months to resolve a difficult problem, but because of the integration work done by Oracle, the problem was resolved in just a few days: The Unexpected Advantage of Engineered Systems

- Not upgrading hardware/firmware levels to assure latest supported levels are implemented
- Not utilizing latest software versions, releases, and associated patches that are installed for highest support
- Misaligned drive layouts
- Incorrect/ineffective backup of OS and applications
- Ineffective restoration of backups in a timely manner
- No database tablespaces set up correctly for future growth
- No hardware storage provisioning for maintenance of future growth
- Noncompliance to security standards
- Lack of secure cryptographic security set up at each link in a customer's interactions
- Ineffective knowledge of the performance penalty associated with virtualization
- Knowledge and ability to provision more services to normalize that penalty associated with virtualization
- Not running test and development on the correct hardware
- Not taking advantage of hardware-specific performance and security features
- Not taking advantage of hardware failover and high-availability options
- Technical infrastructure not resilient to single-point-of-failure scenarios
- Uncertain knowledge of system/service interdependencies
- Lack of awareness of shutdown/startup procedures
- Lack of clarity around upgrade paths and procedures

- Lack of awareness of compatibility between third-party hardware and devices
- Lack of awareness of compatibility of third-party hardware and protocols
- Differences between production hardware and sales/presales prototypes

It is the goal of this paper to help customers see not only what Oracle tests internally, but also to shed light on some common configuration and install-time choices that create problems far down the line—problems that are not immediately apparent when a system is new.

## How Oracle's Test Methodology Goes Beyond Product Testing

Oracle Engineering focuses in the following three areas: Core, Integration, and Solution. Each test area builds upon the framework of the previous layer, and it is another goal of this paper to describe in detail what each area does, in the hope that customers who read this paper will be able to reduce the amount of testing they are performing and avoid duplicating Oracle tests.

- **Core**: The core (also known as sustaining) team tests old software as well as recently announced features to ensure that they work and do not introduce regressions/bugs.
- **Integration**: The Integration team takes up where the Core team leaves off and assembles those components into multiple-layer configurations of hardware and software that are based on actual customer setups and runs tests between all components (Oracle Database, middleware, and applications).
- **Solutions**: The Oracle Optimized Solutions team focuses on testing and tuning the individual components based on real-world workloads, and it is in charge of getting the best performance possible out of the work the Integration team has done. This also includes sanity checks for baseline components in order to determine anticipated functionality that encompasses CPU, memory, networks, and storage in order to assure a well-balanced systems offering.

At all levels, the test teams focus on finding "hard" bugs that will stop or prevent installations or a smoothly running architecture. In addition, the teams evaluate the "spirit" of the software to make sure it is easy to use and fully documented, and that it provides as smooth a process as possible to the end-goal of a high-performance customer deployment.

What follows is a more detailed description of the three groups' work.

## Core/Sustaining Testing

The Core test team has experience improving and supporting customers running Oracle Solaris (with all the Oracle hardware offerings on which Oracle Solaris runs) and all associated technologies for a period of 15 years and counting (at the time of this writing). This is the group, for example, that customers engage to ask questions about how to move from existing file system technologies like UFS to more modern ones like Oracle's ZFS. Alternatively, this group also solicits feedback from customers about core functionality of Oracle Solaris, like virtualization technologies, and sees how it is being used

in actual customer sites. **Error! Reference source not found.** lists some of the common test patterns this group oversees.

