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Autonomous Database on Exadata Cloud@Customer X10M

Oracle Autonomous Database uniquely combines automation, machine learning, and cloud agility to deliver the world's first autonomous database management system.

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Service overview

Oracle Autonomous Database

The Oracle Autonomous Database is a Cloud Database Management System for organizations that require enterprise-grade Oracle Database support and desire the administrative simplicity and automation of cloud services.

Autonomous Database uses machine learning and automation to eliminate human labor, human error, and manual tuning, thereby reducing cost and complexity while ensuring higher reliability, security, and operational efficiency. Built on Oracle's Exadata Database Machine, Autonomous Database delivers the highest performance and cost-effective operation customers require for their most demanding and mission-critical applications.

The underlying converged database capabilities of the Oracle Database enable the Autonomous Database to be offered with default configurations that are optimized for common workloads, including transaction processing or JSON document management, and data warehousing. Autonomous Transaction Processing (ATP) is tailored to online transaction processing, JSON document management, batch, reporting, IoT, machine learning, and mixed workload applications. Autonomous Database when used for JSON document storage and retrieval comes with a developer-oriented simple document access API (SODA) and works seamlessly with Oracle SQL data tables. Autonomous Data Warehouse (ADW) is tailored to data warehousing, data marts, data lakes, and machine learning workloads.

Dedicated Exadata Infrastructure

Autonomous Database supports two Exadata deployment choices, serverless and dedicated. In a serverless environment, multiple customers may share the resources of a single Exadata infrastructure; the focus is on simplicity and elasticity with a standardized configuration and lifecycle. In a dedicated environment, the Exadata infrastructure is wholly dedicated to the subscribing customer, isolated from other cloud tenants, with no shared processor, storage, and memory resource.

Autonomous Database on Dedicated Exadata Infrastructure 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 corporate 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 Database in their assigned environments. Autonomous Database on Dedicated Exadata Infrastructure provides customers with a simple, complete, and private Database as a Service to enable developers of new database applications.

Autonomous Database on Dedicated Exadata Infrastructure is available in the Oracle Public Cloud and in the customer's data centers via Oracle Cloud@Customer[1].

Autonomous Key Benefits

- Most powerful Oracle Database
- All Exadata capabilities, ensuring extremely high levels of performance, availability, and security
- Easy and rapid Infrastructure and database provisioning in a few clicks or an API call
- Lower total cost of ownership from pay-per-use, elimination of manual labor
- Lower risk thru automated security updates and no human error
- Increased pace of innovation thru skilled DBAs focusing on business change instead of administration
- Win-win for IT and Development. IT governance and best practices with self-service agility for developers

Autonomous Key Features

- Self-service database cloud running on dedicated Exadata infrastructure
- Available in the Oracle Public Cloud and in the customer's data centers via Oracle Cloud@Customer[1]
- Dynamic online auto-scaling of CPU triggered by real-time workload
- Online scaling of storage
- Customizable operational policies supporting mission-critical requirements
- Multi-level workload isolation
- Managed backup and recovery
- Deploy anywhere, public cloud or on-premises
- Autonomous configuration management
- Autonomous performance management with real-time stats capture and auto-indexing
- Secure, external encryption key management

[1] *Autonomous Database on Exadata X10M is only initially available on Exadata Cloud@Customer*

Subscription overview

Autonomous Database on Dedicated Exadata Infrastructure is available through two flexible subscription offerings:

- License Included
- Bring Your Own License (BYOL)

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), Automatic Storage Management (ASM). Active Data Guard, Partitioning, Advanced Compression, Advanced Security, Label Security, Database Vault, Real Application Testing, OLAP, Advanced Analytics, and Spatial and Graph. Also included in an Autonomous Database Dedicated PaaS subscription is Oracle Multitenant, enabling high consolidation density, rapid provisioning, and cloning. This subscription model is ideal for customers without existing Oracle database licenses, customers seeking to use Oracle database features beyond those currently licensed, and customers with variable workloads who can reduce their costs by paying for only what they use.

Bring your own license (BYOL)

Autonomous Database on Dedicated Exadata Infrastructure 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 and Database Option licenses. When a customer brings an Oracle Database license entitlement, they are additionally 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. Users of BYOL are required to have Oracle Database Enterprise Edition licenses and the Real Application Cluster (RAC) Option for databases with more than 16 OCPUs; they must also have Oracle Active Data Guard if Autonomous Data Guard will be used.

