



Author: Marc Staimer

W H I T E P A P E R

Gen 2 Oracle Exadata Cloud at Customer: **Sacks the Competition**

Gen 2 Oracle Exadata Cloud at Customer: Sacks the Competition

Introduction

The cloud database market has been one of the fastest growing public cloud services. It accounted for approximately \$6.12 Billion USD in 2018 and is expected to grow to nearly \$495.26 Billion USD by 2026, per Statistics MRC. That's an incredible 62.9% compounded annual growth rate (CAGR), with the Asia Pacific market expected to grow the fastest.

The reasons for this phenomenal growth are clearly evident. Database as a Service (DBaaS) makes it easy to access large databases, different kinds of databases (such as relational, data warehousing, JSON, Object, key value, time series, document, graphical, spatial, and more) at nearly any given time and from any Internet connected location. There are no upfront capital expenditures (CapEx) in database servers, storage, networking, rack space, cables, transceivers, conduit, allocated overhead, and data centers. There is no upfront requirement to license and maintain, or subscribe for one or more database licenses by core or system. There is no ongoing requirement to expand those licenses as the databases scale. There are no professional services for installations, implementations and upgrades. There are no application disruptive multi-vendor patching and no database maintenance in-general. In fact, DBaaS is supposed to ensure that all database administrative and maintenance tasks are performed by the service provide, thereby allowing the DBA to focus on new revenue producing projects. Not all cloud service providers see it that way. Some require the user to manage some or all of these issues.

Cloud DBaaS is again supposed to be subscription-based and elastic. Users pay for what they use, only when they use it, thereby reducing their risk. They no longer have to oversubscribe to make sure they have enough resources. That's huge, especially for organizations that have seasonal or spiky business such as retail. They no longer have to size their database and supporting infrastructure. Again, not all cloud service providers see it that way. Scaling up or down may not be automatic and require a disruptive outage to accomplish.

Oracle's DBaaS goes considerably further than any other DBaaS with its unique Autonomous Database Cloud. The Oracle Autonomous Database service is self-driving, self-tuning, self-indexing, self-managing, self-troubleshooting, self-healing, self-learning with built-in AI/ML modeling, and more. It's completely elastic up and down where users only pay for what they use when they use it. The costs commonly come in less than half of other public cloud service providers such as AWS. The service is based on the 1st all-inclusive database that supports just about every type of database including relational, data warehousing, time series, object, JSON, key value, document, spatial, and graphical each with access to the same data and all included in the same subscription. Oracle refers to this as converged database technology. No data movement or ETLs are required. The Oracle Autonomous Database service turns databases into a complete service with pre-built and production-proven algorithms. Database administrators no longer have to be database experts.

But what can organizations do that need or want those cloud database services, but can't move to the cloud? The reasons vary as to why they can't move to the cloud. The most common reasons being because of regulatory requirements, tight sub-second database application response times, immovable legacy applications, data sovereignty laws, personally identifiable information (PII) laws, or just strong risk aversion. The answer for these organizations is instead of moving the customer's databases to the cloud, move the managed DBaaS cloud to the customer's premises. Managed DBaaS cloud on-prem gives them some, most, or all of the DBaaS cloud capabilities (depending on the vendor) while satisfying their cloud DBaaS objections. Managed DBaaS on-prem is frequently referred to in the trade press as a "hybrid cloud" or "multi-cloud" implementation that keeps the mission-critical/sensitive applications and data on-prem, and their data protection and DR in the public cloud.

When seeking a managed DBaaS on-prem, the essential question is whether or not the service provider is delivering the managed DBaaS on-prem at your expense or benefit? Are they learning from you what they don't know? It's analogous to someone learning how to shave on your face. This is what AWS will be delivering when they roll out Outposts and VMware Outposts. Since Outposts is based on commodity-off-the-shelf hardware, and AWS RDS performance is well known, it is likely to come in at $\leq \frac{1}{4}$ of Gen 2 Oracle

Exadata Cloud at Customer. Neither Google Anthos nor Microsoft Azure currently offer or have announced a managed DBaaS on-prem at this time. If or when they do, their on-prem services rely on the customer buying or leasing from the usual hardware vendor suspects that neither Google nor Microsoft use in their own clouds. That means the hardware on-prem will be different from the hardware in the cloud, changing the user experience. Recent changes in accounting procedures require hardware leases to be counted as capital expenditures (CapEx), not operating expenditures (OpEx), degrading the managed DBaaS on-prem value proposition. Azure Stack additionally requires an “Azure Stack Operator” customer headcount. This is a skilled employee on the customer payroll, not Microsoft Azure’s payroll. This is analogous to a customer paying for the right to pump gas in addition to paying for the gas.

