ORACLE

Oracle Exadata Cloud@Customer X9M

Run the world's most advanced database services - Oracle Autonomous Database and Oracle Exadata Database Service - on the most powerful, available, and secure database cloud platform, in your data center

EXADATA CLOUD@CUSTOMER

Exadata Cloud@Customer is a hybrid cloud platform for Oracle databases. It is the database cloud platform for customers who desire cloud benefits, but require their databases to be located on-premises. This could be due to data residency laws, industry regulations, corporate policies, security requirements, network latency, or the impracticality of moving databases away from other tightly coupled on-premises infrastructure.

Exadata Cloud@Customer uniquely combines the world's #1 database technology with Exadata, the most powerful database platform, delivering the simplicity, agility and elasticity of a cloud-based deployment.

Exadata Cloud@Customer runs the same Oracle Database services as in the public cloud deployments on Exadata dedicated infrastructure - Oracle Autonomous Database and Exadata Database Service. This database compatibility enables a consistent Exadata Cloud experience. Existing on-premises Oracle Database customers, especially those already benefiting from the power of the Exadata Database Machine, can easily move to the cloud with minimal risk and effort.
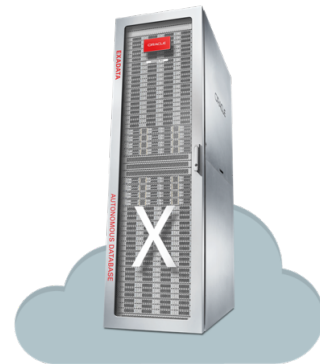
WHAT'S NEW IN EXADATA CLOUD@CUSTOMER X9M

Exadata Cloud@Customer X9M brings Exadata X9M hardware, a faster network fabric, more CPU cores, and increased storage to Exadata Cloud@Customer. Exadata X9M storage servers include persistent memory (PMem), creating an additional tier of storage, boosting overall system performance. Exadata X9M combines PMem 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 the traditional network and I/O stack, 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 industry leading database platform for over 10 years and has been established as the best performing, highest available, and most secure 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. It delivers many smart hardware and software innovations for Oracle databases, distinguishing itself from other generic converged systems.

Exadata has been engineered to run Oracle Database, the world's most popular and most versatile database technology. With decades of technology innovation, Oracle Database has become the industry standard for mission-critical deployments. Oracle Database on Exadata delivers Online Transaction Processing (OLTP), Data Warehousing (DW), In-Memory Analytics, and Mixed/Hybrid workloads, making it the ideal database consolidation platform. Exadata is available on-premises, in the public cloud, and as a hybrid cloud with Exadata Cloud@Customer.

EXADATA CLOUD@CUSTOMER: THE BEST ON-PREMISES CLOUD DATABASE PLATFORM

Exadata Cloud@Customer combines enterprise-proven, robust database technology on the best database platform with a cloud-based consumption model in customer data centers, behind their firewalls. It includes all the Oracle Database and Exadata capabilities, including exceptional performance, availability, and security. Running in customer data centers allows customers with data residency requirements to now realize the many benefits of the cloud. Customers maintain their existing on-premises architecture and application relationships. Along with full Oracle Database compatibility, this ensures existing applications can quickly migrate to the cloud with minimal disruption.

Customers have the option of running Autonomous Database, Exadata Database Service, or both on Exadata Cloud@Customer. Autonomous Database with machine-learning–driven automated tuning, scaling, and patching eliminates human labor and error, thereby reducing cost and complexity while ensuring higher reliability, security, and more operational efficiency. Exadata Database Service is co-managed by Oracle and customers. Oracle manages the infrastructure while customers manage the operating systems and databases in virtual machines running on the system using cloud automation, giving customers more control over their operating environment.

Both Autonomous Database and Exadata Database Service on Exadata Cloud@Customer are deployed according to best practices that have been proven at thousands of mission-critical Exadata sites around the world. Infrastructure managed by Oracle experts eliminates much of the effort customers spend supporting these database services. When combined with built-in automation, this significantly reduces administration costs and risk, freeing IT to focus on higher business value tasks that improve overall efficiencies and business results. Customers see further savings through cloud economics and pay-per-use that aligns usage with cost and lowers total cost of ownership.

