



Oracle Exadata Database Service on Exadata Cloud@Customer X9M

Exadata Cloud@Customer is ideal for customers desiring cloud benefits but cannot move their databases to the public cloud due to sovereignty laws, industry regulations, corporate policies, security requirements, network latency, or organizations that find it impractical to move databases away from other tightly coupled on-premises IT infrastructure. Oracle Exadata Database Service on Exadata Cloud@Customer delivers the world's most advanced database cloud to customers who require their databases to be located on-premises.

EXADATA CLOUD@CUSTOMER

Exadata Cloud@Customer uniquely combines the world's #1 database technology and Exadata, the most powerful database platform, with the simplicity, agility and elasticity of a cloud-based deployment. It runs the same Oracle Exadata Database Service as in the public cloud, but located in customers' own data centers and managed by Oracle Cloud experts, thus enabling a consistent Exadata cloud experience for customers – whether on-premises, or in Oracle Cloud Infrastructure data centers.

Customers that already own database and database option licenses can choose to deploy them on Exadata Cloud@Customer to minimize costs. Customers that do not have existing database licenses can choose to use Oracle Database Enterprise Edition Extreme Performance which enables every Oracle Database feature and option, ensuring highest performance, best availability, most effective security and simplest management. All Exadata features are included in both cases. Databases deployed on Exadata Cloud@Customer are 100%



compatible with both existing on-premises databases and databases that are deployed in Oracle Cloud Infrastructure.

WHAT'S NEW IN EXADATA CLOUD@CUSTOMER X9M

Exadata Cloud@Customer X9M brings Exadata X9M hardware, a faster network fabric and increased storage to Exadata Cloud@Customer. Exadata X9M storage servers include persistent memory, creating an additional tier of storage, boosting overall system performance. Exadata X9M combines persistent memory with innovative RDMA algorithms that bypass the network and I/O stack, eliminating expensive CPU interrupts and context switches, reducing latency by 10x compared to traditional IO, from 200µs to less than 19µs.

Exadata Cloud@Customer X9M has a faster 100Gbps active-active Remote Direct Memory Access over Converged Ethernet (RoCE) internal network fabric, providing more bandwidth than previous generations and an extremely low-latency interconnect between all compute and storage servers. The servers now use PCIe4 to enable the full 200Gbps aggregate bandwidth of the active-active RoCE fabric.

THE BEST DATABASE ON THE BEST CLOUD PLATFORM

Oracle Exadata has been the best database platform for over 10 years. Similarly, Oracle Exadata in the cloud is the best cloud database platform, as it can deliver extreme performance, mission critical availability and the highest security for all Online Transaction Processing (OLTP), Data Warehousing (DW), In-Memory Analytics, and Mixed/Hybrid workloads, making it the ideal database consolidation platform for the cloud.

Best Database Technology

Oracle Database is the most popular and most versatile database technology for both OLTP and Analytics. With decades of technology innovation, it has been proven at hundreds of thousands of mission-critical deployments around the world. Exadata Cloud@Customer makes this enterprise-proven, robust database technology available in a cloud-based consumption model at customers' data centers behind their firewalls.

Most Powerful Database Infrastructure and Platform

The platform that delivers Exadata Cloud is Oracle Exadata, which has been established as the highest performing, most cost effective and highest available platform for deploying Oracle databases. Exadata was designed from the beginning as a cloud architecture featuring scale-out database servers and scale-out intelligent storage servers. With X9M, they are now connected by a faster RoCE network. Exadata delivers many smart hardware and software innovations for databases, distinguishing itself from other generic converged systems.

Cloud Automation and Subscription Model

On top of the rock-solid Oracle Database and Exadata platform, Exadata Cloud@Customer adds the ease, simplicity, and flexibility of the software that powers Oracle Cloud Infrastructure. Organizations can now access the Oracle Database on Oracle Exadata with a simple consumption/subscription model in their own data center behind their firewall. Oracle experts manage the Exadata infrastructure on behalf of customers, which means human resources and IT

Key Features

- Easy and rapid database provisioning in a few clicks
- Cloud automation software reduces administration
- Subscribe to only the compute cores needed by the application
- Scale up and down as needed
- 100% compatibility with on-premises and Oracle Cloud Infrastructure databases
- Comprehensive database management through Oracle Enterprise Manager, as well as Cloud-based self-service automation
- Exadata infrastructure management and monitoring by Oracle Cloud Operations

Key Business Benefits

- Cloud simplicity with on-premises deployment
- Faster time-to-market with web-based database provisioning
- Subscription-based pricing, with ability to bring your own licenses (BYOL) to cloud
- Scale up and down as needed and pay only what you use
- Easily migrate existing databases with no application changes
- Reduced IT administration
- Fast local RoCE network connectivity delivers better response times than Public Clouds
- On-premises deployment to meet compliance and data sovereignty requirements
- Proven mission-critical database and platform
- Extreme performance for OLTP, Analytics, Hybrid, and Consolidation workloads
- Focus staff on improving business, not operating infrastructure

administration costs are significantly reduced, and IT can focus on improving business results. Full Oracle Database functionality with Exadata Cloud@Customer ensures that any existing application can be quickly migrated to a cloud model without changes. Provisioning and expanding the database service deployed on the Exadata Cloud@Customer is driven through simple web interfaces, providing customers rapid elasticity to meet changing business demands.