Clearly while most public cloud service providers are trying to figure out their managed DBaaS on-prem offering, Oracle is busy delivering its second generation managed DBaaS on-prem. Exadata Cloud at Customer has been production-hardened over the last three years across hundreds of top tier customer deployments worldwide. An example is the Ford Motor Company. They highlighted at Oracle OpenWorld 2019 their very successful experience with Exadata Cloud at Customer. Ford indicated that they reduced provisioning time from 1 day to 30 minutes, reduced their database instances using multi-tenancy, and drastically reduced patching cycles from 2.5 years to quarterly. These are tangible business results not marketing promises of what could happen if everything aligns in the just the right way.

Gen 2 Exadata Cloud at Customer profoundly ups the ante in expectations for functionality and cost-performance for all other managed DBaaS on-prem vendors. In other words, Gen 2 Oracle Exadata Cloud at Customer has changed the game so much, that other managed DBaaS on-prem offerings have been **sacked** before they’ve been released.

This research report examines how that 2nd generation of Oracle Exadata Cloud at Customer renders all other on-prem managed DBaaS **obsolete**.

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Business & Government IT Organizations DBaaS On-Prem Requirements

User requirements, expectations, and demands are the criteria upon which all DBaaS on-prem managed services are or will be judged. Establishing that criteria is the first step. That criteria are the key to delivering an effective service. Every IT organization will have variations, but there are several commonalities. As previously stated in the introduction, IT organizations that would like to utilize cloud DBaaS but can't because of tight sub-second database application response times; regulatory requirements; immovable legacy database applications; data sovereignty laws; personally identifiable information (PII) laws such as GDPR; or strong risk aversion. That means any effective on-prem managed DBaaS must address and solve these issues.

Performance

The DBaaS performance must meet or exceed all database application requirements including tight sub-second response times, volume, variety, veracity, and volume. It cannot be less and more importantly, it must be capable of scaling more than what they have today.

Flexibility

Elastic, easy, seamless, on-demand scalability to meet performance and capacity demands as they increase both for the databases, database instances, and the hardware supporting it. Provide more than one kind of database such as relational, key value, object, XML, JSON, time series, graphical, document, spatial, in-memory, in addition to the consolidation of multiple databases.

Security

Security is more important than ever today. Malware attacks, especially ransomware attacks, have increased exponentially with a new variant hitting the wild every 18 seconds. Data breaches have become increasingly costly with new laws and regulations that protect personally identifiable information (PII) data. End-to-end security has become a must. And for managed DBaaS, that security must not reduce performance.

Simplicity: in Implementation, Operations, Management, & Troubleshooting

It's a managed service. That means it needs to provide fast, easy installation, database set-up, hardware setup, configuration, provisioning of storage, and network setups. Database and hardware day-to-day operations and management beyond the actual database usage is transparent to the database applications and DBAs. This includes patching, tuning, troubleshooting, and upgrading.

OpEx: Must be an End-to-End Operating Expenditure (OpEx) And Relatively Low Cost

The cloud means not having to invest capital or CapEx. A managed DBaaS on-prem moves the cloud on-prem. Any managed DBaaS on-prem needs to be fully OpEx or subscription-based, including the database software, supporting software, hardware, maintenance, management, and support. That means the entire DBaaS must be managed by the service provider. And the total OpEx must be cost-justifiable. In other words, it has to have a financially competitive total cost of ownership (TCO) that's preferably less than what they are doing today over the next 3 to 5 years.

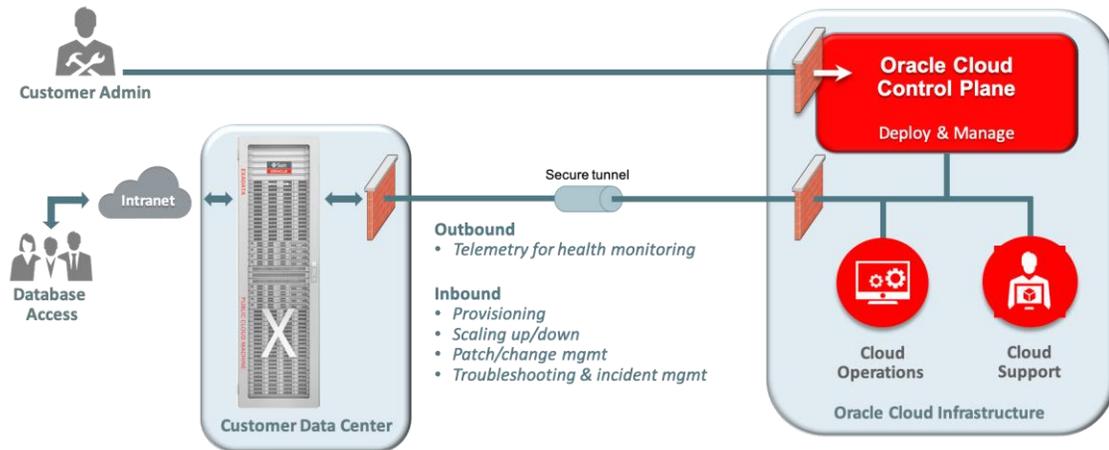
Oracle DBaaS Solution: Gen 2 Exadata Cloud at Customer