**TABLE 1 CORE TEAM TESTS**

| CATEGORY | TESTED | BENEFIT |
|---|---|---|
| Upgrading | UFS→ZFS migration | Issues detected and commonly encountered via this upgrade path are either mitigated, or avoidance of issues is explained in existing documents. |
| Networking | IPoIB protocol stack tested extensively | This protocol is able to withstand load at the limit of InfiniBand bandwidth without suffering timeouts. |
| Virtualization | 50+ zone testing | Ability to run many zones concurrently; tested centralized patching of sparse-root zone. |
| Performance | Base validation | All new versions of Oracle Solaris do not have performance regressions from older versions. |
| Experience | Automated install scripts for engineered systems | The Oracle SuperCluster uses complex install scripts to self-configure, and the Core team members are the maintainers of this process, ensuring dependable installation and configuration methods for the Oracle engineered systems family, and ensuring “correct” installs at all times for the hardware and base software. |
| Management | Oracle Solaris Fault Management Architecture (FMA) tie-ins tested | Stated functionality for hardware monitoring works as described, lowering chance of service downtime through proactive management |
| Regression | All new patches tested with previous versions of OS, and all older versions | Other features of the environment do not break when new patches are added. |
| Regression | All drivers for I/O, networking, and storage are tested | Oracle components (HBAs, cards) work without affecting existing components. |
| Conformance / Standards | Testing software for governmental and industry rules adherence | Assurance that governmental and regulatory standards are met, which can be critical to RFPs. |
| Certification | Third-party certification testing | Assurance that third-party certifications, both by Oracle of third-party software and third-party certification of Oracle software, will deliver software that works as intended. |

| | | |
|---|---|---|
| Software | Functional validation of Oracle software (applications and middleware) | Error-free installation and documentation that is prescreened for individual products. |
| Globalization | Manages translations and same-experience testing for all languages which Oracle hardware and software are distributed | Delivery of the same experience for all localizations in working with Oracle Solaris, Java, and associated software/hardware. |
| Security | Tests security | Assurance that the stated strength of published ciphers is present. |
| Coverage | "What Works with What and When" testing | A comprehensive database of all components, from individual Oracle Solaris commands to driver interactions, to make sure that all customer use cases are covered in the testing. |

This table explains what the Core team does: All of the individual components, both existing and pre-released software, are tested first by the Core team for functional testing. Functional testing in this sense means both "does it install/run as it should?" and "does it then work with everything else that is already there?"

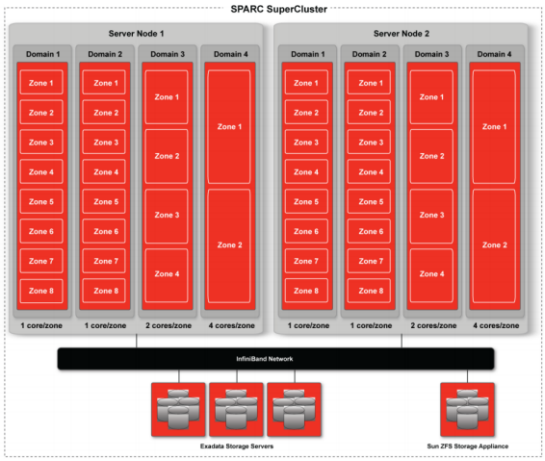



Figure 1. Multiple typical Oracle Solaris Zones configurations on the Oracle SuperCluster.

For instance, the Core team initially tested Oracle Solaris Zones (a virtualization technology) at a maximum number of 10 zones on a server. The team members routinely found that customers were using in excess of 50 zones per server and adjusted their test use cases to exceed what the customers were deploying. Later on, the Oracle Optimized Solutions team used that information to create the Oracle Optimized Solution for Enterprise Database Cloud.

The Systems Integration Test team picks up where the core team stops. The Core team makes sure that installation methods for individual products work as they should, and that new products do not interfere with existing functionality. The Systems Integration team, the next step in the testing framework, focuses on making sure that all of the higher level components work together.

## Systems Integration Testing

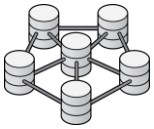
The Systems Integration team tests how components work together in more complex deployment scenarios. This team builds upon years of customer engagements to architect optimal test architectures proactively, replicating those architectures inside of Oracle to create real-world, multitier architectures upon which to do testing. The resultant configurations encompass the full range of deployment scenarios that exist at customer sites. In some cases, the configurations include all Oracle gear; and in other cases, third-party storage or networking is used to run tests. After these customer deployment methods are replicated inside of Oracle, the Systems Integration team deploys software and plans and implements complex evolutions about which customers express concerns to Oracle. See **Error! Reference source not found.** for a list of what the Systems Integration team looks for and tests.

