Exalogic & Exadata: The Optimal Platform for Oracle Knowledge
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Executive Summary

Increasing customer satisfaction while containing service costs in an ever more competitive landscape is critical to ensuring business success. One of the largest factors contributing to service costs is lengthy calls into the contact center. Contact center managers are constantly striving to shave seconds off of call handling times. Improving the performance of Oracle Knowledge (formerly InQuira) can reduce average call handling times while improving customer satisfaction. Improving the performance of Oracle Knowledge can also improve web-facing performance. According to Jupiter Research, 33% of dissatisfied website visitors attributed their dissatisfaction to the website being too slow¹.

Oracle’s engineered system (hardware and software optimized to work together) for Oracle Knowledge is the Exalogic Elastic Cloud and Oracle’s engineered system for the Oracle database is the Exadata Database Machine. Together, these engineered systems can improve customer satisfaction by improving the performance of Oracle Knowledge by 2x over its already industry-leading baseline performance on a traditional hardware/software stack. For an organization receiving 250,000 calls per day, that translates to $21.9m in savings per year in just contact center labor – not including the benefits of consolidation, integrated management/monitoring, and any additional top-line revenue that is gained by loyal customers who receive an excellent support experience.

In addition to unbeatable performance, Exalogic and Exadata allow Oracle Knowledge deployments to be brought to market faster than traditional systems. Exalogic and Exadata contain everything needed for a new environment. They contain networking switches, storage (special database-aware storage in the case of Exadata), flash, RAM, and compute nodes, which are all pre-integrated and optimized to work together. Exabus (InfiniBand networking technology, related protocols, and Java APIs) connects all components within the system and between engineered systems. Furthermore, the software on top of the hardware has been vertically optimized to work with other software as well as with the hardware. New environments can be up and running in as little as a day² as opposed to the months it traditionally takes.

Finally, the total cost of ownership is dramatically reduced due to Exalogic and Exadata’s pre-integrated architecture, end-to-end vertically integrated monitoring (Oracle Enterprise Manager) and because Oracle Knowledge runs 2x more efficiently on Exalogic and Exadata, you can eliminate 1/2 of the CPU cores, when compared to traditional systems. An example of how Exalogic and Exadata reduce the total cost of ownership is in how patching is performed. All patches and firmware updates at and below the operating system are provided in one certified update, similar to how hardware and

¹ http://www.akamai.com/dl/reports/Site_Abandonment_Final_Report.pdf
² http://www.youtube.com/watch?v=aWHPc188tus
software updates are all bundled in single iPhone updates. Gartner\(^3\) estimates that staffing and implementation account for 71% of a system’s total cost of ownership over five years. Oracle Enterprise Manager coupled with Exalogic and Exadata will reduce these costs.

Together, these benefits come together to create an unparalleled platform for Oracle Knowledge.

Oracle Knowledge Introduction

Oracle Knowledge is the industry’s leading enterprise knowledge management solution for multi-channel customer support.

Key components of Oracle Knowledge include:

- **Knowledge for Contact Center.** Fast, accurate answers for contact center staff. Fully integrated with Oracle CRM
- **Knowledge for Web Self Service.** Provides a rich experience for customers seeking answers through the web so that they don’t have to initiate expensive support calls
- **Integrated Social Forums.** Cost-effectively scale an organization using social media channels to crowd source knowledge and deflect problems to the community
- **Knowledge Platform.** Search, content management, integration, analytics, and other platform services required to build a robust knowledge foundation

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\(^3\) Philip Winslow, “Dr. Exalove: How I Learned to Stop Worrying (about Sun) and Love Exalogic Too,” Credit Suisse, Nov. 23 2010
Technical Architecture

Oracle Knowledge is a Java-based application that runs on Oracle WebLogic. It uses a traditional tiered architecture with a relational database on the back-end.

Oracle Knowledge, especially Web Self Service, is deployed in the most demanding of environments, with large configurations serving millions of end-customers concurrently and thousands of page views per second. All components in the stack are scaled horizontally and/or vertically, depending on what makes the most sense for a given use case. Bottlenecks in the system are most frequently due to I/O – both within a single JVM and when calling out to remote hosts. Exalogic and Exadata eliminate these bottlenecks.

While the traditional deployment architecture that Oracle Knowledge uses has proven to be sufficient, Exalogic and Exadata bring benefits that are substantially better and simply unachievable through other means.