Gen 2 Exadata Cloud at Customer starts with the industry's most powerful, production and cloud DBaaS-proven Exadata database machine. Exadata is the only database system co-engineered with the Oracle Database that delivers unprecedented performance, flexibility, scalability, data resilience, and reliability. Exadata is unique as the only database system that supports standard on-prem deployments, DBaaS in the public cloud, and DBaaS on-prem. Exadata Cloud at Customer is a simple, agile, and elastic, subscription, cloud-based deployment in the customer's data center. This Oracle service is derived from the Oracle public Cloud DBaaS. And although the public cloud DBaaS has capabilities not available on Gen 2 Exadata Cloud at Customer such as the Autonomous Database, those capabilities will migrate to the managed DBaaS on-prem in mid 2020. One essential thing that is the same is

that both are managed by Oracle Cloud experts providing a consistent Exadata cloud experience on-prem or in the Oracle Cloud.

Oracle provides customers the option to utilize their own up-to-date Oracle Database licenses on Exadata Cloud at Customer. Or they can utilize the Oracle Database Enterprise Edition Extreme Performance service with every Oracle Database feature and option. The second option ensures customers can use all the features for the highest performance, best availability, most effective security, and simplest management. Customers that bring their own Oracle Database licenses to the Exadata Cloud at Customer will be limited to the features they have licensed. Customers that elect the full DBaaS service from Oracle get all Oracle Database capabilities. Either way, all Exadata features are included. All Oracle Databases deployed on Exadata Cloud at Customer are 100% compatible with existing on-prem Oracle Databases, and Oracle Databases deployed in Oracle Cloud Infrastructure.



Oracle Gen 2 Exadata Cloud at Customer increases performance and functionality over Gen 1. CPU clock speed increases by 28%, and throughput increases by approximately 25%. These performance improvements also mean customers can utilize less hardware to get the same throughput results as Gen 1 Exadata Cloud at Customer. Gen 2 Exadata Cloud at Customer improves on the IOPS as well, increasing them up to 4.78 Million SQL IOPS (8K) per rack. Gen 2 Exadata Cloud at Customer also eliminated the on-premise control plane that shipped with Gen 1, and replaced with the Oracle Cloud Infrastructure (OCI) cloud control plane running in the cloud, assisted by two lightweight control plane servers built-into the Exadata rack. It also automatically encrypts/decrypts in silicon. The new OCI control plane delivers the same UI and APIs as the Oracle Exadata Cloud Service providing a consistent customer experience. That radical control plane hardware reduction significantly reduces power, cooling, supporting infrastructure, and allocated overhead. The increase in performance while reducing OpEx is non-trivial. But it is support for Oracle Database 19c with increased automation such as Automatic Indexing and the built-in AI machine learning that truly sets Gen 2 Exadata Cloud at Customer apart.

Automatic Indexing performs more efficient and effective indexes than master DBAs can provide in multiple orders of magnitude less time. The AI machine learning is far more than a tool kit. It comes with more than 40 production hardened algorithms ready for use.

But how does Gen 2 Exadata Cloud at Customer compare with new managed DBaaS on-prem offerings from AWS, Azure, and Google? The next section looks at exactly what is being offered and how they compare with the Oracle Gen 2 Exadata Cloud at Customer in terms of **performance, flexibility, security, simplicity, OpEx, and TCO**.

Public Cloud Managed DBaaS On-prem Contenders?

There appears to be at first glance, several managed DBaaS on-prem offerings including: AWS Outposts with RDS, AWS VMware Outposts, Microsoft Azure Stack running SQL Server, and Google Anthos. But are they actually managed DBaaS on-prem?

AWS Outposts RDS/AWS VMware RDS (Relational DBaaS) on Outposts Overview



Amazon announced both AWS Outposts and AWS VMware on Outposts in the fourth quarter of 2018. They are scheduled for general availability (GA) by the end of 2019. Both are nascent services with nominal installations in 2019. Hardware and software will be offered on a subscription OpEx basis.

Both flavors of AWS Outposts are general purpose on-prem extensions of the standard AWS cloud and the AWS VMware cloud and services. Amazon is making its relational database service (RDS) available on both. The database utilized in RDS must be specifically selected. Choices include Amazon Aurora (based on MySQL and PostgreSQL), MySQL, PostgreSQL, MariaDB (MySQL fork), Microsoft SQL Server, and the Oracle Database.