Exadata Hardware

Exadata Cloud@Customer is built with powerful database servers, scale-out intelligent storage servers, PMem, 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 DRAM, 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 Cloud@Customer Key Benefits

- Fastest transition to the cloud with minimal disruption
- All Exadata capabilities - exceptional performance, availability, and security
- On-premises data residency meets compliance and security requirements
- Exadata infrastructure management by Oracle reduces effort and risk
- Choice of Autonomous Database and/or Exadata Database Service
- Compatible with on-premises and Oracle Cloud Infrastructure databases
- Cloud UI and REST APIs simplify provisioning and lifecycle management
- Autonomous Database eliminates labor and error
- CapEx to OpEx cloud economics
- Pay-per-use aligns usage with costs and lowers TCO
- Database consolidation increases value

Elastic Compute

- 3rd Generation Intel® Xeon® Scalable Processors
- Up to 1,984 Database Server Cores
- Up to 44 TB of DDR4 DRAM

Scalable Storage

- Up to 3.1 PB Database Size (High Redundancy, Without Compression)
- Up to 1.6 PB PCI NVMe Flash
- Up to 96 TB Persistent Memory
- 3rd Generation Intel® Xeon® Scalable Processors
- Up to 3,072 Storage Server Cores

Exadata Cloud@Customer offers elastic infrastructure shapes to support workloads of different sizes. Flexible shapes range from a Quarter Rack, 2 database and 3 storage servers, up to 32 database and 64 storage servers across multiple racks to meet a variety of CPU processing and storage requirements. Base System provides a cost-effective Exadata entry point and supports expansion in a single rack up to 8 database servers and 12 storage servers.

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:

- 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
- 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 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.

Maximum Availability Architecture (MAA)

Exadata is engineered to provide the highest levels of availability with completely redundant hardware components. It has also been designed with Oracle Maximum Availability Architecture (MAA) in mind, a set of tiered best practices and blueprints for the use of Oracle's High Availability (HA) and Disaster Recovery (DR) technologies. These technologies include Real Application Clusters (Oracle RAC), ASM, RMAN, Flashback, Active Data Guard, and Application Continuity and optimize availability to meet the business continuity requirements of critical applications. Further, Exadata-specific HA capabilities such as Instant Detection of Database and Storage Server Failures and Exadata I/O Latency Capping, significantly enhance the availability of Exadata. Autonomous Database and Exadata Database Service are deployed

Fastest Networking

- 100 Gbps RoCE Internal Fabric
- 25 Gbps Ethernet shared for client and backup connections

Exadata Software

- Smart Scan
- Persistent Memory Data Accelerator
- Persistent Memory Commit Accelerator
- Storage Indexes
- Data Mining Offload
- Hybrid Columnar Compression
- Smart Flash Cache
- Smart Flash Logging
- In-Memory Fault Tolerance
- I/O Resource Management
- Network Resource Management
- Instant Failure Detection
- Sub-second I/O Latency Capping
- Columnar Flash Cache
- JSON/XML Smart Scan
- Direct-to-Wire OLTP protocol
- Test/Dev Snapshots
- Fastest RAC Node Failure Recovery
- Fastest Data Guard Redo Apply

Related Products

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

with MAA best practices enabling customers to take immediate advantage of key HA and DR features including Oracle RAC and Autonomous or Active Data Guard.

Multiple Virtual Machine Clusters

Database services run securely in Virtual Machine (VM) Clusters running on the Exadata Cloud@Customer infrastructure. Each Exadata Cloud@Customer can run multiple VM Clusters to increase value through greater consolidation. They provide isolated operating environments for different database workloads through separate access rules and network configurations as well as customizable compute, memory, and storage resources. Each VM Cluster can run Autonomous Database or Exadata Database Service, which allows Autonomous Database to be deployed alongside Exadata Database Service on the same infrastructure, eliminating the need to deploy separate systems for these services. VM Clusters are easily provisioned through the Cloud Control Plane.

CLOUD CONTROL PLANE

The Cloud Control Plane is a sophisticated software suite which runs in the Oracle Public Cloud, Oracle Cloud Infrastructure (OCI). Customers can connect to the Cloud Control Plane through a secure link using a web browser, command line interface (CLI), REST APIs, or language-specific SDKs.

