

Oracle Exadata Database Service on Cloud@Customer X10M

Run Oracle’s most powerful, available, and flexible cloud database service – Oracle Exadata Database Service – in your data center on Exadata Cloud@Customer

Exadata Database Service

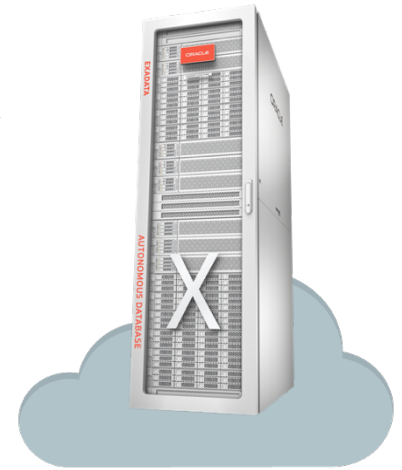
Exadata Database Service combines the world’s #1 database technology, Oracle Database, with Exadata, in a choice of either Oracle public cloud or customer data centers, delivering the simplicity, elasticity, and economics of a cloud-based deployment. It offers fully-featured Oracle Enterprise Edition databases with pay per use software licensing on Exadata infrastructure subscribed to as a service. Exadata Database Service is co-managed by Oracle and customers. Oracle manages the infrastructure while customers manage their operating environments.

Customers have the flexibility to control many aspects of the service, which provides capabilities similar to 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 service with minimal effort while still providing full access to database instances, database homes, and Grid Infrastructure. Customers have root access to the virtual machines (VMs) hosting the databases in the Exadata database servers, as well as full DBA privileges for the databases they provision. Customers can configure the database VMs as required and deploy additional software, such as backup and monitoring agents.

Data residency laws, industry regulations, corporate policies, security requirements, network latency, and the impracticality of moving databases away from other tightly coupled on-premises infrastructure all prevent customers from moving databases to the public cloud. Customers subject to these requirements can run Exadata Database Service in their own data centers on Exadata Cloud@Customer, thus retaining full physical control of their data while leveraging the operational and economic benefits of the cloud.

Exadata Cloud@Customer

Exadata Cloud@Customer is a hybrid cloud platform for customers who desire cloud benefits and a cloud-based consumption model but require their databases to be located on-premises, behind their firewalls. Exadata Cloud@Customer runs Exadata Database Service and Autonomous Database just like public cloud Exadata deployments in Oracle Cloud Infrastructure. Service



Oracle Exadata Cloud@Customer X10M

“Exadata Cloud@Customer enables us to keep very low latency between the database engine and the applications, which we couldn’t achieve otherwise. The machine is very reliable, secure, and performs magnificently as a truly responsive database.”

Jakub Valenta
Director of Data and IT Infrastructure
MONETA Money Bank

“Moving to 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

compatibility between the Oracle public cloud and customer data centers enables a consistent Exadata cloud experience. Along with full Oracle Database compatibility, this ensures existing applications can quickly migrate to the cloud with minimal disruption. 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.

Exadata Cloud@Customer is 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 Exadata Cloud@Customer. 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.

Exadata: The Best Database on the Best Cloud Platform

Exadata has been the industry leading database platform for over a decade and is 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 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 as Exadata Database Machine, in the public cloud as Exadata Cloud Infrastructure, and as a hybrid cloud with Exadata Cloud@Customer.

What's new in Exadata Cloud@Customer X10M

Exadata Cloud@Customer X10M is built on Exadata X10M hardware, offering more CPU cores, more and faster DDR5 memory, new Exadata RDMA Memory (XRMEM), and higher storage capacity compared to the previous generation. Exadata X10M storage servers feature the XRMEM Data Accelerator with Remote Direct Memory Access (RDMA) accessible memory to boost overall system performance. Innovative RDMA algorithms bypass the network and I/O stack, eliminating expensive CPU interrupts and context switches, reducing latency by more than 10x compared to the traditional network and I/O stack, from 200µs to less than 17µs.

Exadata Cloud@Customer X10M has a 100Gbps RDMA over Converged Ethernet (RoCE) internal network fabric, providing an extremely low-latency interconnect between all database and storage servers. Each server is connected

“This wasn’t just a lift and shift but consolidation that was a transformational opportunity. We always wanted a hybrid model with compute capacity on-premises in a seamless move to the cloud. Exadata Cloud@Customer helped accelerate thinking about cloud services as mature and secure.”