EXADATA: THE BEST DATABASE PLATFORM

Exadata Hardware

Exadata Cloud@Customer comes in different infrastructure shapes to support workloads of different sizes. The Exadata Cloud@Customer base system provides a cost-effective Exadata entry point, while traditional quarter, half, and full rack shapes can meet nearly any CPU processing and database storage requirements. Online dynamic scaling of OCPU resources is available in every Exadata Cloud@Customer shape so that customers can pay only for the OCPUs that they use, dramatically reducing costs compared to a traditionally purchased platform. Exadata Cloud@Customer also supports online storage server expansion up to a total of twelve storage servers, allowing customers to add storage independently from compute.

All the Exadata Cloud@Customer shapes are built on powerful database servers, scale-out intelligent storage servers, PCIe NVMe flash, and high capacity disk drives. Internal connectivity between database and storage servers is enabled by a low-latency RoCE fabric. External connectivity to the Exadata Cloud@Customer system is provided using standard 10 or 25 Gigabit Ethernet.

The database-optimized data tiering between RAM, PMEM, flash and disk implemented in Exadata provides lower latency, higher capacity, and faster performance than other flash- or PMEM-based solutions. Flash and PMEM storage arrays cannot match the throughput of Exadata's integrated and optimized architecture with full RoCE-based scale-out, high speed persistent memory, PCIe NVMe flash, offload of data intensive operations to storage, and algorithms that are specifically optimized for databases.

Exadata Software

The technology that enables Exadata's unparalleled performance without any of the bottlenecks of traditional storage arrays is Exadata Storage Server software. This software powers the Exadata storage servers, providing an extremely efficient and database-optimized storage infrastructure. All Exadata Storage Server software features are included in Exadata Cloud@Customer.

One of the many unique features of Exadata Storage Server software is Smart Scan technology, which offloads data intensive SQL operations from the database servers directly into the storage servers. By pushing SQL processing to the storage servers, data filtering and processing occur immediately and in parallel across all storage servers, as data is read from disk and flash. Only the rows and columns that are directly relevant to a query are sent to the database servers. This greatly accelerates analytic queries, eliminates bottlenecks, and significantly reduces the CPU usage of the database servers.

In addition to Smart Scan, Exadata includes a vast array of software capabilities that enables its unparalleled scalability, performance and availability. Some of these Exadata software features are:

- Shared Persistent Memory Accelerator uses RDMA to read data from persistent memory with unprecedented low latency
- Persistent Memory Commit Accelerator uses RDMA to write commit records to persistent memory providing 8x faster log writes
- Storage Indexes avoid unnecessary I/O operations by replacing them with a few in-memory lookups
- Exafusion Direct-to-Wire Protocol allows database processes to read and send Oracle RAC messages directly over the RoCE network, which considerably improves OLTP response time and scalability in Exadata

Related Products

- Oracle Autonomous Database
- Oracle Exadata Cloud Service
- Oracle Exadata Database Machine
- Oracle Database 12c and 19c
- Real Application Clusters
- Partitioning
- Multitenant
- Database In-Memory
- Advanced Compression
- Advanced Security
- Active Data Guard
- Real Application Testing
- Advanced Analytics
- Enterprise Manager
- Oracle Linux

- Smart Fusion Block Transfer improves OLTP performance further by eliminating the impact of redo log write latency when moving blocks between nodes
- Hybrid Columnar Compression utilizes a combination of row and columnar methods to greatly compress data, enabling tremendous cost-savings and performance improvements due to reduced storage capacity and reduced I/O, especially for analytic workloads
- In-Memory columnar formats in Flash Cache extend the Exadata Columnar Flash Cache by automatically transforming data into In-Memory columnar formats as it's loaded into flash cache. Smart Scans then leverage ultra-fast Single Instruction Multiple Data (SIMD) Vector instructions, thus processing multiple column values with a single instruction

Exadata is engineered to provide the highest levels of availability. Each Exadata Cloud@Customer system has completely redundant hardware components. In addition, Exadata Cloud@Customer comes pre-integrated with Oracle Maximum Availability Architecture (MAA) best practices for Database High Availability (HA) technologies such as RAC, ASM, RMAN, Flashback and Data Guard. Further, Exadata-specific HA capabilities such as Instant Detection of Compute and Storage Server Failures and Exadata I/O Latency Capping, significantly enhance the availability of Exadata.