When selecting the Oracle Database for AWS RDS, there are severe restrictions. RDS Oracle Database is based on Oracle Standard Edition and cannot run many of the most popular and most useful capabilities including: Real Application Clusters (RAC); AI/ML; auto-tuning; recovery manager (RMAN); automatic storage management (ASM); Database Vault; Flashback Database; Multi-tenant container databases (CDB) and with multiple pluggable databases (PDB) in a single CDB; Oracle Enterprise Manager Cloud Control Management Repository; Real Application Testing; Unified Auditing; Pure Mode; and many more Oracle Database capabilities. It also lacks approximately 60 features only available on Gen 2 Exadata Cloud at Customer such hybrid columnar compression (HCC); Automated Indexing; Smart Flash; Smart Scan; and much more.

AWS RDS Oracle Database data protection is restricted to AWS storage snapshot and asynchronous replication. Replicas lack the fine granularity of RMAN, meaning the entire replica must be recovered even if only a single transaction is sought. And the storage replicas are not readable. They must be recovered first to be readable. Multi-zone RDS only provides the Oracle Database redundancy because once again, the replicas are not readable. RDS also does not provide cross-region DR for the Oracle Database because it does not support Data Guard or Streams.

Most of the other AWS RDS choices are seriously limited in scale – typically 10TB or less unless serious complicated sharding is utilized. More importantly, they are limited in Enterprise or high-end functionality and performance. However, the most hamstrung by AWS is the Oracle Database.

The choices for RDS on AWS VMware on Outposts are fewer with Microsoft SQL Server, PostgreSQL, MySQL, and MariaDB. The Oracle Database is a future choice, but with the same severe limitations.

AWS has several other types of databases other than RDS. However, those databases, which typically support other non-relational data models, are not being offered initially with either AWS Outposts or AWS VMware Outposts. When they are, they will be completely separate databases and separate subscriptions just as they are in the AWS public cloud. Accessing data or data elements from one type of database to another is a complicated, error-prone process that duplicates data and storage costs.

Oracle Gen 2 Exadata Cloud at runs Oracle Enterprise Edition and all its options. Customers who subscribe to Gen 2 Exadata Cloud at Customer have access to all the advanced performance, scalability, security, and availability features in Enterprise Edition. The Oracle Database subscription on Gen 2 Exadata Cloud at Customer is an all-inclusive multi-database, database type, and multi-tenant for consolidation and different customer database requirements. There is no need to use multiple different databases to support customer requirements. There is no duplicate data or additional subscriptions required. There are no islands of data or ETLs required.

Microsoft Azure Stack Running SQL Server

Microsoft released Azure Stack in the second half of 2017. It's an extension of the Azure cloud that provides infrastructure as a service and platform as a service in an on-prem environment. Microsoft Azure Stack is a consistent cloud platform with Microsoft Azure Cloud.



Azure Stack

To deploy Azure Stack requires specific hardware configurations from Microsoft partners; Cisco, Dell-EMC, HPE, Huawei, Lenovo, and others. Note that the Microsoft Azure public cloud doesn't run on these hardware vendors. For Azure Stack, the hardware is purchased

from and maintained by the partner. This makes the Azure Stack a mix of CapEx for the server and OpEx for the Azure Stack. Support is also split.

It is important to note that Microsoft does not have a managed DBaaS on-prem at the time this paper was written, nor have any been announced. Microsoft offers a “SQL Resource Provider” option that enables SQL Server or MySQL to be allocated as a service on Azure Stack. However, those databases must be licensed separately and are not a DBaaS from Microsoft. Oracle Database is not currently supported by SQL Resource Provider. Microsoft does not currently provide the Azure Stack as a managed service either. That is only available from Microsoft partner Avanade (a joint venture between Microsoft and Accenture), and only for infrastructure as a service (IaaS) and platform as a service (PaaS.) The Avanade managed service is only in Avanade’s data center and not the customers’ data center. Avanade does not currently provide a cloud based DBaaS at this time.

Google Anthos



Google made Anthos generally available in April 2019. Anthos is a service for building and managing Google Cloud Platform (GCP) services via Google Kubernetes Engine (GKE), and in a customers' data center with GKE on-prem. It also enables customers to manage workloads running on third-party clouds, like AWS and Azure. It is designed to operate on third party server hardware from Cisco, Dell-EMC, HPE, and others. Once again, Google doesn’t use these vendors’ hardware for its Google public cloud services. This also means that Anthos is subscribed (OpEx) and the hardware it runs on-prem is purchased (CapEx). Support is also split

Although Anthos is a subscribed service, it’s not a managed service. It’s a Kubernetes software platform designed to orchestrate, manage, and run applications in containers on-prem or in the cloud. It does not deliver GCP IaaS or PaaS on-prem. It does not even support GCP databases (Google Cloud Spanner, Google Cloud SQL, others) on-prem. Databases from DataStax, MongoDB, and Splunk are supported. However, there is no managed DBaaS available on Google Anthos at the time of this writing. Oracle Database is also not supported.