Kevin de Kock

Director of Enterprise Solutions and Applications
McMaster University

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
- Compatible with on-premises and Oracle Cloud Infrastructure databases
- Exadata infrastructure management by Oracle reduces effort and risk
- Cloud UI and REST APIs simplify provisioning and lifecycle management
- CapEx to OpEx cloud economics
- Pay-per-use aligns usage with costs and lowers TCO
- Database consolidation multiplies value

to the RoCE internal network fabric with two 100Gbps PCIe5 ports, enabling the RoCE internal network fabric to provide an aggregate active-active bandwidth of 200Gbps between the servers.

Exadata Hardware

Exadata Cloud@Customer X10M features powerful database servers, scale-out intelligent storage servers, XRMEM, PCIe NVMe flash, and high-capacity disk drives. Connectivity between database and storage servers is enabled by the low-latency RoCE internal network fabric. External network connectivity to the Exadata Cloud@Customer infrastructure is provided using standard 10 or 25 Gigabit Ethernet.

The database-optimized data tiering between XRMEM, PCIe NVMe flash, and disk implemented in Exadata storage provides lower latency, higher capacity, and faster performance than other flash-based solutions. All-flash storage arrays cannot match the throughput of Exadata's integrated and optimized architecture with full RoCE-based scale-out, XRMEM, PCIe NVMe flash, offload of data intensive operations to storage, and algorithms optimized for databases.

Exadata Cloud@Customer X10M elastic infrastructure shapes provide database compute and storage resources for any workload and scale for any database size. Flexible shapes range from a Base System, 2 database and 3 storage servers, which can be expanded up to 16 total servers in a single rack. A Quarter Rack also starts with 2 database and 3 storage servers, each with more compute and storage hardware resources than Base System servers, and can be expanded up to 32 database and 64 storage servers across multiple racks to meet a variety of CPU processing and storage requirements.

Exadata Software

The technology that enables Exadata's unparalleled performance without any of the bottlenecks of traditional storage arrays is the Exadata Storage Server Software. This software powers the 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 for databases of any size occurs immediately and in parallel across all storage servers, as data is read from XRMEM, flash, and disk. 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.

AI Smart Scan, another Exadata unique feature, greatly accelerates AI Vector Search with optimizations that deliver extremely low-latency, high-throughput, and parallelized scans across massive volumes of vector data. AI vector data is processed at memory speed, leveraging XRMEM and flash in the storage servers, avoiding unnecessary network data transfer and database server processing.

Elastic Compute

- 4th Generation AMD EPYC™ Processors
- Up to 6,080 Usable Database Server Cores Available to VMs
- Up to 87.5 TB of DDR5 DRAM

Scalable Storage

- Up to 4.0 PB Database Size (High Redundancy, Without Compression)
- Up to 1.7 PB NVMe Flash
- Up to 80 TB Exadata RDMA Memory (XRMEM)
- 4th Generation AMD EPYC™ Processors
- Up to 4,096 Storage Server Cores

Fastest Networking

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

Exadata Software

- Smart Scan
- Exadata RDMA Memory Data 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 Oracle RAC Node Failure Recovery
- Fastest Data Guard Redo Apply

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:

- Exadata RDMA Memory Data Accelerator uses RDMA to read data from XRMEM in the storage servers with unprecedented low latency
- Smart Flash Log Write-Back and Smart Flash Log eliminate storage disks as a potential log write throughput bottleneck and provide consistent log write latency
- 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

Related Products

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

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 and software. It has been designed around Oracle Maximum Availability Architecture (MAA), 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. Exadata Database Service on Cloud@Customer is deployed with MAA best practices enabling customers to take immediate advantage of key HA and DR features including Oracle RAC and Active Data Guard.

Multiple Virtual Machine Clusters

Database services run securely in Virtual Machine (VM) Clusters running on the Exadata Cloud@Customer infrastructure. Multiple VM Clusters can be provisioned 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 can span a subset of database servers in the infrastructure with a single database server minimum to better align resources to workload requirements. VM Clusters are provisioned through the Cloud Control Plane.

Cloud Control Plane

The Cloud Control Plane is a sophisticated software suite that runs in the Oracle Public Cloud on 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 that 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 is used.