**TABLE 2 SYSTEMS INTEGRATION TESTS**

| CATEGORY | TESTED | BENEFIT |
|---|---|---|
| Upgrade: Storage | Migration from older FC storage to Oracle's Pillar Axiom storage system | Documentation provided in Oracle Pillar Axiom documentation set derived from this testing |
| Upgrade: OS | Migration and upgrade from Oracle Solaris 10 to Oracle Solaris 11 | Assurance that upgrading the OS does not introduce regressions in functionality. |
| Upgrade: Legacy Oracle's SPARC | New I/O layouts and performance profiles detailed | Direct input into Oracle Optimized Solutions teams to document optimal migration path (see later section in this paper) |
| Management: | Stated capabilities of Oracle Enterprise Manager Ops Center for hardware and software monitoring and maintenance verified | Validation of functionality for management of individual servers as well as Oracle Engineered Systems |
| Install and Deploy | Verification of installation checklists and remediation of bugs, if found | Standardized installs of software both by service technicians, as well as preloaded Oracle Solaris, prevent need for reinstall and repatching by customers. |
| Install and Deploy | Out-of-the-box experience (OOBE) testing to ensure that complex installs happen the way the software designers intend and meet customer expectations | Manual installs and automated installs happen in less time and are synchronized with installation documents. |
| Install and Deploy | Multiple methods tested | Testing of non-obvious procedures seen via customer engagements. Testing of OS installation from backups, using USB devices, migrating from existing platforms ensures that the variety of installation methods work |

| | | |
|---|---|---|
| | | as described.. |
| RAS | Oracle VM Server for SPARC (LDOM) dynamic reconfiguration execution on high stress systems | Assurance that dynamic removal/addition of vCPUs and memory occur without failure. |
| RAS | Injecting faults into: I/O subsystems, Externally Initiated Interrupt XIR on a high-performance system, applying a JTAG shadow scan on a high-stress system, injecting CPU and memory errors on a running system, running many (10+) users on the service processor at one time, service processor fast reboot loop testing | Assurance that silent data corruption or or other non-obvious failures are found and corrected. |
| RAS | Testing for memory leaks in software. | Often these errors are found only after 24/48/72 hours and are, therefore, impossible to diagnose at install time. Elimination of the need for memory stress testing at customer sites. |
| RAS | Hot plug testing for all components | No unexpected driver or OS issues arise when removing components from a running/high stress system. |
| RAS | Burn in testing of all hardware components | New hardware burn-in to verify supplier burn-in for disks, memory, networking, CPU, system board, and all components to ensure they meet established reliability guidelines for new componentry. Long term reliability of hardware is more assured by internal validation of supplier guarantees for quality products. |
| Fault Remediation | If bugs are found, the systems integration team assigns an engineer to be responsible for the bug tracking and resolution | There is a known contact point for monitoring the bug and the process for resolution. |
| Performance | Logical domain/Oracle VM Server for SPARC performance testing with multiple combined virtualization technologies | Assurance that contention issues, when running multiple virtualization technologies, do not appear when resources are fully utilized on high-stress systems. |
| Interoperability | Combined I/O technology testing: iSCSI, FCoE, FC, InfiniBand, IPMP, link aggregation | All connectivity stacks talk to each other at maximum performance levels. |

Oracle is committed to the integration testing of current system designs in a manner that is robust against future potential changes in design or features. For example, recommended system designs employ root disk mirroring and failover to alternative physical or virtual drives. Reflecting the popularity of emerging iSCSI SAN technology, **Error! Reference source not found.** shows the following nine related combinations of technologies that also have been tested.



For an in-depth look at the test processes the internal teams use, please see the Oracle white paper entitled: The Oracle Integrated Stack – Complete, Trusted Enterprise Solutions

**TABLE 3 TYPES OF BOOT DRIVE TECHNOLOGIES TESTED**

| | | ROOT MIRROR TYPE | |
|---|---|---|---|
| **ROOT DISK TYPE** | Local | Virtual | iSCSI |
| **LOCAL** | X | X | X |
| **VIRTUAL** | X | X | X |
| **ISCSI** | X | X | X |

Although some of these specific technology combinations may not be part of current technical designs, the validation of "plausible" combinations of technologies ensures that current and future engineered system designs are robust against both intended and inadvertent design changes. This is a robust engineering design practice based on testing "more than necessary" rather than testing "just enough." Figure 2 shows some of the variations on engineered system technologies that have been investigated and tested for compatibility and interoperability.