Exalogic Introduction

Exalogic is a rack-based system containing compute nodes (x86 servers), RAM, FlashFire SSD, and ZFS storage, all pre-integrated to work well together and connected using Exabus (InfiniBand networking technology and related protocols). Exalogic is available in configurations containing 48 CPU cores (⅛th rack), 96 CPU cores (¼th rack), 192 CPU cores (½ rack), and 360 CPU cores (full rack), with the ability to seamlessly link up to eight racks of Exalogic together using Exabus.
Each configuration of Exalogic contains the appropriate amount of RAM, SSD, and storage so that the system is “balanced” for optimal performance. Configurations below a full rack (\(\frac{1}{8}\), \(\frac{1}{4}\), \(\frac{1}{2}\)) may be upgraded (e.g. \(\frac{1}{4}\) to \(\frac{1}{2}\)) without any downtime. Each configuration leverages the same physical rack.

Oracle Linux or Solaris 11 Express for x86 may be selected for the operating system, with each having been extensively tuned for the underlying hardware. Oracle Linux, like Red Hat Linux, is based on the Fedora Core codebase, so applications are likely to be highly compatible. Oracle’s JVMs (HotSpot and JRockit), Oracle WebLogic, Oracle Coherence, and many Oracle applications have been modified and tuned to transparently take advantage of the hardware and software below it in the stack. The additional changes and tuning are fully transparent, so no special knowledge or hotfixes are required. This vertical integration between software and hardware is part of what enables Exalogic to provide such exceptional performance for Oracle Knowledge. Similar gains can be realized in the database tier by using the Exadata Database Machine, an engineered system optimized for OLTP and OLAP workloads.

A defining feature of Exalogic is the elimination of I/O bottlenecks through an I/O subsystem called Exabus. This subsystem is a collection of technology including InfiniBand switches, gateways, host channel adapters, firmware, device drivers, operating system extensions and software libraries. Together, this technology allows the kernel and operating system’s TCP/IP stack to be bypassed (also known as Remote Direct Memory Access, or RDMA) for most inter-process communication. Within the same Java process, I/O bottlenecks are eliminated through extensive tuning at all layers.

Exalogic is engineered to be managed and monitored as one single stack. Oracle Enterprise Manager (for software) and Oracle OpsCenter (for hardware) allow for comprehensive system-wide management because they were modified and configured for Exalogic. While Enterprise Manager and OpsCenter work well in a heterogeneous environment with non-Oracle products, they work especially
well with Oracle products including Exalogic. Patching and other maintenance becomes a lot easier because Oracle can provide single file patches (from storage to operating system) due to its knowledge of each system’s configuration. With a finite and well-known number of system configurations, it becomes easy for Oracle to release consolidated patches. Finally, embedded hardware diagnostic capabilities allow for Exalogic to “phone home” to file Oracle Service Requests in the case of hardware failures. The integrated nature of Exalogic, the quality of the products on their own, and the value of the integrations between these best-of-breed products inside of Exalogic allows for unparalleled management, monitoring and ease of maintenance.

Internally, Oracle uses Exalogic as the foundation for its Public Cloud. Exalogic is easy to set up and performs exceptionally well, which makes it optimal for an environment such as Oracle’s.

Exadata Introduction

Exalogic and Exadata are very similar, with the major difference being that Exadata is optimized for running the Oracle Database whereas Exalogic is optimized for running Oracle middleware and applications. Much of the technology that comprises Exalogic came from Exadata. Exadata is the preferred platform for the database(s) behind Oracle Knowledge because of its performance, reliability, advanced connection capabilities to Exalogic, and overall total cost of ownership. Oracle Knowledge is fully certified to run with Exadata and requires no further optimizations to Oracle Knowledge to take advantage of Exadata.

Exadata comes in quarter, half, and full rack configurations. A full rack of the X2-8 model contains 160 cores, 4 TB of RAM, 14 storage cells (up to 150 TB total usable storage), and 5.3 TB of PCI-based flash. A full rack of Exadata is more than sufficient for most Oracle Knowledge deployments. Within one rack of Exadata, there may exist multiple database instances, each of which may or may not be in a clustered RAC configuration. A single database may be split across two or more racks of Exadata in a RAC configuration, for high availability. A database on Exadata may be replicated to another database for disaster recovery using Oracle Data Guard. Exadata runs Oracle Database 11g Release 2, but with transparent optimizations for the Exadata hardware and other software. Any feature available in Oracle Database 11g Release 2 is available on Exadata.