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

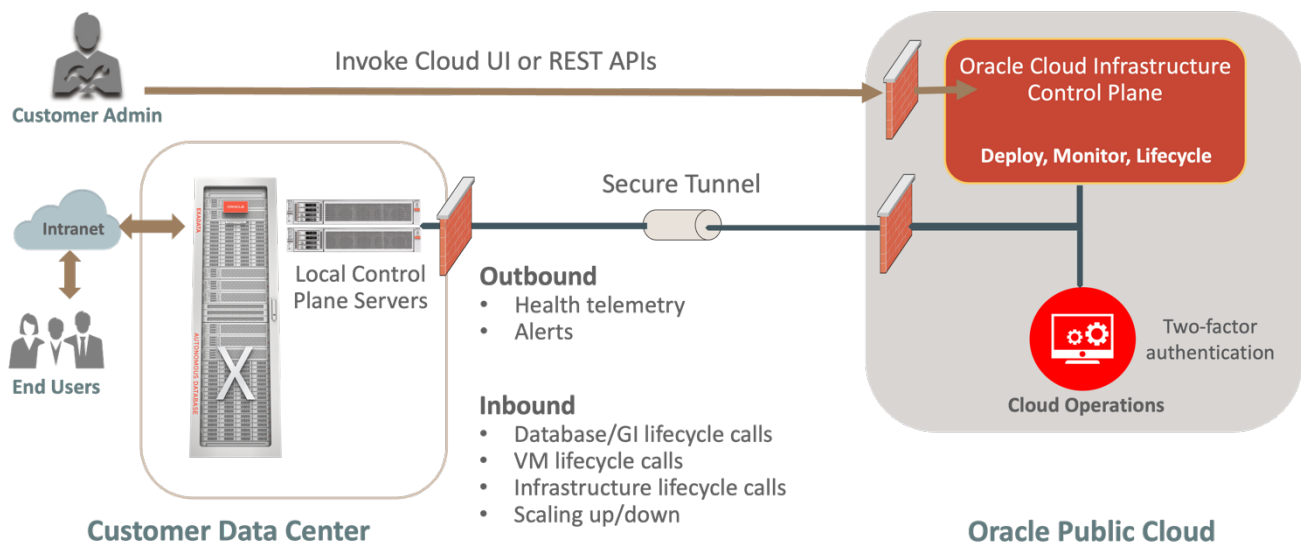


Figure 1: Management Flow for Exadata Cloud@Customer

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 encrypting data for all databases, enforcing strong passwords, 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 supplies the 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 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 so 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

Customers running Exadata Database Service have full root access to the database 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 Database Service 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 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.

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
- 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

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

Exadata Database Service on Cloud@Customer offers two software licensing subscription models:

- License Included
- Bring Your Own License (BYOL)

Exadata Database Service software licensing is based on database cores allocated to a VM Cluster. Customers can scale database 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.

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. Oracle Database Standard Edition is not supported. When a customer brings an Oracle Database Enterprise Edition license entitlement, 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.