Exadata Cloud@Customer systems can be used to deploy a large number of databases, enabling high database consolidation. To ensure consistent performance in a highly consolidated environment, Exadata provides unique end-to-end prioritization and resource management capabilities spanning database servers, network and storage.

EXADATA CLOUD@CUSTOMER: THE BEST CLOUD DATABASE PLATFORM

Exadata Cloud@Customer enables Oracle databases to run on the Exadata platform in customers' data centers, orchestrated by Oracle's cloud automation, with infrastructure managed by Oracle's cloud experts. Exadata Cloud@Customer instances come pre-configured according to best-practices that have been proven at thousands of mission critical Exadata sites around the world.

Customers have the option of running the co-managed Exadata Database Service or the Autonomous Database on Exadata Cloud@Customer. This document describes the characteristics of the Exadata Database Service on Exadata Cloud@Customer. For more information on Autonomous database on Exadata Cloud@Customer please visit www.oracle.com/autonomous.

Subscription Overview

Exadata Database Service on Exadata Cloud@Customer is available through a subscription offering that requires a minimum term of 4 years. Exadata Database Service has two subscription models:

- Enterprise Edition Extreme Performance Included
- Bring Your Own License (BYOL)

ENTERPRISE EDITION EXTREME PERFORMANCE INCLUDED

This subscription model includes all the features of Oracle Database Enterprise Edition, plus all the Oracle Database Enterprise Manager Packs and all Database Enterprise Edition Options. These industry-leading capabilities include Database In-Memory, Real Application Clusters (RAC), Active Data Guard, Automatic Storage Management (ASM), Partitioning, Advanced Compression, Advanced Security, Database Vault, Real Application Testing, OLAP, Advanced Analytics and Spatial and Graph. Also included in an Exadata Database Service PaaS subscription is Oracle Multitenant, enabling high consolidation density, rapid provisioning and cloning, efficient patching and upgrades, and significantly simplified database management. This subscription model is ideal for customers without existing Oracle database licenses, or customers seeking to use Oracle database features beyond what they are currently licensed.

"Exadata Cloud@Customer enables us to step into Oracle Public Cloud. ... Before, it took us days to create a database ... now we can do it within minutes."

Jochen Hinderberger
Director, IT Applications
Dialog Semiconductor

"With our capacity on demand needs and for our privacy of patient and healthcare information, really the only solution was Exadata Cloud@Customer. ... We have also seen an ROI of over 100% in the first 6 months using Exadata."

Kim Jacques
EVP & CIO
Sentry Data Systems

Exadata Cloud: Most Powerful Database + Platform

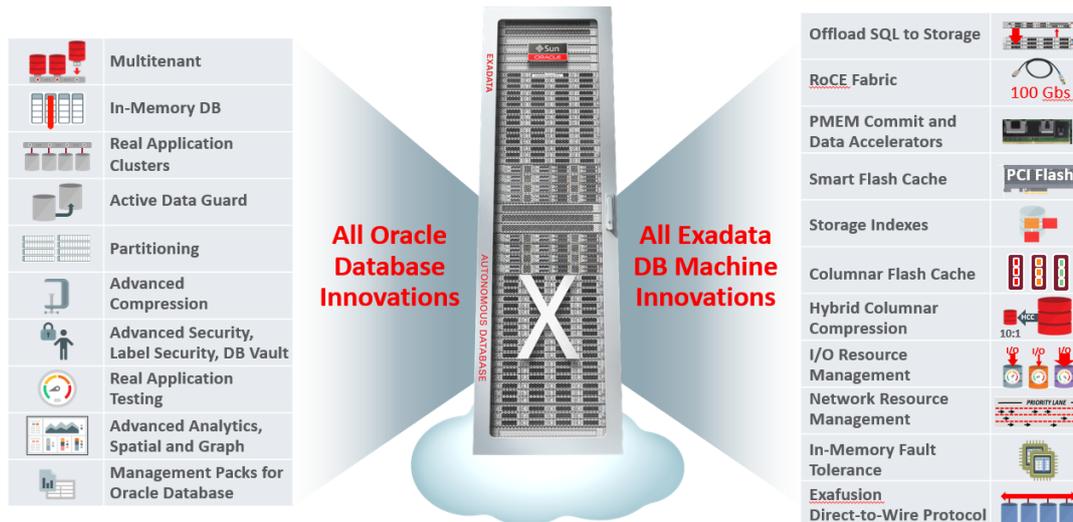


Figure 1: Exadata Database Cloud PaaS with all Database and Exadata features

BRING YOUR OWN LICENSE (BYOL)

Bring Your Own License (BYOL) is designed to minimize costs when migrating to the cloud. In a BYOL model, customers can deploy their existing Oracle Enterprise Edition and Database Option licenses to run the Exadata Database Service on Exadata Cloud@Customer. Oracle Standard Edition is not supported on Exadata Cloud@Customer.