Exadata can run the Oracle Database exceptionally well for the same reasons that Exalogic runs Oracle Knowledge exceptionally well – extensive tuning, engineering the hardware and software to work together, and innovations that are only available with the stack. Exadata contains a number of innovations, including:

- **Hybrid Columnar Compression.** Traditionally, all columns for a particular row are stored sequentially within a single database block. This allows for fast record-oriented read access but allows for only minimal compression. The alternative is to store columns of data together, which allows for high compression but can create excessive I/O for multi-column access. Hybrid Columnar Compression permits data to be stored in a hybrid of both, which achieves the benefits of columnar storage compression and the performance of sequential row storage. Average storage savings are 10x-15x with some customers seeing significantly higher
compression rates, depending on the data structure. So the 150 TB of usable storage in a full rack is effectively 1.46 PB (assuming 10x compression)

- **Smart Scans.** In a non-Exadata configuration, an Oracle database typically uses a SAN for storage. When a query is executed, all relevant rows and columns are returned to the database, with the database CPU performing the filtering and returning the resultset to the application. With Exadata, each storage cell contains 12 CPU cores and portions of the Oracle Database software, with the ability to perform data filtering at each storage cell. As a result, the database receives only the data it actually needs and applicable queries will be executed in parallel across each of the 14 storage cells. This results in less data being sent to the database and less processing needed in the compute nodes.

- **Smart Flash Cache.** A full rack of Exadata contains 5.3 TB of flash (PCI cards, not flash disks), which functions as an intelligent cache to offload physical I/O from the disks. Smart Flash Cache allows up to 1.5 million random I/O operations per second (IOPS) and can scan data at up to 75 GB/sec. This feature allows for at least 10x better performance (roughly ½ a millisecond per single block read) when compared to a traditional disk.

- **Full Database Encryption.** Hardware-based encryption may be used to encrypt a database running on Exadata. Moving encryption and decryption from software to hardware results in a 5x performance improvement. Data can be decrypted at a rate of hundreds of gigabytes per second.

While Exadata and Exalogic are outstanding on their own, they are even more powerful when linked together. Using the Active GridLink for Oracle RAC feature found in Oracle WebLogic, Oracle Knowledge running on Exalogic can communicate with an Oracle database running on Exadata using Exabus, at a rate of 960 gigabits/sec with latency of 1.2 microseconds. Traditionally, application servers are connected to databases over gigabit Ethernet with milliseconds of latency. In addition to raw throughput and low latency, Exabus allows the TCP/IP stacks (and thus kernels) to be bypassed in both Exadata and Exalogic, which is a form of Remote Direct Memory Access (RDMA). Together, these optimizations allow for 3x better OLTP performance.

![Exabus Diagram](image)

In addition to latency and throughput improvements, Active GridLink for Oracle RAC provides other functionality such as fast connection failover, runtime connection load balancing (balance queries...
across RAC nodes based on real-time load), and XA affinity (bind certain queries back to the same RAC node).

Together, these features come together to provide the optimal database platform for Oracle Knowledge.

**Benefit #1: Improved Operational Efficiency**

Gartner attributes 71% of a system’s total cost of ownership to staffing (people who maintain systems) and implementation (people who build and deploy systems)⁴. Exalogic and Exadata provide dramatically reduced total cost of ownership by reducing the amount work that people have to do and reducing the quantity of hardware and software that must be managed. This allows organizations to focus limited resources on activities that contribute to the top-line revenue. For example, resources can be freed up to improve search relevancy as opposed to tuning Oracle Knowledge for optimal performance.

Exalogic and Exadata reduce the total cost of ownership in the following three ways 1) the systems are pre-built so there is no need to design, procure, assemble, deploy, and tune each one, 2) the systems are easier to manage because of the holistic management approach that is taken with Oracle Enterprise Manager, and 3) less hardware is required because Oracle Knowledge runs 2x more efficiently on Exalogic and Exadata.

Since each rack of Exalogic and Exadata is an entire pre-built system (as opposed to a collection of individual components), there is no need to design, procure, assemble, deploy and tune each unique system. Exalogic and Exadata are conceptually similar to a laptop, in that customers buy pre-packaged complete systems containing hardware and software optimized in a vertical stack. Customers would not tolerate having to design a new laptop, procure individual parts from different vendors (e.g. screen,

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⁴ Philip Winslow, “Dr. Exalove: How I Learned to Stop Worrying (about Sun) and Love Exalogic Too,” Credit Suisse, Nov. 23 2010
RAM, processor, hard disk, etc), assemble the parts into a single laptop, install an operating system, and tune the operating system to take advantage of the hardware on which it is installed. Instead, everybody buys pre-assembled laptops that can be plugged in, turned on, and immediately operational. Oracle is taking this concept to the enterprise.