Exadata Cloud: Most Powerful Database plus Platform

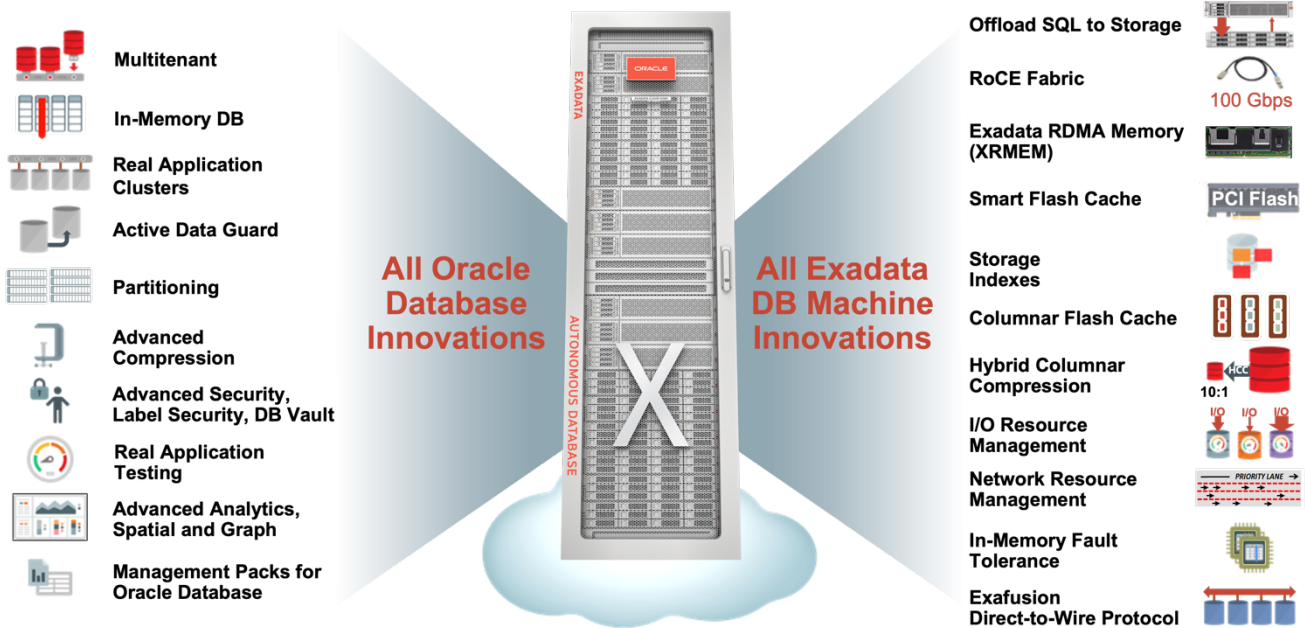


Figure 2: Exadata Cloud with all Oracle Database and Exadata features

Managing Exadata Database Service on Cloud@Customer

Customers provision Exadata Database Service on Cloud@Customer by deploying the infrastructure and creating VM Clusters running Oracle Linux. VM Clusters can host multiple container databases and one or more pluggable databases within each container database. Lifecycle operations for the service are performed using the web browser UI or REST API-driven automation available through the Cloud Control Plane, including provisioning, scaling, updating, and backup. 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 VM Cluster resources, including database cores, 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 database core 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 database cores are scaled in this manner.

Exadata Database Service on Cloud@Customer enables automatic database backups, to destinations such as local disk, 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.

Autonomous Database on Exadata Cloud@Customer

The same Exadata Cloud@Customer infrastructure can run both Exadata Database Service and Autonomous Database, which allows Autonomous Database to be deployed alongside Exadata Database Service. 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.

For more information on Autonomous Database on Exadata Cloud@Customer, visit www.oracle.com/autonomous-database/autonomous-database-on-exadata-cloud-at-customer/

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 Database Service is Oracle's most powerful, available, and flexible cloud database service. It runs in the Oracle public cloud, or on Exadata Cloud@Customer, the world's fastest OLTP and Analytics on-premises cloud database platform.

With more compute and storage resources in the latest generation of Exadata Cloud@Customer along with 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. Infrastructure managed by Oracle and built-in automation for common lifecycle tasks simplifies the overall management of the system and databases. Customers also only pay for the processing power they require by elastically scaling database 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.