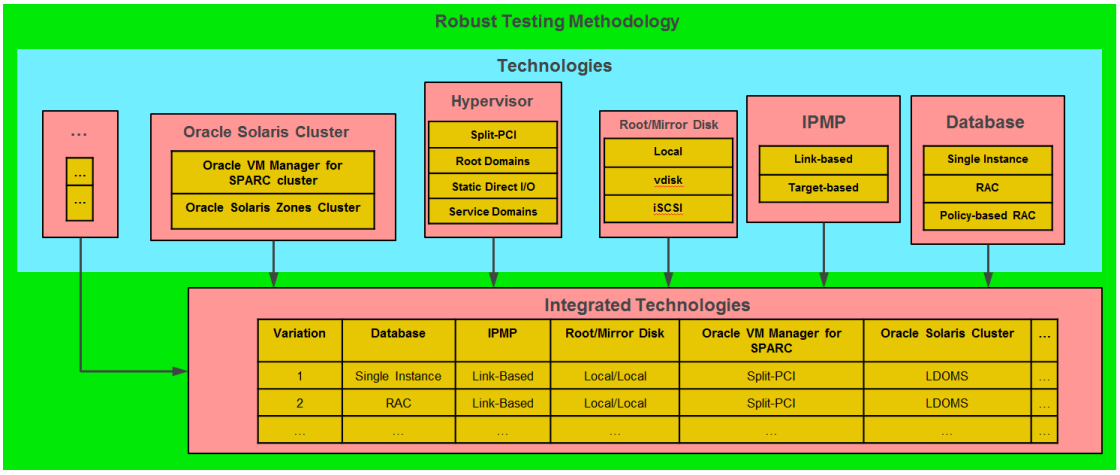



Figure 2. Systems Integration Team test matrix for engineered systems.

In addition to testing functional components, the Systems Integration team tests themed configurations that are determined by real customer setups. These "themes" are:

- ERP
- Financial

- Database
- Performance validation
- Next-generation testing (for testing prerelease systems)

The testing done on these themed platforms is based on the previous functional validations but differs in significant ways. These differences are centered on the subtleties that arise out of specifics related to the hardware itself, and are listed here:

- I/O card are positioned for best utilization of resources, based on overall I/O bandwidth.
- Architectures are installed to comply with "best practices" for storage layouts, networking redundancy, and ease of backup/recovery, as suggested in Oracle best practices guides.
- Installations are performed via jumpstart (Oracle Solaris 10 and earlier) or the Oracle Solaris Automated Installer feature (Oracle Solaris 11) as per installation standards.

The final layer of product testing takes configurations from the Systems Integration team and builds high-performance, customer-deployable configurations via Oracle Optimized Solutions. The Oracle Optimized Solutions team incorporates all of the previous testing methodologies and lessons learned, but focuses more on real-world deployment and lifecycle concerns. Specifically, the focus is measurement of overall system performance, not just at install time, but over years of upgrade and improvement cycles.

## Oracle Optimized Solutions

The third area of testing that is performed in Oracle Engineering happens in the Oracle Optimized Solutions group, and it is the most publicly available resource for customers. Taking up from where the core and Systems Integration teams leave off, the Oracle Optimized Solutions group is tasked with creating architectures that push the limits of what can be done between Oracle software and Oracle hardware. While the Systems Integration team performs testing of multicomponent architectures, the Oracle Optimized Solutions team takes that work and spends significant time tuning and optimizing the architectures to get the best possible performance. Additionally, the team addresses longer-term considerations like backup and recovery and upgrade cycles, and then documents those tunings for use by customers. As a result, the Oracle Optimized Solutions group highlights externally-reproducible reference architectures that provide specific performance for specific use cases.

The Oracle Optimized Solutions team offers specific architectures that can be purchased and implementation guides that explain how to get the best possible performance without lengthy performance studies at customer sites. Internally to Oracle, the Oracle Optimized Solutions team has free reign to choose the best products (both hardware and software) upon which to perform this testing. The result is best-of-breed architectures that can be implemented immediately at customer sites while delivering predictable performance. Care is taken to provide for not only initial deployment ease, but also for ease of manageability and future growth. The benefits gained from Oracle Optimized Solutions are shown in **Error! Reference source not found.**.