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 such as Exadata Cloud@Customer within a single tenancy.

The Cloud Control Plane is used to deploy Exadata Cloud@Customer and databases running on the system. It is also used to perform lifecycle operations such as provisioning, patching, backup, and configuring Data Guard. Policies can be used to grant fine-grain permissions within a single database for separation of duty. Another key function of the Cloud Control Plane is to track customer usage and bill only for what they use.

The Cloud Control Plane used by Exadata Cloud@Customer is the same as the one in the Oracle Public Cloud. This allows customers to have the same experience in both the Oracle Public Cloud and Exadata Cloud@Customer, using the same UX and REST APIs.
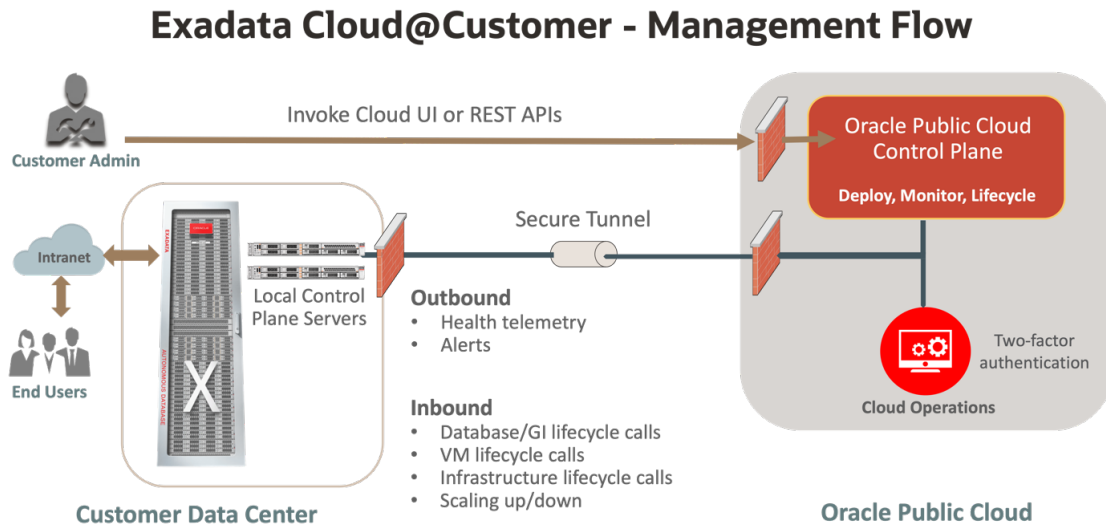
Exadata Cloud@Customer - Management Flow

Figure 1: Typical Configuration of Exadata Cloud@Customer

Secure Cloud Control Plane Connectivity

Cloud 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 software images and updates. Interruptions in the connectivity between the Cloud Control Plane and the Exadata Cloud@Customer system do not impact database availability.

ENTERPRISE CLASS SECURITY

Oracle Exadata benefits from scrutiny by Oracle security experts and by hundreds of industry experts around the world. 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 secure data that enters, leaves, and resides on the system, authenticate access to the system, and validate Oracle provided software that runs on the system. Oracle Cloud automation further enhances security by enforcing strong passwords, encrypting data for all Oracle databases, and making it fast and easy for customers to keep databases updated with the latest security updates 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 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
- For Exadata Database Service, virtual machines to provide secure isolation between customer data and Oracle Cloud Operations
- For Autonomous Database, Oracle Database Vault is deployed in Operations Control mode to provide secure isolation between customer data and Oracle Cloud Operations

Customers have full control of the data in Oracle Database so it 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 Oracle 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 leverages virtual machine isolation. 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
- Comprehensive logging and auditing that tracks access and modification

With Autonomous Database, customers have no access to the virtual machines running their databases. All service automation is performed through autonomous software operations. In contrast, with Exadata Database Service, customers have full root access to the virtual machines using Token-based SSH access, 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 also supports all enterprise security features of the Oracle Database. TDE encryption keys are stored in a password protected Oracle wallet in the customer's database VM by default, and customers can optionally configure external key stores such as Oracle Key Vault.