When a customer brings a Database Enterprise Edition license entitlement to Oracle Exadata Cloud@Customer, they are granted the rights to use Oracle Transparent Data Encryption (TDE), Diagnostics Pack, Tuning Pack, Data Masking and Subsetting Pack, and Real Application Testing without bringing license entitlements for those Database Options and Management Packs. The Exadata System software is also included in a BYOL subscription, so BYOL customers do not have to bring a license entitlement for the Exadata System Software.

Service Overview

Customers can consolidate Oracle Database 19c, Oracle Database 12c Release 2 (12.2.0.1), and Oracle Database 12c Release 1 (12.1.0.2) on Exadata Cloud@Customer. Customers connect to databases from their applications using standard Oracle Net Services clients such as JDBC and OCI. As shown in Figure 1, Exadata Database Service on Exadata Cloud@Customer also includes all capabilities of the underlying Exadata platform.

Customers choose an Exadata configuration starting with a base system, which has 2 database servers and 3 storage servers. Customers dynamically provision database servers with any number compute cores (OCPU) within the hardware limits of the chosen configuration. Pricing is based on the size of the Exadata hardware configuration and the number of enabled compute cores. As the business grows, customers can enable or disable compute cores completely online, thus paying only for the processing power that they require. All the disk/flash, IOPS and memory for the configuration chosen is included in the subscription price. There is no charge for network communication to the Exadata Cloud@Customer.

Customers with additional resource requirements may choose larger Exadata shapes, such as the quarter, half and full racks, which includes persistent memory and enables higher compute, network and storage capacity. Customers can also expand base system as well as quarter and half rack shapes up to a total of twelve storage servers. Detailed specifications for each Exadata Cloud@Customer shape are provided in Table 1.

Cloud Control Plane

Customers can manage their Exadata Database Service and perform life cycle management operations for the databases running on the platform using the Cloud Control Plane. It is a sophisticated software suite which runs in the Oracle Public

“Having the data within our premises but having the cloud capabilities enable us to take the best of both worlds. That’s great for the business, great for the customers.”

Zoubair Scheurich
CIO
Sejel Technology

“What is very intriguing about Oracle Cloud at Customer is that it offers all the benefits of a public cloud with the security and performance of a private cloud.”

Claude Garalde
Lead Principal Technical
Architect AT&T

Cloud. Customers can connect to the Cloud Control Plane through a secure link using a web browser, command line interface (CLI), or REST APIs. User administration, create/modify/delete VM clusters and databases, backup, restore, patching, auditing, and OCPU scaling are examples of operations customers can perform using the Cloud Control Plane. Another key function of the Control Plane is to track a customer's usage and bill only for what they use.

The Cloud Control Plane includes a sophisticated identity management system which allows multiple departments or groups to share an Oracle Cloud Infrastructure tenancy. Compartments enable access control across resources and provide an effective mechanism to organize and control access to resources like an Exadata Cloud@Customer within a single tenancy.

Policies can be used to grant fine grain permissions within a single database for separation of duty. For example, one administrator could be responsible for backup and another for patching.

The Cloud Control Plane used by Exadata Cloud@Customer is the same as the one in the Oracle public cloud. This allows customers to work with the Exadata Database Service in both the public cloud and Exadata Cloud@Customer, using the exact same UX and REST APIs. Any investments in automated scripting developed for a Cloud@Customer environment will be preserved should a customer eventually choose to migrate to the Oracle Public Cloud.

“Oracle Cloud at Customer has enabled us to strengthen security and performance while using the cloud service at a flat rate, regardless of seasonal fluctuations to run a system in a cost-efficient manner.”

Kenichi Yajima
Senior Manager, Corporate Strategy
JTB

Secure Remote Access to Exadata Cloud@Customer

Control plane instructions are sent to the Exadata Cloud@Customer system through a dedicated secure tunnel between the Exadata Cloud@Customer and the Cloud Control Plane. Two Control Plane Servers installed in the Exadata Cloud@Customer rack host the secure tunnel endpoint and act as a gateway for access to the infrastructure. They also host components that orchestrate the cloud automation, aggregate and route telemetry messages from the Exadata Cloud@Customer environment to the Oracle Support Services infrastructure, and host images for database grid infrastructure and infrastructure patching.

The following diagram shows a typical configuration of Exadata Cloud@Customer.