**TABLE 4 OPTIMIZED SOLUTIONS TESTING**

| CATEGORY | TESTED | BENEFIT |
|---|---|---|
| Performance | Oracle Optimized Solutions materials come with an implementation guide, a step-by-step manual on how to configure all aspects of the software to best utilize all aspects of Oracle hardware. | The average time for development of one of the Oracle Optimized Solutions is 10 weeks of tuning and performance study. Following the steps in the implementation guide results in achieving up to 90% of the best performance, saving time and establishing an optimal baseline for future growth. |
| Simplicity | Oracle Optimized Solutions materials describe set configurations of the latest hardware and software based on the best choices in the Oracle portfolio. | There are many ways to choose hardware, and relying on an architecture that has already been extensively tested saves time and ensures the best deployment baseline. |
| Baseline | Oracle Optimized Solutions materials take into account backup and recovery, disaster recovery, and future growth. Additionally, there are sane checks made on all components of the Oracle Optimized Solutions architecture to assure each solution works as anticipated and the components are proven to work collectively together. | Though longer term lifecycle concerns like Backup and Recover, or Disaster Recovery are critically important when they do come up, many times they are not considered at service instantiation time, requiring more complex integration efforts later on. When all components of the architecture function initially as planned and collectively as a complete solution, benefits include reduced costs, reduced risks, and increased productivity for customers. |
| Simplicity | All Oracle Optimized Solutions materials are designed to work with other Oracle Optimized Solutions materials. | The Oracle Optimized Solution for Oracle Database is designed to work with the Oracle Optimized Solution for Oracle E-Business Suite, for example, so the methods described in one solution apply to all others, aiding in creating architectures from the documented components. |
| Applicability | The extensive (12 week) test time is predominantly taken up with workload development to create the most customer-like workloads possible. Often, Oracle Optimized Solutions have access to unreleased internal-access-only software and perform sanity plus performance checks to ensure internal feedback and internal regression testing. | Extensive documentation ensures that what is tested internally is documented and is the best fit for the largest number of customers to allow for easier translation of sizing between what Oracle tested and what customers are running. By doing so, customers can rest assured that everything works collectively together. Checks and balances along the way pull components from a solution that may not be best of breed or are not working properly in order to prevent loss of time and productivity on the part of customers |

| | | |
|---|---|---|
| | | who deploy Oracle Optimized Solutions. |
| Cost | All architectures consider the balance between overall performance and hardware/software costs. | Extensive total cost of ownership (TCO) studies are available with individual solutions in the Oracle Optimized Solutions family, and they stand up well against competitor offerings, with everything based on real testing. |
| Applicability | All testing is performed as customers would run those tests. | Some vendors get better numbers by disabling specific components, or running without virtualization in order to get better performance number. All Oracle Optimized Solutions testing is performed as customers would and should run them in production. |

Consider these benefits, available only from Oracle, which are shown in **Error! Reference source not found.**. They all are pretested in Oracle Engineering to work correctly and arise from running Oracle software on Oracle hardware:

**TABLE 5 INTEGRATION-SPECIFIC BENEFITS**

| CATEGORY | SYNERGY | BENEFIT |
|---|---|---|
| Security | Integration between Oracle WebLogic Server and Oracle's SPARC on-processor crypto acceleration | No-added cost cryptographic acceleration that is 3x faster than Intel or IBM solutions, and implementation in 10 minutes. |
| Security | Native Oracle WebLogic Server crypto acceleration support | Delivery of the above benefits WITHOUT application changes as the crypto protection happens at the application server level and not within the application. |
| Security | Native transparent data encryption (TDE) for the Oracle Database on Oracle's SPARC servers | No-added cost encryption accelerates crypto functions by up to 300% compared to competitive platforms and implements in an entire database in only minutes. |
| MORE | | |

The Oracle Optimized Solutions group, and the underlying work of the other two teams, provides some notable benefits to running an Oracle on Oracle stack:

- Performance information at each level already has been done at a granular level to help customers estimate the size and amount of hardware needed to accomplish specific goals within a solution area.
- Lifecycle concerns around patching, maintenance, and disaster recovery (often overlooked at the time of sale) are well documented and known within Oracle hardware engineering, and are planned for with specific guidelines.

