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Performance Testing Results:
Oracle's Enterprise-grade Cloud is Here



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Putting Oracle Cloud to the Test

Cloud computing is revolutionizing many aspects of business. In particular, the ability to provide technology platforms and infrastructure "as a service" is driving positive change in IT operations, helping companies bridge the gap to digital innovation, quickly and cost effectively.

By doing so, it is simplifying and accelerating the modernization of systems, and enabling the kind of IT innovation and flexibility that is increasingly important to the business.

The advantages of the cloud are increasingly clear. But less clear is the path that companies should take to move to the cloud. In what might be called the "Cloud Wars," a growing range of vendors are bringing cloud-based solutions to the market—and with them, a flood of claims and messages that can be difficult to sort through. To make decisions, executives need solid information—the details of database performance and insights into the real-world feasibility of putting critical systems on the cloud. To a great extent, their concerns boil down to two key questions: "Is the cloud ready to handle enterprise-grade solutions? And is it going to be cost-effective?"

To help answer these questions, Accenture conducted a series of performance tests on various Oracle Infrastructure-as-a-Service (IaaS) and Platform-as-a Service (PaaS) cloud solutions, along with other commonly used solutions, both on-premises and cloud-based. For the tests, the researchers ran the Oracle Database using a high transactional data set, mirroring what high-performance enterprises have in their production environments.

The test results indicate that the answers to those key questions are "yes and yes." Overall, the Oracle solutions delivered more than three times the performance of other solutions, and demonstrated that they could handle more than five times the transactions per dollar. The researchers had hypothesized that Oracle would naturally build its cloud to work well with Oracle Database. The test results showed that Oracle solutions provide a cost-effective approach to handling enterprise workloads; and in a larger sense, the results underscore the fact that the cloud has evolved into an attractive mainstream technology for businesses.

Examining the Cloud

In assessing the Oracle cloud solutions, Accenture looked at the performance they delivered, and then calculated the cost of that performance. The tests deployed Oracle Database 12c on a variety of solutions.

These included two IaaS offerings: Oracle Compute Cloud Service and Oracle Bare Metal Cloud, a new offering that Accenture was able to test before its actual release. The bare metal service runs on dedicated servers, rather than in a virtual, shared environment. Tests were also conducted on two PaaS offerings (or Database-as-a-Service offerings, in this case): The Oracle Database Cloud Service (DBCS) and the Oracle Exadata Cloud Service.

For comparison, the tests were also performed with on-premises implementations of commodity hardware and the Oracle Exadata solution, as well as on a non-Oracle cloud solution. For all the tested solutions, the researchers used "off the shelf" offerings; no enhancements, modifications or configuration changes were made to them.

The tests were conducted by the Accenture Enkitec Group, which brought extensive real-world experience to the process. The group has one of the largest concentrations of senior talent in Oracle database and engineered systems in the world, and has completed well over 600 Oracle Exadata implementations worldwide. The Oracle cloud tests were conducted at the group's Oracle Innovation Center in Dallas, Texas, and drew on experts from around the globe.

The researchers used the Swingbench load generator tool both to create data for testing and then to execute the various testing scenarios, which provided a consistent approach across all the tested solutions.

The tests were conducted in two phases: one involving a "vanilla" configuration of the database, and one where common tuning adjustments had been applied to the database. Researchers ran workloads involving 40, 80 and 200 users for 60 minutes. In total, Accenture ran 66 test cases.

The tests clearly showed that the Oracle Cloud options provided the high levels of performance that enterprise solutions require. Overall, the Oracle Cloud solutions delivered up to 3.4 times the performance of a similar IaaS solution on the other cloud when running the same workloads on like-for-like configurations.

To develop a clear understanding of costs, Accenture performed tests with cloud solutions running on servers with two Oracle Compute Units (OCPU), the equivalent of a 4-vCPU server. Researchers found that the Oracle solution could complete 4.8 million transactions an hour with 200 virtual users. The other cloud solution was able to handle 1.4 million transactions. To achieve performance similar to the Oracle solution, the researchers had to scale the other cloud solution's configuration up to a 16 vCPU server with an advanced storage solution, which allowed them to reach 5.4 million transactions. By comparison, when the researchers ran the same test on the Oracle solution with 4 OCPUs (8 vCPU), more than 8.5 million transactions were completed, resulting in more work with half the resources.

The Cost of Cloud

Looking at performance and factoring in standard pricing, Accenture determined that the Oracle Public IaaS Cloud could run about 24,000 transactions per hour for each dollar spent per month.

The other IaaS cloud solution would run about 4,650 transactions per hour for each dollar spent per month. And the expanded, 16 vCPU version of the other IaaS solution would handle about 3,000 transactions per hour for each dollar spent per month, making it up to five times more expensive than the comparable Oracle IaaS Cloud solution.

Another way to compare the costs is on a per-transaction basis. The costs for the Oracle IaaS cloud solution would be \$.15 per transaction per second, compared to \$.77 for the other IaaS solution, and \$1.21 for the high-performance version of that solution. It's valuable to note that as Oracle's solution increases in size and power, the cost of a transaction per second does not change.

Many Accenture clients have asked how the Exadata Cloud solution compares to running Exadata on premise. With that in mind, the researchers ran head-to-head tests of the two. The Oracle Exadata Cloud Service provided performance similar to that of the on-premises version. The researchers also calculated the total cost of ownership of the two approaches, using standard pricing.