How Oracle, AWS, Microsoft, and Google Managed DBaaS On-prem Compares

Since neither Microsoft Azure nor Google Cloud are currently providing a managed DBaaS on-prem service, they can be ruled out pretty quickly. Microsoft Azure Stack’s focus is to extend the Azure cloud on-prem to reduce latencies while providing a consistent IaaS and PaaS look and feel in a hybrid cloud. They are dependent on their hardware and managed service provider partnerships to provide a complete managed service. Even then, there is no managed DBaaS on-prem at this time.

Google is focused on managing applications wherever they reside on-prem or in the cloud. They are not offering any managed DBaaS on-prem nor have they announced any in the near future.

Neither Microsoft Azure nor Google Cloud Platform compare at this time. That leaves Oracle and AWS. Here’s how they compare.

Performance



| Gen 2 Oracle Exadata Cloud at Customer | | | | | AWS Outposts RDS/VMware Outposts RDS | | | | |
|---|--------------------|-----------------|-----------------|------------------|--|--|--|--|--|
| Oracle publishes its performance. | | | | | AWS does not publish RDS performance numbers for AWS public cloud, AWS VMware cloud, Outposts, or VMware Outposts regardless of the database chosen. The closest it comes to publishing RDS performance numbers is for EBS (Elastic Block Storage) which are not directly correlated with any RDS database. RDS performance will be less. They also publish performance numbers per EC2 instance. AWS claims up to 64,000 16K IOPS/volume w/provisioned SSDs, 16,000 w/general purpose SSDs, | | | | |
| | Base System | 1/4 Rack | 1/2 Rack | Full Rack | | | | | |
| Max SQL Flash BW ² (GB/s) | 25 | 64.5 | 129 | 258 | | | | | |
| Max SQL Flash Read IOPS ³ | 562,500 | 1,194,000 | 2,388,000 | 4,776,000 | | | | | |
| Max SQL Flash Write IOPS ⁴ | 518,000 | 1,088,000 | 2,176,000 | 4,352,000 | | | | | |
| Max SQL Disk BW ² (GB/s) | 2.7 | 5.4 | 10.8 | 21.5 | | | | | |
| Max SQL Disk IOPS ³ | 3,900 | 7,800 | 15,600 | 31,000 | | | | | |
| Max Data Load Rate ⁵ (TB/hr) | 3.8 | 7.5 | 15 | 30 | | | | | |

| | |
|--|--|
| <p>2 Bandwidth is peak physical scan bandwidth achieved running SQL, assuming no database compression. Effective user data bandwidth is higher when database compression is used.</p> <p>3 Based on 8K I/O requests running SQL.</p> <p>4 Based on 8K I/O requests running SQL.</p> <p>Flash write I/Os measured at storage servers after ASM mirroring, which issues multiple storage I/Os for redundancy.</p> <p>5 Load rates are typically limited by database server CPU, not I/O. Rates vary based on load method, indexes, data types, compression and partitioning.</p> <p>If performance is a high criterion, then Oracle Generation 2 Exadata Cloud at Customer is the choice. Even if it is not a high criterion, the Exadata Cloud at Customer requires significantly less hardware, power, cooling, rack space, and subscription than AWS for the same performance.</p> <p>Hardware accelerated encryption and encrypt/decrypt offload to storage servers delivers unprecedented nominal performance impact, whereas all other database systems encrypt/decrypt noticeably reduces database performance.</p> <p>Only Oracle Exadata Cloud at Customer is specifically co-engineered with the hardware to deliver the best possible performance from managed DBaaS on-prem. AWS Outposts RDS/VMware Outposts RDS utilize commodity-off-the-shelf hardware not optimized for any database.</p> | <p>500 w/throughput optimized HDDs, and 250 w/Cold HDDs. The max IOPS/instance (EC2 server) is 80,000. Max throughput/instance is 1,750 MB/s. To match Oracle Exadata Cloud at Customer quarter rack read IOPS, EBS would minimally require 7 clustered EC2 servers. For a full rack, that number goes up to 60. This assumes EBS IOPS translates to RDS IOPS, which is likely optimistic. Matching throughput is considerable worse. ¼ rack Exadata Cloud at Customer throughput requires 15 EC2 servers. Matching the full rack throughput demands AWS deliver 148 EC2 servers and that assumes 148 instances can be clustered, which is not possible when using the Oracle Database. The clustering does not add significant latency or decrease throughput (unlikely since there is no free lunch), and the performance correlates to the specific RDS database utilized.</p> <p>The VMware Outposts RDS has the additional overhead of the VMware hypervisor which will further reduce performance.</p> |
|--|--|