Gen 2 Exadata Cloud at Customer— Management Flow

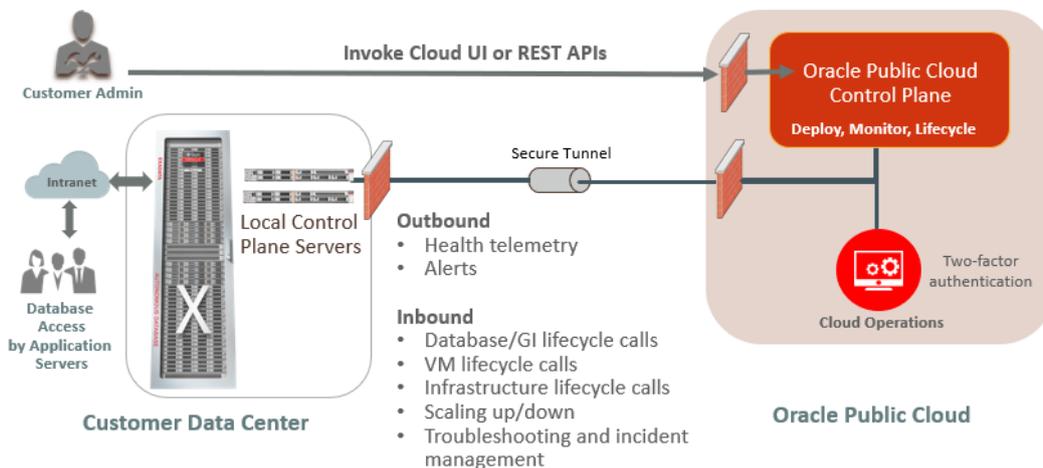


Figure 2: Typical Deployment of Exadata Cloud@Customer

Administration

Customers have complete access to all Oracle Database and OS features to ensure smooth and simple migration from on-premises Oracle deployments to Exadata Cloud@Customer. The customer is responsible for managing the virtual machines on the Exadata Cloud@Customer. Customers have root privileges for the Exadata database virtual servers and DBA privileges on the Oracle databases. They can configure the Exadata database server as they like and load additional agent software on the Exadata database servers to conform to business standards or security monitoring requirements.

Customers perform familiar database administration and OS administration tasks aided by cloud automation for database provisioning, backup, patching, and upgrades. Database and OS updates are initiated by customers on their

preferred schedule. Underlying infrastructure for Exadata Cloud@Customer, including Exadata RoCE network, storage servers, compute nodes, hypervisors and Exadata System Software, is deployed, monitored, maintained and managed by Oracle Cloud Operations. This allows customers to focus on application and business logic necessary for the core business, instead of getting bogged down with infrastructure maintenance projects. This enables customers to accelerate time to market, increase availability, and reduce business risk.

Oracle Cloud Operations

Oracle Cloud Operations monitors and maintains the infrastructure components of the Exadata Cloud@Customer service. Key components and activities include:

- Components managed
 - Exadata storage servers and physical database servers
 - Power distribution units (PDUs)
 - RoCE network and switches
 - Management switch
 - Control plane servers
 - Oracle KVM (hypervisor)
 - Exadata system software and all firmware
- Monitoring activities
 - Exadata Cloud@Customer infrastructure layer incident monitoring, management, and root cause analysis
 - Threshold performance analysis
- Maintenance Activities
 - Bug and security fixes inside hypervisor
 - Exadata System Software updates and upgrades
 - Firmware updates and upgrades to any of the hardware components including networking components and RoCE switches
 - Proactive infrastructure upgrades to update software and firmware as required

Oracle Operator Access Control

Oracle Operator Access Control (OpCtl) is an Oracle Cloud Infrastructure access management service for Exadata Cloud@Customer. OpCtl provides the customer interfaces to:

- Control access to Exadata Cloud@Customer infrastructure by Oracle staff, limiting when they have access, components they can access, and commands they can execute.
- Observe and record Oracle operator commands and keystrokes Oracle staff execute on Exadata Cloud@Customer infrastructure.
- Terminate Oracle operator connections at the customer's discretion.

OpCtl is ideal for regulated industries such as banking and financial services, energy utilities, and defense, and any industry where risk management is a key pillar of application success. These controls are a standard part of Exadata Cloud@Customer and are available at no extra cost to Oracle customers.

Deployment by Oracle

Exadata Cloud@Customer includes deployment by a specialized Oracle hardware engineer. The engineer will come onsite, deploy the hardware in your data center, connect the system to your network, and configure the system to communicate with the Oracle Cloud Control Plane. Before handing over the system Oracle will do an end-to-end validation of the system to ensure it is ready for deploying databases.

Scaling Exadata Cloud@Customer

With Exadata Cloud@Customer, customers can easily scale their system as business conditions change. Customers can scale CPU, memory, local disk space and Exadata storage allocated to the VMs from the OCI Console. This avoids the costly practice of sizing for the highest possible peak workload, which is often required for on-premises systems and with reserved cloud capacity solutions common to other cloud providers.