- End-to-end security is also planned for, which is also often overlooked in application-specific conversations. The holistic, experience-based perspective on Oracle hardware engineering allows for the unique values offered by Oracle's leading security features to apply to each layer above.

Additionally, because Oracle has engineering teams that work together between the hardware and software divisions, there are synergies that occur that do not exist when technology components are sourced from different vendors.

## Conclusion

Going beyond the test groups doing their jobs and building on each other's work, Oracle strives to showcase why having the complete stack of hardware and software can offer unique benefits to customers. Through documentation and testing, the benefits of using all Oracle components come out when the interplays between specific hardware and software features become clear. Study the example below that shows an architectural layout of one of Oracle's Industry Business Unit solutions:

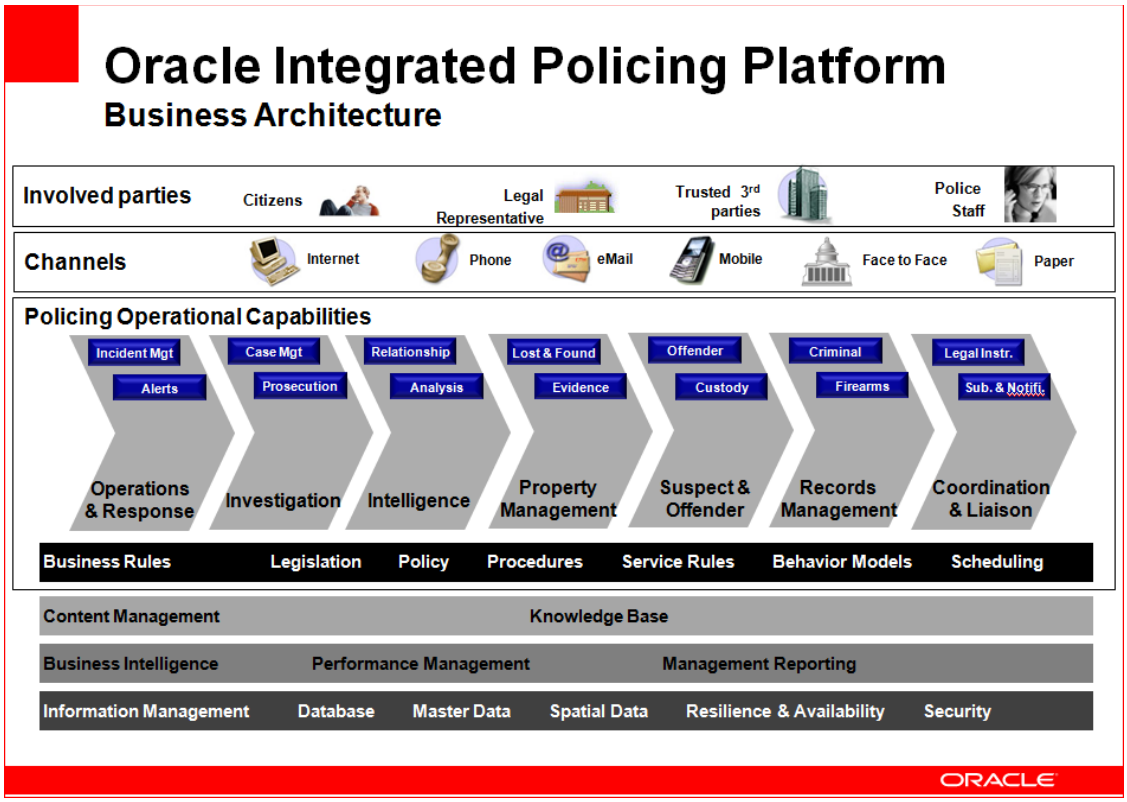



Figure 3. Integrated policing platform high-level overview.

This is a high-level overview of how a multitier architecture solves a specific problem; in this case, a complex public sector/inter-agency communications need. Overlaying the work of the three groups on

this architecture, it is possible to see how an extremely complex set of technologies can be implemented much more simply using the work that Oracle has already done internally.