Instead of being a collection of individual components, Exalogic and Exadata are single cohesive systems providing all the benefits of being single systems. Exalogic and Exadata are maintained, managed, monitored, deployed and tested as one system.

The components of Exalogic and Exadata are engineered to work well together, leading to such benefits as single file patches and storage to application management through Oracle Enterprise Manager. Enterprise Manager has even been modified to work better with Exalogic:
In addition to providing management and monitoring capabilities, Enterprise Manager 12c supports static (self-service) and dynamic (real-time load-based) provisioning. When it is used in this capacity, Exalogic is used as a pool of hardware resources that can be either statically or dynamically provisioned for different uses. For example, hardware in a single Exalogic system could be provisioned to a pre-
production environment for testing, a production environment for a big sale, and then finally to the contact center for post-sale customer service. Provisioning in this manner is scaling out an environment. This drives up resource utilization, which allows for a greater return on investment.

Finally, the 2x better throughput (page views per second per CPU core) and better resource utilization due to the provisioning capabilities of Enterprise Manager lead to needing half of the hardware that would traditionally be required. So a production environment for Oracle Knowledge requiring 300 CPU cores would only require 150 CPU cores with Exalogic, and so on. Exalogic also reduces the number of physical servers that must be managed. A traditional blade server has around eight CPU cores. So a production environment requiring 300 CPU cores would require 38 individual servers, each of which must be procured, shipped, racked, stacked, cabled, etc. A single rack of Exalogic would be all that is required. It costs less money to manage fewer CPU cores. The benefits only multiply when Exadata is being used.

The integrated nature of Exalogic and Exadata, the quality of the products on their own, and the value of the integrations between these best-of-breed products allows for unparalleled management, consolidation and time-to-market, leading to a reduced total cost of ownership.

**Benefit #2: Improved Customer Satisfaction**

While Oracle Knowledge is already recognized for excellent performance, Exalogic and Exadata bring performance to a level that is unattainable elsewhere.

Better performance translates to customers not giving up on the self-service experience and picking up the phone to initiate an expensive service call. Better performance means agents are able to more quickly answer calls, which makes customers more satisfied while lowering costs.

Extensive benchmarking has shown the throughput and performance of Oracle Knowledge to be at least 2x better on Exalogic, WebLogic and Exadata when compared to traditional commodity x86-based blades, Tomcat and a database running on commodity x86-based blades. Here’s a breakdown by functionality:

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Exalogic</th>
<th>WebLogic</th>
<th>Exadata</th>
<th>Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput (tx/sec)</td>
<td>2X</td>
<td>2X</td>
<td>2X</td>
<td>2X</td>
</tr>
<tr>
<td>Avg SQL Query Improvement</td>
<td>8X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* for Analytics
In addition to customer and associate-facing response time improvements, the top 10 analytics database queries (from a large customer) were executed and the results were made available to the application on average 8x faster.

<table>
<thead>
<tr>
<th>Query</th>
<th>Description</th>
<th>Traditional (sec)</th>
<th>Oracle Exa* (sec)</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Session Usage</td>
<td>174.86</td>
<td>21.36</td>
<td>718.63%</td>
</tr>
<tr>
<td>2</td>
<td>Response Timing</td>
<td>45.53</td>
<td>52</td>
<td>-12.44%</td>
</tr>
<tr>
<td>3</td>
<td>Popular Questions</td>
<td>58.21</td>
<td>11.75</td>
<td>395.40%</td>
</tr>
<tr>
<td>4</td>
<td>Activity Usage Report</td>
<td>28.07</td>
<td>43.9</td>
<td>-36.06%</td>
</tr>
<tr>
<td>5</td>
<td>Popular Responses</td>
<td>1824.23</td>
<td>235.75</td>
<td>673.80%</td>
</tr>
<tr>
<td>6</td>
<td>Process Wizard</td>
<td>2182.9</td>
<td>268.3</td>
<td>713.60%</td>
</tr>
<tr>
<td>7</td>
<td>Unknown Words</td>
<td>58.53</td>
<td>14.61</td>
<td>300.62%</td>
</tr>
<tr>
<td>8</td>
<td>Concept Matches</td>
<td>85.64</td>
<td>2.87</td>
<td>2883.97%</td>
</tr>
<tr>
<td>9</td>
<td>Number of Questions</td>
<td>83.33</td>
<td>18.26</td>
<td>356.35%</td>
</tr>
<tr>
<td>10</td>
<td>Questions by Type</td>
<td>111.23</td>
<td>19.86</td>
<td>460.07%</td>
</tr>
</tbody>
</table>

