Scale Up vs. Out:
A Brief Guide to Scaling Oracle Databases
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Executive Summary

Big data has put a big squeeze on businesses, as data grows much faster than IT budgets: Gartner forecasted a worldwide overall IT spending increase of only 3.8% for 2014,\(^1\) while global information volumes rising over 59% each year.\(^2\)

Since companies need all their data to glean insights about their business, organizations are now looking for ways to handle exploding data volumes while reducing costs and maintaining performance.

These trends are overwhelming both databases and budgets, particularly when it comes to Oracle, which prevails as the most popular relational database management system or RDBMS.\(^3\) Scaling Oracle solutions can be difficult and expensive. Managing large volumes and achieving high levels of concurrency often means expensive, scale-up hardware.

As such, many businesses with Oracle databases have began to investigate solutions that can affordably scale-out on commodity hardware. Scale-out solutions spread the data and the computation across a cluster of inexpensive machines in parallel instead of centralizing data and computation on more expensive hardware.

On the surface there are many alternative scale-out technologies, but it turns out that most are inadequate for current Oracle database users:

- **NoSQL solutions** (e.g., MongoDB, Cassandra), by design, lack SQL joins, aggregations, and transactions, which will force major rewrites for any application currently using an Oracle database.
- **SQL-on-Hadoop** solutions (e.g., Hive, Impala), designed only for ad-hoc analytics, are unable to support real-time operational applications, which often require transactional updates and a high concurrency of small reads and writes.

Thus, for organizations that are looking to scale affordably with a proven scale-out technology but still maintain full SQL support and RDBMS functionality, a Hadoop RDBMS is the obvious answer.

Harte Hanks, a global digital marketing services provider, selected Splice Machine, a Hadoop RDBMS, to replace its Oracle RAC databases and saw the following results:

- Queries become 3-7x faster
- Over 75% less expensive
- Well over 10x better price/performance
- Dramatically simplified scaling going forward

Harte Hanks was able to achieve these results without rewriting its IBM Unica campaign management software, Cognos business intelligence reports, Ab Initio ETL scripts, or Trillium data quality software.
In 2013, American market research firm IDC projected that from now until 2020, the digital universe will double every two years, driven by a plethora of data sources—financial transactions, web and application logs, device data, advertising, email, demographics, and social media. Most businesses recognize that data is an important corporate asset that they can no longer throw away. However as data grows, many are facing frustrating setbacks: reports taking hours to complete, users impatiently waiting for applications to respond, and DBAs constantly tuning their databases.

These bottlenecks can occur at hundreds of gigabytes, but they become significant issues with Oracle and MySQL databases once data volumes exceed 1TB. In fact, in a recent survey conducted by marketing research firm Zer0 to 5ive, 70% of those polled are already experiencing cost and scaling issues with their Oracle databases.

Since IT budgets have grown less than 5% annually over the past three years, this rapid data growth is putting a “big squeeze” on IT departments. This has led many companies to actively investigate more affordable scaling alternatives to their expensive ‘Big Iron’ databases, such as Oracle and IBM DB2.
Scale-Up vs. Scale-Out

Scalability is the ability of a system to accommodate a growing amount of data and/or workload. There are generally two ways to scale:

- **Scaling up** by adding more resources to a single server
- **Scaling out** by adding more servers to the system that simultaneously cooperate

Of course, there are the options of throwing the data away or storing it in cold storage, but in practice these are not viable options for companies that want to extract business value from their data in a timely fashion.

The decision ultimately comes down to price/performance. If money is no object, scaling up works well because it often does not require changes to the applications if you stick with your vendor, but it will require a hardware migration every time a new larger server replaces the old one.

However, even if scaling up works well initially, it suffers from the law of diminishing returns: costs will rise significantly faster than performance, and eventually technological innovation will plateau to the point when higher performance cannot be achieved no matter the price.

On the other hand, scaling out may pose its own issues, depending on the functionality of the scale-out solution. For instance, NoSQL solutions will often require rewriting applications currently on an Oracle database. However, SQL scale-out solutions require less migration over the lifetime of an application, because they automatically redistribute loads as new nodes are added and do not require discrete hardware upgrade projects.