An example use case that leverages cloud scalability is running a standby database at a minimum level required to apply the logs, but then scaling up in the event the standby needs be activated. Other common use cases are workloads that go up or down depending on time of day, week, month, quarter, or year—for example, a retailer whose workload peaks at the holidays. Capacity adjustments can be made while the databases are online and as frequently as needed. The OCI CLI and REST APIs allow customers to create scripts that automatically scale the system up and down either on metrics or on a schedule.

Elastic Storage Server Expansion

Exadata Cloud@Customer is available in fixed base system as well as quarter, half, and full rack shapes. However, Exadata Cloud@Customer also supports online storage server expansion up to a total of twelve storage servers during deployment or post-deployment. This enables customers to provision workloads with higher storage capacity requirements without having to increase the number of database servers associated with larger fixed rack shapes.

Backup & Recovery

Exadata Cloud@Customer provides automatic built-in database backup facilities, with weekly full backups and daily incremental backups. Customers can choose to store backups on local disk in the Fast Recovery Area (FRA) provisioned directly on the Exadata system, in the Oracle Cloud Object Storage service, or to a local Zero Data Loss Recovery Appliance or NFS Filer. Customers can also use third-party backup solutions by installing the necessary agents in the customer-managed virtual machines.

Disaster Recovery

Exadata Cloud@Customer cloud automation provides the option to enable Oracle Data Guard to protect mission-critical databases from data corruptions as well as database failures and site outages. Customers can failover from primary to standby databases to protect against unplanned failures or switchover to eliminate potential downtime associated with planned maintenance. With Active Data Guard, applications benefit from advanced data protection including Automatic Block Recovery and Application Continuity. In addition, Active Data Guard supports offloading queries and reporting to read-only standby databases.

ENTERPRISE CLASS SECURITY WITH THE SIMPLICITY OF CLOUD, IN YOUR DATA CENTER

Exadata benefits from scrutiny by Oracle Security experts and by hundreds of industry experts around the world. Exadata Database Service on Exadata Cloud@Customer delivers Exadata as an Oracle Cloud Service in the physical protection of a customer data center and is based on comprehensive security measures deployed in the hardware infrastructure, network, Exadata platform, and Oracle database. The security features of Exadata Cloud@Customer segregate customer data access and Oracle Cloud Operations and ensure that data that enters or leaves the Exadata Cloud@Customer is secure, data that resides on the system is secure, access to the system is secure, and the code that runs on the system is secure. Oracle cloud automation further enhances security by enforcing strong passwords and data encryption on all databases and making it fast and easy for customers to keep databases updated with the latest security patches from Oracle.

Exadata Cloud@Customer Infrastructure Security protects the physical servers and components that are the building blocks of the system. Infrastructure security features include:

- Vendor signed firmware on most hardware components to ensure hardware components will only run valid code from the vendor that supplied that component
- Hardware acceleration that delivers near-native encryption and decryption speed so that encryption can always be used for all Oracle database data
- Infrastructure optimizations that uniquely move decryption processing to Exadata Storage Server infrastructure
- Virtual machines that provide secure isolation between customer virtual machines and Oracle Cloud Operations. A maximum of 8 virtual machine clusters is supported on Exadata Cloud@Customer X9M

Customers have full control to ensure data in the Oracle database can only be accessed by users with explicit rights to access that data. Oracle Cloud Operations does not access customer data to carry out their duties of infrastructure support.

Exadata Cloud@Customer Network Security is implemented with isolated networks, and each network is equipped with additional security measures to secure critical data processing tasks. Network security features include:

- Internal RoCE network: RoCE Secure Fabric isolates and protects storage and RAC interconnect traffic
- Customer client network: Oracle Net Encryption secures application traffic to databases
- Customer backup network: Oracle Net Encryption secures traffic for high-bandwidth use cases such as backup, data loading, and disaster protection using Data Guard
- Customer controlled VLANs mapped directly to the database VMs

Exadata Cloud@Customer Platform Security is based on customer-accessible virtual machines that deliver the Exadata Cloud@Customer Compute Node platform. The operating system deployment for the Exadata Cloud@Customer platform includes:

- A minimal Linux distribution ensures that just the packages needed to run Oracle Database are installed and enabled
- Minimal open ports and running services that minimize attack surfaces
- Token-based SSH that provides secure access to customer virtual machines
- Comprehensive logging and auditing that tracks access and modification

Customers have full root access to the virtual machines running the Exadata Compute Node software, and they can add additional tools to implement their existing security best practices, such as installing software agents, configuring the iptables firewall, and LDAP authentication.

Exadata Cloud@Customer Database Security is based on the enterprise security features of the Oracle database. Enterprise Edition Extreme Performance subscription includes all Oracle Advanced Security features, such as Transparent Data Encryption (TDE), Database Vault, Label Security, Redaction, Subsetting, and Masking. BYOL adds Transparent Data Encryption (TDE) and the Data Masking and Subsetting pack entitlements to any Oracle Database Enterprise Edition license they move to Exadata Cloud@Customer.