Advantage: Gen 2 Exadata Cloud at Customer

Flexibility



| Gen 2 Oracle Exadata Cloud at Customer | AWS Outposts RDS/VMware Outposts RDS |
|---|--|
| <p>Is available as a base system (1/8 rack), quarter rack, half rack, and full rack. Will be fully upgradeable on-demand from one to another in the near future. All software and hardware are subscription-based or the customer can transfer or bring their own current Oracle Database licenses (BYOL) to Exadata Cloud at Customer.</p> <p>Oracle Gen 2 Exadata Cloud at Customer is co-engineered with the Oracle Database Enterprise Edition. All functionality is always enabled including pluggable databases, and container databases. Multiple databases and different kinds of databases can run in a multi-tenant environment, at no additional cost. If the customer requires relational and/or time series, key value, graphical, object, JSON, spatial, or even a document database, they simply spin it up. And all of those databases can utilize the same data without creating storage consuming copies or requiring ETLs. No other database or managed DBaaS on-prem can do this.</p> | <p>Outpost racks come in quarter rack, half rack, and full rack options with flexibility to add capacity to an Outpost as workloads scale. Systems can be upgraded from quarter to half to full racks. All software and hardware are subscription based. Customers can subscribe to the different RDS databases available for Outposts or VMware Outposts or they can BYOL if their databases are supported on Outposts. Outposts is primarily an IaaS and PaaS service. RDS is an add-on. If other types of databases are required, as long as they are supported on Outposts or VMware Outposts, AWS will license them separately.</p> |

Advantage: Gen 2 Exadata Cloud at Customer

Security



| Gen 2 Oracle Exadata Cloud at Customer | AWS Outposts RDS/VMware Outposts RDS |
|---|--|
| <p>Built-in end-to-end comprehensive security measures deployed in the hardware infrastructure, network, Exadata platform, and Oracle database. Segregates customer data access from Oracle Cloud Op; ensures data entering, leaving, residing on, or accessing the system is secure; and all system code is secure. Hardware security includes encrypt/decrypt acceleration; vendor signed firmware ensures valid vendor run code.</p> <p>Network security includes InfiniBand partitioning securing storage and RAC interconnect traffic; Net Encryption securing application traffic to databases and traffic for high-bandwidth backup, data loading, and disaster protection; layer 2 (Ethernet) network physical isolation between client and backup networks within a VM cluster and internally via virtual bridges. Minimal open ports, running services, and Linux distribution designed specifically for Oracle Databases, reduces attack vectors; token SSH provides secure access to VMs; comprehensive logging and auditing tracks access and/or modifications.</p> <p>Oracle Database Enterprise Edition subscription or BYOL (bring your own license) comes with market leading advanced security features, Transparent Data Encryption (TDE), Database Vault, Label Security, Redaction, Subsetting, and Masking. (NOTE: TDE, Data Masking, and Subsetting is automatically added when customers move their BYOL Enterprise Edition license to Exadata Cloud at Customer.) Exadata Cloud at Customer additionally enables best practices, such as installing software agents, configuring the iptables firewall, and LDAP authentication. Exadata Cloud at Customer unique advanced Intrusion Detection Environment (AIDE) detects and alerts when unknown changes to system software are made. Oracle Recovery Manager (RMAN) flags and does not back up un-recognizable database blocks such as those that are part of malware. Exadata Cloud at Customer satisfies data sovereignty requirements.</p> | <p>AWS does not provide unique Outposts or RDS security functionality. Security is an extension of the AWS cloud. It provides several security capabilities and services to increase privacy and control network access. These include: network firewalls built in AWS VPC enabling private networks and control access to instances and RDS; customer-controlled encryption in transit with TLS across all services including RDS; private or dedicated connectivity options; auto-encryption for traffic between AWS Outposts and AWS Availability Zones (AZ).</p> <p>RDS database security is tied to the database chosen by the customer. AWS does not enhance that security.</p> <p>It is critical to note; AWS Outposts and AWS VMware Outposts are NOT designed to support data sovereignty requirements or circumstances when data cannot be sent of premises...period.</p> |

