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# Oracle Exadata Cloud Infrastructure X9M comparisons to AWS RDS and Microsoft Azure SQL Server

Exadata Cloud Infrastructure X9M is a high-performance cloud database platform delivered in Oracle Cloud Infrastructure (OCI) data centers and Dedicated Regions. It enables organizations to benefit from cloud automation and consumption-based economics using either Oracle Exadata Database Service or Oracle Autonomous Database Service. Customers can run OLTP, analytics, and in-database machine learning workloads with IO latencies as low as 19 microseconds, analytic scan throughputs of up to 2.88 TB/second, and up to 22.4 million SQL IOPS with only 8 Exadata Database servers.

Exadata Cloud Infrastructure X9M builds on a unique scale out design and implements more than 60 optimizations that are coengineered with Oracle Database and are not available on other cloud services or cloud platforms delivered in customer data centers. For instance, the use database-transparent persistent memory (PMem) with Remote Direct Memory Access over Converged Ethernet (RoCE) enables Oracle Database to read data from storage servers with less than 19 microsecond latency, which is 25X faster than AWS RDS and 50x faster than Microsoft Azure SQL Server.

## Exadata Cloud Infrastructure X9M performance compared to AWS RDS in the AWS cloud

Customers can run Oracle Database in AWS RDS in the AWS cloud. For this comparison, we are looking at the highest performance available to a single Oracle Database instance. The highest performing AWS RDS platforms in the cloud are the db.r5b configurations using EBS on SSD io2 Block Express storage. This solution provides EBS throughput of "Up to 60 Gbps of EBS bandwidth" (equal to 7.5 GB/second) and "sub-millisecond" latency which has been documented in an AWS blog as being 500 microseconds for Oracle Database.

The relative advantage for Exadata Cloud Infrastructure X9M is calculated as:

Exadata X9M Latency advantage (lower latency is better):

- AWS RDS Latency/Exadata Cloud Infrastructure X9M latency= 500/19 = 26.8x

Exadata X9M Throughput advantage (higher is better):

- Exadata Cloud Infrastructure X9M throughput/AWS RDS throughput = 2,880/7.5 = 384x

AWS's supporting information can be found at:
https://aws.amazon.com/rds/instance-types/ and
https://aws.amazon.com/blogs/storage/achieve-higher-database-performance-using-amazon-ebs-io2-block-express-volumes/

## Exadata Cloud Infrastructure X9M performancecompared to Microsoft Azure SQL Server

Microsoft Azure SQL Server runs the Microsoft SQL Server database for use by enterprise customers. It is not running Oracle Database. For this comparison, we are looking at the highest performance available to a single Oracle Database instance on Exadata Cloud Service X9M compared to a single Microsoft Azure SQL Server database. According to Azure documentation, the maximum "Data/Log IOPS" rate for an Azure Business Critical system is 320,000 with this IOPS rate supported for IOs of up to 64 KB (65,536 Bytes) in size, resulting in a maximum throughput of 320,000 x 65,536 = 20.97152 GB/second. Similarly, Azure documentation states that the minimum IO latency is 1-2 milliseconds for the premium service tier.

The relative advantage for Exadata Cloud Infrastructure X9M is calculated as:

Exadata Cloud InfrastructureX9M Latency advantage (lower latency is better):

- Azure SQL Server/Exadata Cloud Infrastructure X9M latency= 1,000/19 = 52.6x

Exadata Cloud Infrastructure X9M Throughput advantage (higher is better):

- Exadata Cloud Infrastructure X9M throughput/Azure SQL Server throughput = 2,880/21 = 137x

The supporting Azure documentation can be found at:
https://docs.microsoft.com/en-us/azure/azure-sql/managed-instance/resource-limits

## Exadata Cloud Infrastructure X9M continuous operations during scaling compared to AWS RDS and Azure SQL

Exadata Cloud Infrastructure can scale the number of CPU cores used by database processes without interrupting operations. This is accomplished through the use of Oracle Real Application Clusters, which is a capability supported by both Oracle Autonomous Database Service and Oracle Exadata Database Service.

In contrast, AWS RDS utilizes fixed instance sizes that require a DB image reboot when changing between instance types, and this leads to a database outage. The AWS documentation states

"A DB instance outage occurs when you change a setting that requires a reboot, or when you manually cause a reboot," and continues with "A DB instance reboot occurs immediately when one of the following occurs," with the second entry being "You change the DB instance class, and Apply Immediately is set to true." Resizing a virtual machine running a database always requires that you change DB instance classes. In addition, if "Apply Immediately" is set to false, then no scaling takes place until the next maintenance window – when an outage naturally occurs.

This is outlines in the AWS documentation at:
https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/CHAP_Troubleshooting.html

AWS Azure SQL documentation states "Initiating a scale up, or scale down action, in any of the flavors mentioned above (which include DTU scaling for Business Critical service), restarts the database engine process, and moves it to a different virtual machine if needed." And continues with "You can expect a short connection break while the scale up/scale down process is finished."

This is outlined in the Azure SQL documentation at:
https://docs.microsoft.com/en-us/azure/azure-sql/database/scale-resources

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