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

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

Table 1: Exadata Cloud@Customer X10M: Technical Specifications

Service item	Base System¹	Quarter Rack¹	Elastic Config. - Example 1^{1,2}	Elastic Config. - Example 2^{1,2}
Number of Database (DB) Servers per System	2	2	8	2
Number of Storage Servers per System	3	3	8	14
Total Usable Cores in DB Servers per System	60	380	1,520	380
Min # of DB Cores per VM	2	2	2	2
Total Memory Available for VMs - Standard (GB)	1,320	2,780	11,120	2,780
Total Memory Available for VMs - Large (GB)	n/a	4,180	16,720	4,180
Total Memory Available for VMs - Extra Large (GB)	n/a	5,600	22,400	5,600
Max # of VMs per DB Server ³	4	8	8	8
Max # of VM Clusters per System ³	4	12	24	12
Max Usable Local Storage Per DB Server ⁴ (GB)	1,084	2,243	2,243	2,243
Max Usable Local Storage Per VM ⁴ (GB)	900	900	900	900
VM Image Size Minimum and Default ⁴ (GB)	244	244	244	244
Total Cores in Storage Servers per System	96	192	512	896
Total XRMEM Capacity ⁵ (TB)	0	3.75	10	17.5
Total Flash Capacity (TB)	38.4	81.6	217.6	380.8
Total Usable Disk Capacity ⁶ (TB)	106	240	640	1,120
Max DB Size – No Local Backup ⁶ (TB)	85	192	512	896
Max DB Size – Local Backup ⁶ (TB)	42	96	256	448
Max SQL Flash Bandwidth ⁷ (GB/s)	37.5	135	360	630
Max SQL Read IOPS ^{5,8}	597,000	5,600,000	22,400,000	5,600,000
Max SQL Write IOPS ⁹	544,000	2,748,000	7,328,000	4,000,000
Max SQL Disk Bandwidth ⁷ (GB/s)	2.7	5.4	14.4	25.0
Max SQL Disk IOPS ⁸	3,900	7,800	20,800	36,000
Max Data Load Rate ¹⁰ (TB/hr)	3.8	7.5	20.0	7.5
Network Connectivity	Per Database Server: <ul style="list-style-type: none"> 4 x 10/25 Gb SFP28 Ethernet ports (2 client, 2 backup), or 4 x 10 Gb RJ45 Ethernet ports (2 client, 2 backup) Per Control Plane Server: <ul style="list-style-type: none"> 2 x 10/25 Gb SFP28 Ethernet ports or 2 x 10Gb RJ45 Ethernet ports (Minimum internet connectivity of 50Mbps down and 10Mbps up required) Transceiver support for Base System: <ul style="list-style-type: none"> With SFP28 client network, backup network can be RJ45, SFP28, or backup/client on shared SFP28 With RJ45 client network, backup network can be SFP28, RJ45, or backup/client on shared RJ45 Transceiver support for Quarter Rack and Elastic shapes: <ul style="list-style-type: none"> With SFP28 client network, backup network can be SFP28 With RJ45 client network, backup network can be RJ45 			

Individual Server	Total Usable Database Cores		Total Memory Available for VMs (GB)	
Database - Base	30		660	
Database - Standard	190		1,390	
Database - Large	190		2,090	
Database - Extra Large	190		2,800	
Individual Server	Total Storage Cores	XRMEM Capacity (TB)	Total Flash Capacity (TB)	Total Usable Disk Capacity⁶ (TB)
Storage - Base	32	0	12.8	35.6
Storage - Standard	64	1.25	27.2	80.0

Individual Server	Maximum SQL		
	Flash Bandwidth (GB/s) ⁷	Maximum SQL Read IOPS ^{5,8}	Maximum SQL Write IOPS ⁹
Database - Base	n/a	298,500	272,000
Database - Standard, Large, Extra Large	n/a	2,800,000	2,000,000
Storage - Base	12.5	298,500	260,000
Storage - Standard	45	2,800,000	916,000

¹ Elastic configurations allow adding database and storage servers to a quarter rack to achieve the exact ratio of compute to storage that the application needs. Elastic configurations range from a Quarter Rack, 2 database and 3 storage servers, up to a total of 16 servers in the initial rack and up to a total of 32 database and 64 storage servers across multiple racks. Base System ranges from 2 database and 3 storage servers up to a total of 16 servers in a single rack.

² Elastic configuration example 1 with 8 database and 8 storage servers and elastic configuration example 2 with 2 database and 14 storage servers are examples of typical elastic configurations that provide the highest Flash Read IOPS and Flash Bandwidth in a single rack, respectively.

³ The maximum number of VM Clusters is 12 for systems with 2 database servers. The maximum number of VM Clusters is 24 for systems with more than 2 database servers. The maximum number of VMs per database server is 8 regardless of the number of database servers in the system. The maximum number of VM Clusters and VMs per database server is 4 for Base System regardless of the number of database servers in the system.

⁴ The maximum usable local storage is 2,243 GB per database server and 1,084 GB per Base System database server. Each VM requires a VM image size minimum and default that includes 60GB for /u02. The file system used for Oracle homes can be up to 900 GB per VM. The maximum size may be less than 900 GB as it is limited by the amount of local storage used by file systems of all VMs.

⁵ Exadata RDMA Memory (XRMEM) is included with Quarter Rack and Elastic configurations. Read I/Os use XRMEM.

⁶ 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.

⁷ Bandwidth is peak physical scan bandwidth achieved running SQL, assuming no database compression. Effective user data bandwidth is higher when database compression is used.

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

⁹ 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.