Advantage: Gen 2 Exadata Cloud at Customer

Simplicity



| Gen 2 Oracle Exadata Cloud at Customer | AWS Outposts RDS/VMware Outposts RDS |
|---|--|
| <p>As a managed DBaaS on-prem, Oracle Gen 2 Exadata Cloud at customer has no peer when it comes to simplicity. Complete implementation of hardware, software, and database, takes not more than 1 to 3 days. Any other database hardware and software setup takes minimally at least 3 times as long and usually longer.</p> <p>Operations and management are even simpler with functionality such as automated tuning, automated indexing, automatic I/O reduction, automated monitoring, analytics optimized columnar format, in-memory analytics to storage, OLTP bottleneck elimination, mixed workloads, automated consolidation performance optimization, Active Data Guard automated rapid NOLOGGING. And the built in AI machine learning with built-in usable algorithms makes usable AI modeling easier than ever before.</p> <p>This unprecedented automation and simplicity accelerate analytics, data mining, faster time to actionable information, faster time-to-market, faster revenues, and faster profits. Database administrators can spend their time on their SQL queries, applications, and new projects.</p> <p>Oracle provides complete end-to-end support with best-in-class (up to 99.95%) availability. Automated troubleshooting identifies problems before they are problems. Patches are automated as well. Upgrades can be accomplished non-disruptively.</p> | <p>Outposts and VMware Outposts are architected to be extensions of the AWS Cloud and AWS VMware Cloud. They are principally IaaS and PaaS platforms. AWS services generally run on Outposts the same as they do in the cloud.</p> <p>However, there is nothing specifically architected to simplify RDS databases. There is no built-in automation for those managed DBaaS on-prem service. None.</p> <p>AWS supports, manages, patches, and upgrades Outposts end-to-end, but when it comes to RDS, it depends on the database. They fully support Aurora, but not so much all the others. And AWS does not currently provide a SLA on availability.</p> <p>System upgrades are additionally usually disruptive.</p> |

Advantage: Gen 2 Exadata Cloud at Customer



| Gen 2 Oracle Exadata Cloud at Customer | AWS Outposts RDS/VMware Outposts RDS |
|--|--|
| <p>Completely OpEx unless the customer utilizes purchased Oracle Database licenses via BYOL. Even then, the maintenance is OpEx. The unique and key Oracle Gen 2 Exadata Cloud at Customer OpEx advantage comes from its performance and capacity density.</p> <p>It requires significantly much less database server hardware than AWS Outposts RDS or VMware Outposts RDS to meet or exceed customer database performance requirements. This is because of its highly engineered optimized architecture that squeezes maximum performance from minimal hardware infrastructure. Oracle</p> | <p>Outposts require significantly more hardware to meet user requirements and cannot match Gen 2 Exadata Cloud at Customer performance. RDS licensing costs are tied to computational and storage requirements. The more hardware required, the greater the database licensing costs.</p> <p>AWS has no hardware acceleration or data reduction capabilities at this time. There is no co-engineering between the RDS databases and the server hardware and storage in Outposts it runs on.</p> <p>Every RDS database supported in Outposts and VMware Outposts is relational only. If any other type of database is required, that is a separate subscription licensed service.</p> |

| | |
|---|---|
| <p>Database license costs are tied to database server cores. Fewer database servers equals fewer cores. Fewer cores equals lower Oracle Database license costs.</p> <p>Exadata Cloud at Customer’s unequaled Hybrid Columnar Compression (HCC) delivers a 10-15x reduction in storage requirements and subsequent storage subscription costs.</p> <p>The Oracle Database Enterprise Edition, being the all-inclusive database, supports multiple concurrent databases and database types (relational, object, key value, document, time series, spatial, graphical), multi-tenant. All of these come with Gen 2 Exadata Cloud at Customer. For BYOL Enterprise Edition, some are separately licensed options including spatial databases, graphical databases, and multi-tenant CDB.</p> <p>Less hardware, software, database licensing, power costs, cooling costs, rack space costs, allocated overhead costs, and supporting data center infrastructure costs means a much reduced lower OpEx.</p> | <p>Expect Outposts RDS OpEx to be considerably greater than Oracle Gen 2 Exadata Cloud at Customer.</p> |
|---|---|

Advantage: Gen 2 Exadata Cloud at Customer

Quick Comparison Review

| | Oracle Gen 2 ExaCC | AWS Outpost RDS VMware Outposts RDS | | Microsoft Azure Stack | Google Anthos |
|------------------------------|-----------------------|--|--------|--------------------------|------------------|
| Managed DBaaS On-Prem | Yes | Yes | Yes | No | No |
| Performance | Advantage | Losing | Losing | NA | NA |
| Flexibility | Advantage | Losing | Losing | NA | NA |
| Security | Advantage | Losing | Losing | NA | NA |
| Simplicity | Advantage | Losing | Losing | NA | NA |
| OpEx | Advantage | Losing | Losing | NA | NA |

Conclusion

Most public cloud providers are struggling to provide their first managed DBaaS on-prem. They don’t know what it takes to deliver a high quality, effective, and meaningful service for enterprise customers with business-critical workloads. Being first is not a privilege. Those customers will suffer while their service provider learns how to deliver a quality managed DBaaS on-prem service. In the meantime, Oracle has raised the standard of what a managed DBaaS on-prem service should be by delivering their second generation Exadata Cloud at Customer. When it comes to performance, flexibility, security, simplicity, and OpEx, there is simply no comparison at this time.