ORACLE OPERATOR ACCESS CONTROL

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

- Control access to Exadata Cloud@Customer infrastructure by Oracle staff, limiting when they have access, components they can access, and the privileges they have to access components
- 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.

For Autonomous Database on Exadata Cloud@Customer, OpCtl also allows customers to control when Oracle operators can access Autonomous VM Clusters.

ORACLE CLOUD OPERATIONS

Oracle Cloud Operations manages, monitors, and maintains components for Exadata Cloud@Customer.

- Components managed include:
    - 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
- Additional components managed for Autonomous Database only:
    - VM Clusters
    - Database homes
    - Grid Infrastructure
    - Operating systems
- Monitoring activities include:
    - Exadata Cloud@Customer infrastructure layer incident monitoring, management, and root cause analysis
    - Threshold performance analysis
- Maintenance activities include:
    - 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
- Additional maintenance activities for Autonomous Database only:
    - Grid Infrastructure and Database updates
    - Operating system updates

CLOUD SUBSCRIPTION OVERVIEW

Infrastructure Subscription

Exadata Cloud@Customer is available through an infrastructure subscription offering that requires a minimum term of 4 years. Customers can choose elastic infrastructure shapes with customizable database and storage server quantities to lower infrastructure subscription costs by enabling customers to properly size their hardware configuration to match their workload requirements.

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 Exadata Cloud@Customer. Detailed specifications for each Exadata Cloud@Customer shape are provided in Table 1.

Software License Subscription

Both Autonomous Database and Exadata Database Service on Exadata Cloud@Customer offer two software licensing subscription models:

- License Included
- Bring Your Own License (BYOL)

Autonomous Database software licensing is based on the number of compute cores (OCPUs) consumed by actively running Autonomous databases. As workload requirements change, Autonomous Database automatically scales compute cores online. Exadata Database Service software licensing is based on OCPUs allocated to a VM Cluster. Customers can scale compute cores online, thus paying only for the processing power they require.

License Included

This subscription model includes all the features of Oracle Database Enterprise Edition, plus all the Oracle Database Enterprise Manager Packs and all Oracle Database Enterprise Edition Options. These industry-leading capabilities include Database In-Memory, Real Application Clusters (Oracle RAC), Multitenant, Active Data Guard, Automatic Storage Management (ASM), Partitioning, Advanced Compression, Advanced Security, Database Vault, Real Application Testing, OLAP, Advanced Analytics and Spatial and Graph. 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 to use.

Exadata Cloud: Most Powerful Database + Platform
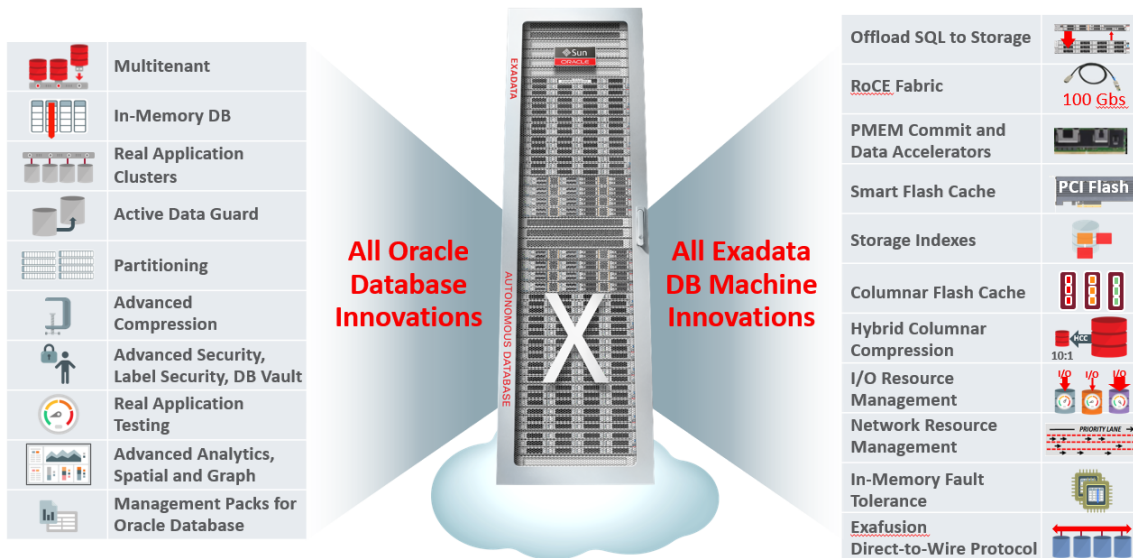
Figure 2: Exadata Cloud with all Database and Exadata features