TDE encryption keys are stored in a password protected Oracle wallet in the customer's Exadata Compute Node VM by default, and customers can optionally configure external key stores such as Oracle Key Vault and commercial hardware security modules (HSMs) to further separate access and duties.

MIGRATION TO EXADATA CLOUD@CUSTOMER

Full compatibility between on-premises databases and databases deployed on Exadata Cloud@Customer makes migration to Exadata Cloud@Customer easy and low risk. Oracle provides tools to make it easy to migrate with or without downtime, and from Linux x86 platforms, or any other supported Oracle database platform.

CONCLUSION: TRANSFORM IT, UNLEASH BUSINESS POTENTIAL

Oracle Exadata Database Service on Exadata Cloud@Customer features the most versatile and functional database technology – Oracle Database, on the fastest, most powerful, and most available platform – Exadata, with the simplicity and cost effectiveness of Oracle Cloud software deployed in customer premises.

Enterprise-proven database capabilities are now instantly available to maximize productivity, lower risk and accelerate time-to-value. To embrace the cloud, customers no longer have to compromise their SQL functionality, performance, availability, data models, or transactional integrity. No changes to on-premises applications are required either, enabling rapid and easy migration to the cloud, or deployment of a hybrid cloud strategy. They can bring their existing on-premises database software license to Exadata Database Service, leveraging their existing investments. Finally, with Exadata Database Service, organizations no longer have to dedicate limited IT talent to managing and maintaining infrastructure.

Exadata Database Service uniquely delivers all these benefits in both the public cloud and in the customer's own data center with Oracle Exadata Cloud@Customer.

Table 1: EXADATA CLOUD@CUSTOMER: Technical Specifications

Exadata Cloud@Customer Typical Hardware Configurations

Service item	Base System	Quarter Rack X9M	Half Rack X9M	Full Rack X9M
Number of Database Servers	2	2	4	8
Maximum Number of OCPUs	48	124	248	496
Total Memory Available for Guest VMs (GB)	656	2,780	5,560	11,120
Max # of VM Clusters per system	4	8	8	8
Min # of OCPUs per VM Cluster	4	4	8	16
Max Usable Local Storage Per DB Server (GB)	892 (with single VM)	1800 (across 2 VMs)	1800 (across 2 VMs)	1800 (across 2 VMs)
Max Usable Local Storage Per VM (GB)	892	900	900	900
Number of Storage Servers	3	3	6	12
Total Cores in Storage Servers	144	144	288	576
Total Persistent Memory Capacity (TB)	0	4.5	9.0	18.0
Total Flash Capacity (TB)	38.4	76.8	153.6	307.2
Total Usable Disk Capacity ¹ (TB)	74	192	384	769
Max DB Size – No Local Backup ¹ (TB)	59	153	307	615
Max DB Size – Local Backup ¹ (TB)	29	76	153	307
Max SQL Flash Bandwidth ² (GB/s)	25	135	270	540
Max SQL PMem/Flash Read IOPS ^{3,6}	562,500	5,600,000	11,200,000	22,400,000
Max SQL PMem/Flash Write IOPS ^{4,6}	518,000	1,842,000	3,684,000	7,368,000
Max SQL Disk Bandwidth 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	15.0	30.0
Network Connectivity	Per Database Server: <ul style="list-style-type: none"> 4 x 10/25 Gb SFP28 (Fiber) Ethernet (2 client, 2 backup), or 4 x 10 Gb RJ45 (Copper) Ethernet (2 client, 2 backup) Per Control Plane Server: <ul style="list-style-type: none"> 2x 10/25 Gb SFP28 (Fiber) Ethernet or 2 x 10Gb RJ45 (Copper) Ethernet (minimum internet connectivity of 50Mbps down and 10Mbps up required) Transceiver support For Base shape: <ul style="list-style-type: none"> With client network on Fiber, backup network can be on Copper, Fiber, backup/client on shared Fiber With client network on Copper, backup network can be on Fiber, Copper, backup/client on shared Copper Transceiver support for Quarter/Half/Full shapes: <ul style="list-style-type: none"> With client network on Fiber, backup network can be on Fiber With client network on Copper, backup network can be on Copper 			

Exadata Cloud@Customer: Elastic Storage Server Expansion⁷

Server Type	Total Cores	Persistent Memory	Total Flash Capacity	Total Usable Disk Capacity ¹
Base Storage Server	48	0	12.8 TB	24.6 TB
X9M Storage Server	48	1.5 TB	25.6 TB	63.6 TB

Exadata Cloud@Customer: Individual Server Performance Metrics

Server Type	Maximum SQL Flash Bandwidth ²	Maximum SQL Read IOPS ³	Maximum SQL Write IOPS ⁴
Base Storage Server	8.3 GB/s	298,500	260,000
X9M Storage Server	45 GB/s	2,300,000	614,000

¹ Usable capacity is measured using normal powers of 2 space terminology with 1 TB = 1024 * 1024 * 1024 * 1024 bytes. It is the actual space available to create a database after taking into account space needed for ASM high redundancy and recovering from a drive failure, but before database compression.