¹⁰ Load rates are typically limited by database server CPU, not I/O. Rates vary based on load method, indexes, data types, compression and partitioning.

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. Multiple rack configurations also include an additional 36-port QSFP28 (100 Gb/s) RoCE switch.

2) Refer to the product documentation for the latest information on product features.

Table 2: Exadata Cloud@Customer X10M: Environmental Specifications

Metric	Base System	Quarter Rack - Standard	Quarter Rack - Large	Quarter Rack - Extra Large		
Height	78.74" (2000 mm)					
Width	23.62" (600 mm)					
Depth	47.12" (1197 mm)					
Acoustic noise (operating)	9.3 B	9.3 B	9.3 B	9.4 B		
Weight	999.4 lb (453.3 kg)	1,035.8 lb (469.8 kg)	1,035.8 lb (469.8 kg)	1,035.8 lb (469.8 kg)		
Maximum power usage	6.0 kW (6.2 kVA)	7.3 kW (7.5 kVA)	7.6 kW (7.8 kVA)	7.8 kW (7.9 kVA)		
Typical power usage ¹	4.2 kW (4.3 kVA)	5.1 kW (5.2 kVA)	5.3 kW (5.4 kVA)	5.5 kW (5.6 kVA)		
Cooling at maximum usage	20,573 BTU/hr	25,069 BTU/hr	25,929 BTU/hr	26,570 BTU/hr		
	21,705 kJ/hr	26,448 kJ/hr	27,355 kJ/hr	28,032 kJ/hr		
Cooling at typical usage	14,401 BTU/hr	17,548 BTU/hr	18,150 BTU/hr	18,599 BTU/hr		
	15,193 kJ/hr	18,513 kJ/hr	19,148 kJ/hr	19,622 kJ/hr		
Airflow at maximum usage ²	952 CFM	1,161 CFM	1,200 CFM	1,230 CFM		
Airflow at typical usage ²	667 CFM	812 CFM	840 CFM	861 CFM		
Individual Server Metric	Database - Base	Database - Standard	Database - Large	Database - Extra Large	Storage - Base	Storage - Standard
Height	3.42" (86.9 mm)					
Width	17.52" (445.0 mm)					
Depth	30.51" (775.0 mm)					
Acoustic noise (operating)	8.4 B	8.4 B	8.6 B	8.6 B	8.4 B	8.4 B
Weight	51.8 lb (23.5 kg)	53.0 lb (24.0 kg)	53.0 lb (24.0 kg)	53.0 lb (24.0 kg)	62.7 lb (28.4 kg)	74.0 lb (33.6 kg)
Maximum power usage	1.0 kW (1.0 kVA)	1.3 kW (1.3 kVA)	1.4 kW (1.4 kVA)	1.5 kW (1.5 kVA)	0.8 kW (0.8 kVA)	1.0 kW (1.1 kVA)

Typical power usage ¹	0.7 kW (0.7 kVA)	0.9 kW (0.9 kVA)	1.0 kW (1.0 kVA)	1.0 kW (1.1 kVA)	0.5 kW (0.6 kVA)	0.7 kW (0.7 kVA)
Cooling at maximum usage	3,439 BTU/hr	4,299 BTU/hr	4,729 BTU/hr	5,050 BTU/hr	2,634 BTU/hr	3,559 BTU/hr
	3,629 kJ/hr	4,536 kJ/hr	4,989 kJ/hr	5,328 kJ/hr	2,778 kJ/hr	3,755 kJ/hr
Cooling at typical usage	2,408 BTU/hr	3,010 BTU/hr	3,310 BTU/hr	3,535 BTU/hr	1,843 BTU/hr	2,491 BTU/hr
	2,540 kJ/hr	3,175 kJ/hr	3,493 kJ/hr	3,729 kJ/hr	1,945 kJ/hr	2,628 kJ/hr
Airflow at maximum usage ²	159 CFM	199 CFM	219 CFM	234 CFM	122 CFM	165 CFM
Airflow at typical usage ²	111 CFM	139 CFM	153 CFM	164 CFM	85 CFM	115 CFM

¹ 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

² 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 X10M: 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, KS C 9835, EN61000-3-11, EN61000-3-12
	Immunity:	EN55024, KS C 9835
Certifications ^{2,3}	North America (NRTL), CE (European Union), International CB Scheme, HSE Exemption (India), BSMI (Taiwan), 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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