Exalogic and Exadata enable this industry-leading performance through vertical integration between hardware and software, the elimination of I/O bottlenecks through Exabus technology, and tuning Oracle Knowledge to fully utilize the entire stack. For example, Active GridLink for RAC, a component of WebLogic, is used to connect Exalogic to Exadata over an InfiniBand-based network with a throughput of 960 gigabits per second, as opposed to the traditional 1 gigabit per second. Bottlenecks have been entirely eliminated from the stack – not simply moved elsewhere. It is the elimination of bottlenecks that leads to such fast performance and high throughput.

Savings can be realized by reducing average call handling time. Let’s apply this to a hypothetical contact center with 250,000 calls per day and an average call length of five minutes.

<table>
<thead>
<tr>
<th>Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calls Per Day</td>
</tr>
<tr>
<td>Average Call Length (minutes)</td>
</tr>
<tr>
<td>Page Views Per Call</td>
</tr>
<tr>
<td>Average Response Time (sec)</td>
</tr>
<tr>
<td>Time Waiting for Response (sec)</td>
</tr>
<tr>
<td>Cost Per Call</td>
</tr>
<tr>
<td>Cost Per Second Per Call</td>
</tr>
<tr>
<td>Cost Per Year</td>
</tr>
</tbody>
</table>

Now let’s introduce Exalogic and Exadata and apply the performance gains identified during benchmarking. With 10 page views per call and reducing the average response time from two seconds to one, that saves 10 seconds from each call and reduces the call length to 4.8 minutes, which is a 4% improvement.
With this 4% reduction in average call handling time, the cost drops by 4% or $21.9m/year.

**Benefits**

- Annual Savings $21,900,000.00
- Savings Over 5 Years $109,500,000.00

Depending on the specific application and the specific implementation, cost savings may be substantially greater.

**Benefit #3: Fast Time-To-Market**

Exalogic and Exadata can go from arriving at a loading dock to being available for an Oracle Knowledge production deployment in as little as a day\(^5\), as opposed to the months it traditionally takes to procure, set up, configure, and tune a traditional bespoke system. Because Oracle is responsible for connecting the storage, networking, compute nodes and all supporting software, on-site setup time is minimal. Oracle has invested significant resources to ensure that Exalogic and Exadata arrive on-site ready to be plugged in, configured, and operational. Oracle has also performance tuned all software that sits on Exalogic so that it can be used to run Oracle Knowledge without further tuning.

Once Exalogic is running, Oracle Enterprise Manager can be used to automate Oracle Knowledge provisioning. Traditionally, application server instances have been statically provisioned by hand in a production environment, with a WAR file being deployed to each application server instance. Exalogic's hardware resources can be dynamically or statically provisioned, with Oracle Knowledge being quickly scaled up or down using a simple admin interface.

The benefit of Exalogic and Exadata’s fast time-to-market capabilities is that it allows organizations to focus resources on higher value activities, like improving search relevancy in order to provide a more satisfying customer experience. With Exalogic, Oracle has assumed responsibility for the majority of an environment’s creation while streamlining Oracle Knowledge’s production rollout by automating many Oracle Knowledge deployment-related tasks. Furthermore, the work Oracle does prior to Exalogic and

\(^5\) [http://www.youtube.com/watch?v=aWHPC188tus](http://www.youtube.com/watch?v=aWHPC188tus)
Exadata delivery helps to take a lot of the risk out of an Oracle Knowledge deployment by ensuring that Oracle Knowledge is deployed to a rock-solid foundation.

Exalogic and Exadata enable fast time-to-market because the software and hardware that comprise them were designed with that in mind. When software and hardware are designed to work together, less time is spent trying to get everything to work together.

Conclusion

Exalogic and Exadata should be considered whenever a new Oracle Knowledge environment is built, whether for a new implementation, a hardware refresh, or an upgrade of Oracle Knowledge. Exalogic and Exadata bring unbeatable time-to-market, increased top-line revenue through increased customer satisfaction, cost savings, and low total cost of ownership (not having to design/procure/assemble/deploy/tune, integrated management/monitoring, needing half of the hardware that would traditionally be needed), all of which act together to provide the best return on investment and make Exalogic and Exadata the best platform for deploying Oracle Knowledge.