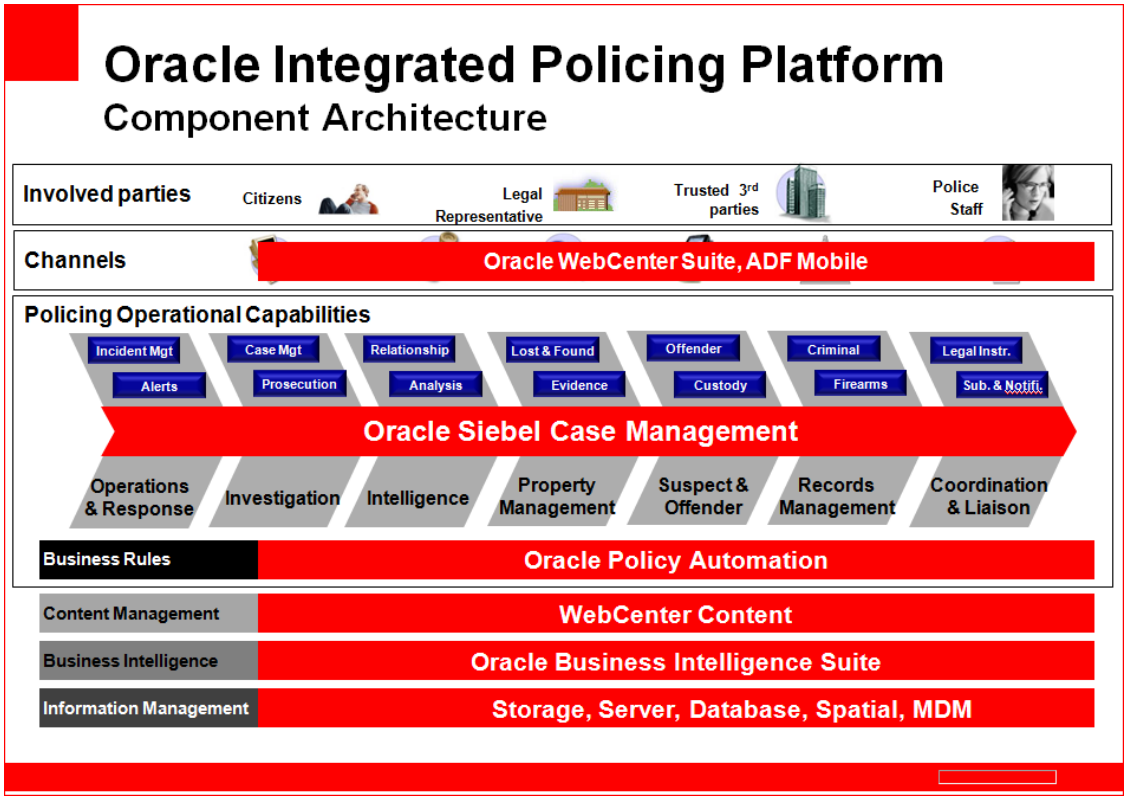



Figure 4. Integrated policing platform mapped to Oracle Optimized Solutions offerings.

Though the above figures denote a complex architecture that is designed to service thousands of highly skilled workers, the implementation of this architecture is made more understandable through the work of the three groups described in this paper. With a solid testing foundation, the Oracle Optimized Solution group has developed ready-made architectures for all of the above components that not only address install-time savings, but also take into account lifecycle concerns such as patching, upgrades, and disaster recovery scenarios.

The tables in this paper are designed to be checklists for organizations to evaluate the testing that they perform in-house that might not need to be done because the same testing is done inside Oracle. For more detailed information on any of these items, organizations should contact an Oracle technical sales consultant who can put them in touch with Oracle Engineering.

Oracle Internal Testing Overview:
Understanding How Rigorous Oracle Testing Saves Time and Effort During Deployment
October 2013

Oracle Corporation
World Headquarters
500 Oracle Parkway
Redwood Shores, CA 94065
U.S.A.

Worldwide Inquiries:
Phone: +1.650.506.7000
Fax: +1.650.506.7200

oracle.com

Oracle is committed to developing practices and products that help protect the environment



**Hardware and Software, Engineered to Work Together**