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.

³ Based on 8K I/O requests running SQL.

⁴ Based on 8K I/O requests running SQL. Flash write I/Os measured at the storage servers after ASM mirroring, which issues multiple storage I/Os to maintain redundancy.

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.

⁶ Persistent Memory (PMem) available for Quarter, Half and Full Rack configurations.

⁷ Elastic storage server expansion provides support for up to a total of twelve storage servers in a base system, quarter rack or half rack for increased storage capacity.

Additional Notes on Technical Specifications:

1) Each rack is 42 RU (Rack Units) in height, has 2x redundant Power Distribution Units (PDUs), 2x 36-port QSFP28 (100 Gb/s) RoCE switches and 1x 48-port Cisco Ethernet switch for infrastructure administration by Oracle Cloud Operations.

2) Included Spare Parts Kit contains: 1 x NVMe PCIe Flash card and 1 x High Capacity disk.

3) Base System is the minimum Exadata Cloud at Customer configuration. Each Base System Database Server has 1x 32-core CPU (24-cores available to the customer) and 12x 32 GB DIMMs installed (328 GB available).

4) A Database Server in any Exadata Cloud@Customer X9M configuration has 4x 3.84 TB local drives

Table 2: Exadata Cloud@Customer Environmental Specifications

Metric	Full Rack X9M	Half Rack X9M	Quarter Rack X9M	Base System
Height	78.74" (2000 mm)			
Width	23.62" (600 mm)			
Depth	47.12" (1197 mm)			
Acoustic noise (operating)	9.4 B	9.2 B	9.1 B	9.1 B
Weight	1954.3 lb (886.5 kg)	1305.7 lb (592.3 kg)	991.4 lb (449.7 kg)	962.7 lb (436.7 kg)
Maximum power usage	19.2 kW (19.6 kVA)	10.4 kW (10.6 kVA)	6.0 kW (6.2 kVA)	5.0 kW (5.1 kVA)
Typical power usage ¹	13.4 kW (13.7 kVA)	7.3 kW (7.4 kVA)	4.2 kW (4.3 kVA)	3.5 kW (3.6 kVA)
Cooling at maximum usage	65,479 BTU/hour	35,568 BTU/hour	20,613 BTU/hour	17,103 BTU/hour
	69,080 kJ/hour	37,524 kJ/hour	21,746 kJ/hour	18,043 kJ/hour
Cooling at typical usage	45,835 BTU/hour	24,898 BTU/hour	14,429 BTU/hour	11,972 BTU/hour
	48,356 kJ/hour	26,267 kJ/hour	15,223 kJ/hour	12,630 kJ/hour
Airflow at maximum usage ²	3031 CFM	1647 CFM	954 CFM	792 CFM
Airflow at typical usage ²	2122 CFM	1153 CFM	668 CFM	554 CFM

Operating temperature/humidity: 5 °C to 32 °C (41 °F to 89.6 °F), as measured by an industry grade temperature measurement device directed at the front bezel of the servers, 10% to 90% relative humidity, non-condensing
 Altitude Operating: Up to 3,048 m, max. ambient temperature is de-rated by 1° C per 300 m above 900 m
¹ Typical power usage varies by application load.
² Airflow must be front-to-back.

Table 3: Exadata Cloud@Customer Regulations and Certifications

Regulations ^{1,2,3}	Product Safety:	UL/CSA 60950-1, EN 60950-1, IEC 60950-1 CB Scheme with all country differences UL/CSA 62368-1, EN 62368-1, IEC 62368-1 CB Scheme with all country differences
	Emissions:	FCC CFR 47 Part 15, ICES-003, EN55032, EN61000-3-11, EN61000-3-12
	Immunity:	EN55024, KN35
Certifications ^{2,3}	North America (NRTL), CE (European Union), International CB Scheme, HSE Exemption (India), BSMI (Taiwan), CCC (PRC), EAC (EAEU including Russia), KC (Korea), RCM (Australia), VCCI (Japan), UKCA (United Kingdom)	
European Union Directives ³	2014/35/EU Low Voltage Directive, 2014/30/EU EMC Directive, 2011/65/EU RoHS Directive, 2012/19/EU WEEE Directive	
¹ All standards and certifications referenced are to the latest official version at the time the data sheet was written.		
² Other country regulations/certifications may apply.		
³ In some cases, as applicable, regulatory and certification compliance were obtained at the component level.		

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