Ultimately, businesses should seek out cost-effective technologies that can scale to large amounts of data without losing key database functionality or performance. The next few sections will discuss the tradeoffs on scaling up on Oracle vs. scaling out on modern architectures such as NoSQL databases and Hadoop.

### Scaling up on Oracle: An expensive endeavor

Although NoSQL databases such as MongoDB and Cassandra have gained traction in the past few years, that does not mean traditional technologies are being abandoned en masse. InfoWorld recently reported that 79 percent of respondents still used relational databases, and many of those were likely to use them in the future.

Whether by virtue of its merit as a legacy RDBMS or by the constraints of vendor lock-in, Oracle remains one of the most widely used databases around the world with a 48% market share according to Gartner. For businesses already utilizing Oracle Database, the two most common scaling options are RAC and Exadata, which are expensive, scale-up solutions.
Oracle RAC

Oracle Real Application Clusters (RAC) is the clustered version of Oracle Enterprise Edition Database which is designed for high availability, agility, and performance. Although Oracle often positions RAC as a scale-out option, given that it is technically distributed across multiple machines, it is important to note that it cannot truly scale out because it still relies on shared storage and thus cannot efficiently tackle bottlenecks.

Shared nothing architectures, on the other hand, are what technologists define as true scale-out infrastructures because each machine takes ownership of some of the data, thus eliminating the need to synchronize, which can degrade performance.

The Oracle RAC architecture includes large servers, very fast networks, and storage area networks (SANs). However, this all comes as a considerable cost: a RAC license is approximately $23,000 per processor in addition to the Enterprise Edition of the Oracle Database license.

<table>
<thead>
<tr>
<th>ORACLE RAC COSTS</th>
<th>UNIT PRICE (DISCOUNTED 60%)</th>
<th>UNIT</th>
<th>3-YEAR COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oracle Database Enterprise Edition with RAC</td>
<td>$37,750</td>
<td>64</td>
<td>$966,400</td>
</tr>
<tr>
<td>3 years DB Maintenance ($22% list price/yr)</td>
<td>$24,915</td>
<td>64</td>
<td>$637,824</td>
</tr>
<tr>
<td>3 years Operating System Support (Oracle Linux)</td>
<td>$6,897</td>
<td>4</td>
<td>$11,035</td>
</tr>
<tr>
<td>Server Costs (mid-range, Intel Xeon-based)</td>
<td>$16,000</td>
<td>4</td>
<td>$64,000</td>
</tr>
<tr>
<td>Primary Storage</td>
<td>$143,360</td>
<td></td>
<td>$143,360</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$228,922</strong></td>
<td></td>
<td><strong>$1,822,619</strong></td>
</tr>
</tbody>
</table>

The costs detailed in the table above from FlashDBA assumes prices for four nodes (16 cores each) and 20TB of usable disk storage. It demonstrates that despite a 60% discount, the total cost of ownership for Oracle RAC can easily reach millions of dollars in just a few years for a relatively small Big Data data set (20TB).
Oracle Exadata

Oracle Exadata is a database appliance that runs the Oracle Database. By using flash memory, InfiniBand switches and Hybrid Columnar Compression, this engineered system is designed to be a turnkey solution for both operational (OLTP) and analytic (OLAP) workloads.

<table>
<thead>
<tr>
<th></th>
<th>EIGHTH RACK</th>
<th>QUARTER RACK</th>
<th>HALF RACK</th>
<th>FULL RACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware Price</td>
<td>$220,000</td>
<td>$330,000</td>
<td>$625,000</td>
<td>$1,100,000</td>
</tr>
<tr>
<td>Exadata Storage</td>
<td>$180,000</td>
<td>$360,000</td>
<td>$840,000</td>
<td>$1,680,000</td>
</tr>
<tr>
<td>Server Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Exadata</td>
<td>$376,000</td>
<td>$856,000</td>
<td>$1,712,000</td>
<td>$3,424,000</td>
</tr>
<tr>
<td>Database Tier Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Exadata</td>
<td>$776,000</td>
<td>$1,546,000</td>
<td>$3,177,000</td>
<td>$6,204,000</td>
</tr>
<tr>
<td>System Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While Oracle positions Exadata as a scale-out solution, it should be noted that it does not fall under commodity scale-out that the marketplace has come to expect. Although it has the potential to store up to large volumes of data (up to a few hundred TBs per full rack, depending on drive capacities), the prices listed above demonstrate that Oracle Exadata can easily place a burden of millions of dollars on IT budgets.\(^{11,12,13}\)

**Oracle scale-up is too expensive**

Whether considering RAC, Exadata, or other database options from Oracle, one advantage is that there are no software migration costs as there would be with NoSQL solutions. The simplicity of having ‘one throat to choke’ may seem appealing, but the exorbitant costs make ownership of Oracle products less and less desirable as the need for scaling exponentially grows over time.