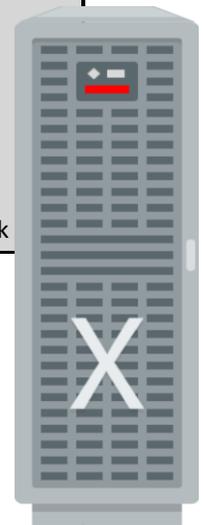
For More Information on Gen 2 Oracle Exadata Cloud at Customer

Go to: [Oracle Exadata Cloud at Customer](#)

Paper sponsored by Oracle. **About Dragon Slayer Consulting:** Marc Staimer, as President and CDS of the 21-year-old Dragon Slayer Consulting in Beaverton, OR, is well known for his in-depth and keen understanding of user problems, especially with storage, networking, applications, cloud services, data protection, and virtualization. Marc has published thousands of technology articles and tips from the user perspective for internationally renowned online trades including many of TechTarget's Searchxxx.com websites and Network Computing and GigaOM. Marc has additionally delivered hundreds of white papers, webinars, and seminars to many well-known industry giants such as: Brocade, Cisco, DELL, EMC, Emulex (Avago), HDS, HPE, LSI (Avago), Mellanox, NEC, NetApp, Oracle, QLogic, SanDisk, and Western Digital. He has additionally provided similar services to smaller, less well-known vendors/startups including: Asigra, Cloudtenna, Clustrix, Conduv, DH2i, Diablo, FalconStor, Gridstore, ioFABRIC, Nexenta, Neuxpower, NetEx, NoviFlow, Pavilion Data, Permabit, Qumulo, SBDS, StorONE, Tegile, and many more. His speaking engagements are always well attended, often standing room only, because of the pragmatic, immediately useful information provided. Marc can be reached at marcstaimer@me.com, (503)-312-2167, in Beaverton OR, 97007.

Appendix A: Gen 2 Exadata Cloud at Customer Hardware

| Oracle Exadata X8 Gen 2 ExaCC Upgraded Hardware vs X7 Gen 1 ExaCC | |
|--|--|
| New Database Servers (DBS) | <p>2-socket Intel 26-core/socket Cascade Lake CPUs </p> <p>28% Faster clock rate</p> <p>“Spectre” & “Meltdown” mitigated in silicon</p> <p>No SW overhead to patch those known vulnerabilities</p> <p>Increased security</p> <p>Up to ≥ 25% greater throughput</p> <p>Scalability from 2 to 8 DB servers - Base system, quarter, half, or full rack</p> |
| New Storage Servers (SS) | <p>2-socket Intel 24-core Cascade Lake CPUs</p> <p>140% more cores to offload database server processing</p> <p>Offloads Oracle Exadata Database Servers for:</p> <ul style="list-style-type: none"> SQL XML JSON Encrypt/Decrypt RMAN Backup Filtering (BCT) Fast Data File Creation  Many in-database Analytics & ML algorithms <p>Extreme All Flash (EF) Storage Servers</p> <p>High-Capacity (HC) Storage Servers</p> <ul style="list-style-type: none"> 40% higher capacity 14TB Helium HDDs 25% greater throughput than previous high capacity storage servers |
| Oracle Gen 2 ExaCC Control Plane Upgraded Hardware | |
| New 1U Servers | <p>2 lightweight (Intel 2-socket 24-core Cascade Lake) 1U servers </p> <p>Same CPU as Storage Server</p> <p>No SW overhead to patch those known vulnerabilities</p> <p>Increased security</p> <p>Enables highly available local control of critical functions</p> <p>Ensures key capabilities available in WAN down (scaling, start, stop)</p> <p>Establishes connectivity to Oracle</p> <p>2 rack units per Gen2 ExaCC vs. a full rack in Gen1 ExaCC</p> <p>Self-contained in ExaCC rack</p> |



The Exadata system is the same whether it is on-prem, in the cloud, or Exadata Cloud at Customer, with one minor difference. The Gen 2 Exadata Cloud at Customer users and Oracle Autonomous Database Cloud users get slightly beefier higher performance cloud only Intel processors with 26 cores per socket versus 24. Gen 2 Exadata Cloud at Customer gets the same functionality. These are the same Exadata systems currently used in the Oracle Autonomous Database Cloud and Exadata on-prem.