Over three years, the cloud solution would cost \$1.4 million, while the on-premises solution would cost just over \$2 million when compared at list prices, as shown in the table below. The annual costs would be much closer to each other by year five—but that similarity would essentially be negated as the hardware would likely be due for a refresh. In addition, these calculations did not take into consideration a number of on-premises costs—such as installation services, networking, cooling, and floor space—which would not be incurred with the Exadata Cloud service.

Figure 1: Costs per transaction illustrates the true cost of cloud computing

	Parameter	Oracle IaaS		Leading Cloud	
		Like for Like	Increased Size	Like for Like	High Performance
Configuration	vCPU	4	8	4	16
	RAM (GB)	30	60	30	122
	Storage Type	Latency Optimized	Latency Optimized	General Purpose SSD	Provisioned IOPS SSD
	Storage Amount (GB)	650	650	650	650
Performance Results	Total Transactions	4,837,067	8,510,204	1,397,270	5,445,992
	Transactions Per Second (TPS)	1343.63	2,363.95	388.13	1512.78
	Average Response Time	75.08	19.00	457.85	12.36
	Cost per Month	\$200.00	\$350.00	\$300.76	\$1,828.56
	Trans/\$1/Hr each Month	24,185	24,314.86	4,645	2,978
	Cost of One Transaction per Second	\$0.15	\$0.15	\$0.77	\$1.21

Figure 2: Exadata Cloud Service helps provide reduced complexity of implementation with a lower TCO

	On-Prem Exadata	Exadata Cloud Service
1st Year Cost	\$1,500,560.00	\$480,000.00
2nd Year Cost	\$252,560.00	\$480,000.00
3rd Year Cost	\$252,560.00	\$480,000.00
Total Cost Over 3 Years	\$2,005,680.00	\$1,440,000.00
4th Year Cost	\$252,560.00	\$480,000.00
5th Year Cost	\$252,560.00	\$480,000.00
Total Cost Over 5 Years	\$2,510,800.00	\$2,400,000.00

Behind the Numbers

How does Oracle's cloud offering provide this performance? Accenture's analysis found that the Oracle server CPUs spent less time waiting, compared to the other cloud solution.

On that other solution, the input/output operations per second (IOP/S) are throttled, leading to delays at the CPU level. In other words, less efficient storage solutions caused the servers to have to wait for results from the disk. Thus, in order to reach the same level of storage input/output (I/O) throughput, the researchers had to upsize the other solution's server.

Beyond the performance illustrated in these tests, Oracle's cloud solutions have a number of differentiating factors that companies should consider. For example, Oracle's approach to building cloud offerings differs from that of other providers. Oracle can provision what clients require, rather than oversubscribing the hardware with the hopes that workloads across the cloud remain consistent. In addition, most providers sell portions of a CPU core, whereas Oracle sells entire physical CPU cores, which means clients are not required to share this physical infrastructure with other companies.

Beyond those performance metrics, the researchers noted a number of other relevant Oracle cloud characteristics:

- During the tests, it took 10 minutes to install the Oracle database software on the Oracle Cloud, and 41 minutes to do a full restore. Based on Accenture's experience, those tasks can typically take up to twice as long on other solutions.
- Oracle Database Cloud Service offers both single-instance and Real Application Cluster (RAC) database options. RAC on DBCS is designed for maximum throughput, while other solutions do not provide the network architecture required to support RAC.
- With IaaS, Oracle allows clients to install a wide variety of Oracle database versions. Throughput-optimized and low-latency storage options are available for supporting both smaller databases and those with more I/O intensive applications.
- Exadata Cloud gives clients the Oracle Database with all its features included; these can be turned on or off as the client requires. The ability to take advantage of

these features—rather than having to purchase them separately—can add to the cost-effectiveness of the Exadata Cloud approach.

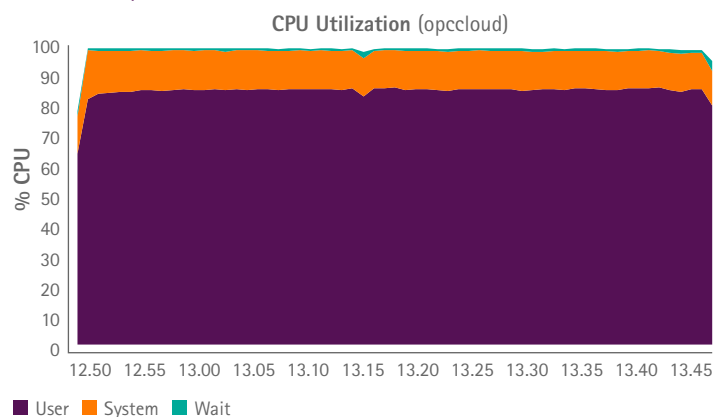
- The Oracle Public Cloud Bare Metal service allows customers to install any version of database software. It offers storage options that include standard disks as well as Non-Volatile Memory express (NVMe) disks—that is, flash disks. These offer storage performance that allows the service to be one of the top-performing options for an OLTP database.

As the tests found, Oracle cloud solutions offer an attractive option for companies interested in the cloud. The tests focused on running a specific solution, Oracle Database. But the findings are widely applicable, because about half the world's data resides on Oracle databases.

Of course, performance and costs are just two of many factors that need to go into a company's assessment of the cloud—but they are critical factors. Understanding them is an important step as companies plan their move to the cloud.

Figure 3: Slower disk results in underutilized server CPUs

Oracle Compute



Other IaaS