Beyond just hardware and direct software costs, scale-up systems can be costly to maintain. Migrating hardware from the original system to new scale-up servers can also be quite disruptive, especially if data growth increases the frequency of those migrations. Organizations may also delay adding new servers because of migration impacts, leading to greater operational costs to constantly tune overloaded databases or to prune data.
Scaling out: Simplifying an Overwhelming Array of Options

The high cost of scaling up Oracle databases has driven many businesses to seek affordable scale-out solutions. Similar to the migration from massive mainframes to smaller PC-based servers, big data has accelerated the replacement of expensive scale-up systems with modern scale-out architectures that use commodity hardware to dramatically improve price/performance.

However, the overwhelming number of scale-out technologies can make it difficult to determine the right technology for a business and its applications. However for Oracle users, most of the scale-out database alternatives can be eliminated because they are niche, not popular, or are very poor substitutes for Oracle databases:

- **NoSQL solutions** (e.g., MongoDB, Cassandra), by design, lack SQL, joins, aggregations, and transactions, which will force major rewrites for any application currently using an Oracle database.
- **SQL-on-Hadoop solutions** (e.g., Hive, Impala), designed for ad-hoc analytics, are unable to support real-time operational applications, which often require transactional updates and a high concurrency of small reads and writes.

Thus, for organizations that are looking to scale affordably with a proven scale-out technology but still maintain full SQL support and RDBMS functionality, a Hadoop RDBMS is the answer.

Hadoop RDBMS: A general purpose, operational database with Hadoop scale-out

A Hadoop RDBMS is a general purpose, operational database capable of handling mixed workloads (OLTP and OLAP) in real time. By combining full ANSI SQL support with the Hadoop ecosystem, businesses can scale-out from gigabytes to petabytes without applications rewrites or IT retraining.

Enterprises will find all of the key functionality they have currently in their Oracle databases in a Hadoop RDBMS:

- Joins
- Secondary indexes
- Aggregations
- Reliable updates through ACID transactions
- Ability to support a high concurrency of small reads and writes
- Support for OLTP or OLAP workloads

A Hadoop RDBMS provides the best of all worlds:

- **FULL** functionality of an operational RDBMS
- **5-10x** better performance with extensive parallelization
- **75-80%** reduction in costs through the use of commodity hardware

**RESULTS**

A Hadoop RDBMS provides the best of all worlds:

- FULL functionality of an operational RDBMS
- 5-10x better performance with extensive parallelization
- 75-80% reduction in costs through the use of commodity hardware
Harte Hanks Case Study: Replacing Oracle RAC

Optimizing Campaign Management. Marketing services provider Harte Hanks was experiencing serious scaling challenges with their Oracle RAC databases. Harte Hanks used the databases to provide its clients with a 360° view of their customers, but their queries were getting slower, in some cases over a half hour to complete. Expecting 30-50% future data growth as more data sources were added like mobile and social interactions, the company was concerned that performance issues would become increasingly worse.

Harte Hanks needed to provide deeper insights to its clients by drastically increasing the amount of data at its disposal without any expensive Oracle database upgrades. It also desired more effective personalization through faster queries that power cross-channel campaigns.

Requirements. To reduce costs and handle the increased data load, Harte Hanks recognized that it needed a new scale-out database solution that could leverage the proven scale-out of Hadoop while still ensuring seamless integration to its complex environment of existing applications and tools (e.g., IBM Unica campaign management, IBM Cognos business intelligence), which require ACID compliance and ODBC/JDBC standards.

Results. The company chose Splice Machine, a Hadoop RDBMS to support its mixed workload applications (OLAP and OLTP). They saw a 75% cost savings with a 3-7x increase in query speeds. They can now easily scale out to hundreds of terabytes by adding commodity servers.