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 Database Enterprise Edition and Database Option licenses on Exadata Cloud@Customer. Oracle Database Standard Edition is not supported on Exadata Cloud@Customer. When a customer brings an Oracle Database Enterprise Edition license entitlement to Exadata Cloud@Customer, they are granted the rights to use 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. For BYOL customers deploying Autonomous Database on Exadata Cloud@Customer, an Oracle RAC license is required if an Autonomous Database will be larger than 16 OCPUs, and if Autonomous Data Guard is deployed, an Active Data Guard license is also required.

EXADATA DATABASE SERVICE ON CLOUD@CUSTOMER

Exadata Database Service on Cloud@Customer is a highly advanced yet flexible database service in Oracle Cloud, based on fully featured Oracle databases deployed on Exadata in customer data centers. It gives customers the flexibility to control many aspects of their database service, providing capabilities similar to those of their on-premises environments while facilitating the transition from on-premises to the cloud with no application changes. Powerful cloud automation enables customers to manage the system with minimal effort while still providing full access to the database instances, database homes, and Grid Infrastructure. Customers

"Moving to Oracle Exadata Cloud@Customer increased availability and performance, reduced license costs by 60%, and helped us provide better and faster municipal services to Saudi citizens, without any interruption."

Khalid Alfleiw

Cloud Database Manager

Ministry of Municipal and Rural Affairs and Housing

have root access to the virtual machines (VMs) in the Exadata database servers, as well as full DBA privileges for the databases they provision. Customers can configure the database VMs as they need and deploy additional agent software, such as backup and monitoring agents.

Lifecycle operations for Exadata Database Service on Cloud@Customer are performed using the web browser UI or REST API-driven automation available through the Cloud Control Plane, including provisioning, updating, scaling, and backup. Customers can create and manage their database services by deploying multiple container databases and one or more pluggable databases within each container database. Operating system and database updates are applied by customers based on their preferred schedule. The underlying infrastructure for Exadata Cloud@Customer, including the database and storage servers, RoCE network, hypervisor, and Exadata System Software, is deployed, monitored, and managed by Oracle Cloud Operations. Customers can set a time preference that determines the infrastructure maintenance window. This flexibility improves customer productivity and reduces business risk by enabling customers to focus on their core business while scheduling infrastructure maintenance around critical business activities.

Customers can easily scale their cluster resources, including OCPUs, memory, local disk space, and Exadata storage allocated to the VMs, as business conditions change. Flexible scaling avoids the costly practice of sizing for the highest possible peak workload, which is often required for on-premises systems. Use cases that leverage such dynamic OCPU scaling are workloads whose busy periods vary depending on the time of day, week, month, quarter, or year -for example, a retailer whose workload peaks during the holidays. Databases remain completely online while OCPUs are scaled in this manner.

Exadata Database Service on Cloud@Customer enables automatic database backups, to destinations such as local disk, Oracle Cloud Infrastructure Object Storage, a local Zero Data Loss Recovery Appliance, or a preferred NFS target. Customers can also enable Data Guard through the Cloud Control Plane to protect mission-critical databases from unplanned failures or reduce downtime for planned maintenance activities.

Customers can deploy all currently supported Oracle Database versions with Exadata Database Service on Cloud@Customer. Review MyOracle Support Note 742060.1 - Release Schedule of Current Database Releases for the latest supportability status of Oracle databases.

"Exadata Cloud@Customer offered us the opportunity to move to the cloud and take advantage of cloud flexibility, while keeping all data on premises and staying GDPR compliant."