Harte Hanks can now cost-effectively add significantly more data to improve the quality of the services it provides to its clients:

• A 360° view through a customer relationship management system
• Personalized campaign execution
• Cross-channel campaign analytics with real-time and mobile access so customer insights can be rapidly shared across organizations

Ultimately, by replacing Oracle RAC with Splice Machine, Harte Hanks has experienced a 10-20x improvement in price/performance, without any rewrites to its IBM Unica campaign management software, Cognos business intelligence reports, Ab Initio ETL scripts, or Trillium data quality software.

“Splice Machine’s Hadoop RDBMS delivers all of the functionality and performance we need. We are delighted with our initial results where queries execute several times faster on a significantly less expensive cluster.”

Rob Fuller
Managing Director of Product Innovation
Harte Hanks
Reducing Risk with Safe Journey

Working with customers like Harte Hanks, Splice Machine has designed a Safe Journey program to significantly ease the effort and risk for companies migrating to a Splice Machine database. The Safe Journey program includes a proven methodology that helps choose the right workloads to migrate, implements risk-mitigation best practices, and includes commercial tools that automate most of the PL/SQL conversion process.

Risk mitigation best practices that are a part of the Safe Journey program

This is not to suggest that all Oracle databases will convert to a Hadoop RDBMS. Best candidates will typically have over 1TB of data, which often leads to cost and scaling issues in Oracle databases.

Companies start deploying Hadoop RDBMSs to:

- **Upgrade ODSs** - Many companies have started first by replacing older Operational Data Stores (ODSs) that have offloaded operational reporting and ETL functions from expensive OLTP systems and data warehouses. ODSs are a great place to start, as they have relatively little PL/SQL and often exceed 1TB.
- **Deploy new applications** - New applications are also excellent candidates to use a Hadoop RDBMS instead of an Oracle database.
Scale-Out: The Future of Databases

Facing increased data growth and cost pressures, scale-out technology has become very popular as more businesses become frustrated with their costly scale-up RDBMSs. With Hadoop emerging as the de facto scale-out file system, a Hadoop RDBMS is a natural choice to replace traditional relational databases like Oracle struggling with cost or scaling issues.

A Hadoop RDBMS enables companies to leverage modern scale-out technology to change how they manage their data and develop new applications:\textsuperscript{14}

<table>
<thead>
<tr>
<th>THE PAST</th>
<th>THE FUTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small data volumes; purge often</td>
<td>Massive data volumes; retain forever</td>
</tr>
<tr>
<td>Slow data velocity</td>
<td>Rapid data velocity</td>
</tr>
<tr>
<td>Rigid, static data of similar structure</td>
<td>Flexible, fluid data of many structures</td>
</tr>
<tr>
<td>One-to-one, shared disk architecture</td>
<td>Many-to-many, shared nothing architecture</td>
</tr>
<tr>
<td>Primary Storage</td>
<td>Scale both writes and reads</td>
</tr>
<tr>
<td><strong>Scale-up on proprietary hardware</strong></td>
<td><strong>Scale-out on commodity hardware</strong></td>
</tr>
</tbody>
</table>
About Splice Machine

Designed to meet the needs of real-time, data-driven businesses, Splice Machine is the only Hadoop RDBMS. Splice Machine offers an ANSI-SQL database with support for ACID transactions on the distributed computing infrastructure of Hadoop. Like Oracle and MySQL, it is an operational database that can handle operational (OLTP) or analytical (OLAP) workloads, while scaling out cost-effectively from terabytes to petabytes on inexpensive commodity servers.

Splice Machine marries two proven technology stacks: Apache Derby and HBase/Hadoop. With over 15 years of development, Apache Derby is a popular, Java-based SQL database. Splice Machine chose Derby because it is a full-featured ANSI SQL database, lightweight (<3 MB), and easy to embed into the HBase/Hadoop stack.

Splice Machine chose HBase and Hadoop because of their proven auto-sharding, replication, and failover technology. HBase also enables real-time, incremental writes on top of the immutable Hadoop file system, and since Splice Machine does not modify HBase, it can be used with any standard Hadoop distribution. Supported Hadoop distributions include Cloudera, MapR and Hortonworks.
ENDNOTES