Cristina Georgakopoulou
Director of IT
EOPYY

"We are taking our digital transformations to the next level by moving more than 30 databases to Oracle Autonomous Database on Exadata Cloud@Customer and improving security with its self-securing capabilities."

Helder Branco
Head of IT Operations
Entel

AUTONOMOUS DATABASE ON EXADATA CLOUD@CUSTOMER

Autonomous Database is the simplest cloud database service for running any application, at any scale or criticality. It uses machine learning driven automation to eliminate human labor, human error, and manual tuning, thereby reducing deployment costs and administrative complexities while ensuring the highest reliability, security, and operational efficiency.

Autonomous Database on Exadata Cloud@Customer provides customers governance controls and automated best practices for the overall health, availability, and cost management of Autonomous Database. Customers can customize operational policies to meet their governance requirements and use a clean separation of roles between fleet administrators who setup operating environments and database consumers (developers and application DBAs) who self-service Autonomous databases in their assigned environments, without visibility into the underlying infrastructure. This separation of fleet administrator and database consumer allows simple budgeting controls and resource isolation without interfering with line of business execution.

Autonomous Database on Exadata Cloud@Customer supports Oracle Database 19c, which is Oracle's current long-term database release. It is highly secure, locking down many SYSDBA privileges and disallowing customer access to VMs hosting the database instances, which are wholly managed by Oracle Cloud Operations. Fleet administrators can configure one or more container databases in VMs, each of which can contain one or more Autonomous databases, configured for workloads such as transaction processing or data warehousing. Customers perform Autonomous Database lifecycle operations such as create, delete, clone, backup, restore, and audit as well as configure OCPU count and storage capacity using the Cloud Control Plane web browser UI or REST APIs. Oracle Cloud Operations is responsible for managing the maintenance updates for operating systems, databases, and Grid Infrastructure. Although customers can customize operational policies and the timing of updates, all operations are still fully automated by Oracle's cloud software.

Database backups for Autonomous databases are either manual or automatic also to destinations such as local disk, Oracle Cloud Infrastructure Object Storage, a local Zero Data Loss Recovery Appliance, or a preferred NFS target. In addition, customers can enable Autonomous Data Guard, which automates disaster recovery with capabilities such as Fast-Start Failover. Autonomous Database can also automatically scale compute cores online as workload requirements change, requiring no manual intervention, enabling customers to only pay for actual core usage, which can even be fractional cores.

With its end-to-end automation and with Oracle Cloud Operations assuming all maintenance and management responsibilities, Autonomous Database is the ideal cloud database service for cloud-native application development while also satisfying the availability, scalability, performance, and security demands of mission-critical enterprise workloads.

MIGRATION TO EXADATA CLOUD@CUSTOMER

Full compatibility between on-premises databases and databases deployed on Exadata Cloud@Customer makes migration to Exadata Cloud@Customer simple and low risk. Oracle recommends using Zero Downtime Migration as a best practice for moving your database workloads to Exadata Cloud@Customer. Oracle ZDM makes it easy to migrate online, and from Linux x86, AIX and Solaris platforms.

For more information on moving your databases to Oracle Cloud, visit www.oracle.com/goto/move

CONCLUSION: TRANSFORM IT, UNLEASH BUSINESS POTENTIAL

Exadata Cloud@Customer is the world's fastest OLTP and Analytics on-premises cloud database platform. It features the most advanced database cloud services – Autonomous Database and Exadata Database Service – to offer the industry's most powerful, available, and secure database solutions, in customer data centers.

With more compute, storage, and networking resources in the latest generation platform along with its extreme scale-out capability, customers can consolidate even more mixed database workloads on less infrastructure. Granular scalability of database and storage servers lowers infrastructure costs by enabling customers to properly size their hardware configuration to match their workload requirements. Customers also only pay for the processing power they require by elastically scaling compute cores online.

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, leveraging their existing investments. Customers no longer have to dedicate limited IT talent to managing and maintaining infrastructure. Database management is fully automated with Autonomous Database.

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

For more information, visit www.oracle.com/engineered-systems/exadata/cloud-at-customer

Table 1: EXADATA CLOUD@CUSTOMER: Technical Specifications

Exadata Cloud@Customer X9M Typical Hardware Configurations

Service item	Base System[1]	Quarter Rack	Half Rack	Full Rack
Number of Database Servers	2	2	4	8
Max # of OCPUs per System	48	124	248	496
Min # of OCPUs per VM	2	2	2	2
Total Memory Available for Guest VMs (GB)	656	2,780	5,560	11,120
Max # of VMs per DB Server	4	8	8	8
Max # of VM Clusters per System	4	8	16	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[2] (TB)	73	190	381	763
Max DB Size – No Local Backup[2] (TB)	58	152	305	610
Max DB Size – Local Backup[2] (TB)	29	76	152	305
Max SQL Flash Bandwidth[3] (GB/s)	25	135	270	540
Max SQL PMem/Flash Read IOPS[4,7]	562,500	5,600,000	11,200,000	22,400,000
Max SQL PMem/Flash Write IOPS[5,7]	518,000	1,842,000	3,684,000	7,368,000
Max SQL Disk Bandwidth[3] (GB/s)	2.7	5.4	10.8	21.5
Max SQL Disk IOPS[4]	3,900	7,800	15,600	31,000
Max Data Load Rate[6] (TB/hr)	3.8	7.5	15.0	30.0
Network Connectivity	Per Database Server: • 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: • 2x 10/25 Gb SFP28 (Fiber) Ethernet or 2 x 10Gb RJ45 (Copper) Ethernet (minimum internet connectivity of 50Mbs down and 10Mbps up required) Transceiver support For Base shape: • 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: • 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 X9M: Elastic Server Expansion[8,9]

Server Type	Maximum OCPUs	Total Memory Available
Base Database Server[1]	24	328 GB
Database Server	62	1,390 GB

Server Type	Total Cores	Persistent Memory	Total Flash Capacity	Total Usable Disk Capacity[2]
Base Storage Server[1]	48	0	12.8 TB	24.6 TB
Storage Server	48	1.5 TB	25.6 TB	63.6 TB

Exadata Cloud@Customer X9M: Individual Server Performance Metrics

Server Type	Maximum SQL Flash Bandwidth[3]	Maximum SQL Read IOPS[4,7]	Maximum SQL Write IOPS[5,7]
Base Database Server[1]	n/a	281,250	259,000
Base Storage Server[1]	8.3 GB/s	298,500	260,000
Database Server	n/a	2,800,000	2,500,000
Storage Server	45 GB/s	2,300,000	614,000

Table 2: Exadata Cloud@Customer X9M Environmental Specifications

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

Metric	Base Database Server	Database Server	Base Storage Server	Storage Server
Height	1.68" (42.6 mm)		3.42" (86.9 mm)	
Width	17.19" (436.5 mm)		17.52" (445.0 mm)	
Depth	29.0" (737 mm)		29.88" (759.0 mm)	
Acoustic noise (operating)	7.9 B	7.9 B	8.0 B	8.0 B
Weight	45.0 lb (20.4 kg)	45.6 lb (20.7 kg)	67.5 lb (30.6 kg)	76.7 lb (34.8 kg)
Maximum power usage	0.7 kW (0.8 kVA)	0.9 kW (0.9 kVA)	0.6 kW (0.6 kVA)	0.8 kW (0.9 kVA)
Typical power usage[1]	0.5 kW (0.5 kVA)	0.6 kW (0.7 kVA)	0.4 kW (0.4 kVA)	0.6 kW (0.6 kVA)
Cooling at maximum usage	2,522 BTU/hour	3,153 BTU/hour	2,134 BTU/hour	2,883 BTU/hour
	2,661 kJ/hour	3,326 kJ/hour	2,251 kJ/hour	3,042 kJ/hour
Cooling at typical usage	1,766 BTU/hour	2,207 BTU/hour	1,494 BTU/hour	2,018 BTU/hour
	1,863 kJ/hour	2,328 kJ/hour	1,576 kJ/hour	2,129 kJ/hour
Airflow at maximum usage[2]	117 CFM	146 CFM	99 CFM	133 CFM
Airflow at typical usage[2]	82 CFM	102 CFM	69 CFM	93 CFM

Table 3: Exadata Cloud@Customer X9M 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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