Oracle Cloud controls and customization

Oracle Cloud Control Plane

Customers perform life cycle operations for Autonomous Databases running on Exadata Infrastructure using an Oracle Cloud Control Plane, 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. Autonomous Database life cycle operations such as create, delete, clone, backup, restore, audit, and 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 Access Management (IAM) system, which allows multiple departments or groups to share an Oracle Cloud Infrastructure (OCI) tenancy. IAM compartments are used as a logical resource grouping construct within OCI that enables access control across resources and provides an effective mechanism to organize and control access to resources within a single tenancy. Policies can be used to grant fine-grain permissions on resources within a compartment for separation of duty and privileged access to specific resources. For example, users can be isolated to only specific databases, and within a given database, one user could be responsible for create/scale and another for restore/audit.

Oracle Cloud Operations

Oracle Cloud Operations monitors and maintains the Database, Virtualization Stack, and infrastructure components of the Autonomous Database on Dedicated Exadata Infrastructure service. Key components and activities include:

- 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
  - VM Clusters
  - Database Homes
  - Grid Infrastructure
  - Operating System
- Monitoring activities include:
  - Autonomous 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
  - Grid Infrastructure and Database updates
  - Operating System updates

Customizable operational policies

Autonomous Database on Dedicated Exadata Infrastructure provides the customer customizations over operational policies, including software and hardware isolation for the highest levels of performance and security governance; it is well suited for customers wanting to deploy Oracle Database in cloud with common enterprise lifecycle controls. Users can configure one or more container databases on their dedicated infrastructure, each of which can have one or more autonomous databases (a mixture of ADW and ATP) within it. Customers can customize the policies used to control the provisioning of new databases, the timing of updates, the availability configuration, the backup retention period, and the density of databases that can run on the infrastructure. Having control over database versions and the timing of updates is essential for critical applications that require a version validation check against pre-production environments before a new software version is applied to production deployments. Although customers can customize these operational policies, all operations are still fully automated by Oracle autonomous software.

Administrative role separation

Autonomous Database on Dedicated Exadata Infrastructure allows a clean separation of roles between IT and database consumers. An IT group of Fleet Administrators would oversee capacity of Exadata Infrastructure, governance policies, and resource quotas. Database consumers, project team developers and application DBAs consume Autonomous Database without visibility into the underlying infrastructure. This separation of fleet versus database consumer allows simple budgeting controls and resource isolation without getting in the way of the line of business execution. A dedicated database deployment will support the entire spectrum of needs, from

simple apps to those that require the highest governance, consistent performance, and operational controls.

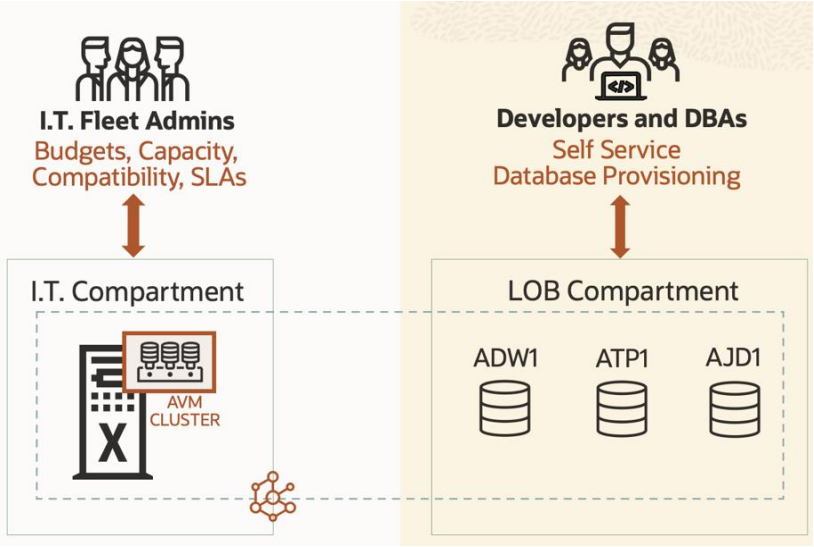

Figure 1. Dedicated fleet and database consumer roles

Enterprise class security with the simplicity of cloud

Autonomous Database on Dedicated Exadata Infrastructure benefits from scrutiny by Oracle Security experts and by hundreds of industry experts around the world. Autonomous Database delivers Exadata as an Oracle Cloud Service based on comprehensive security measures deployed in the hardware infrastructure, network, Exadata platform, and Oracle database. The security features of Autonomous Database 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 and data encryption on all databases and making it fast and easy to keep databases updated with the latest security updates from Oracle.

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

- Vendor signed firmware on 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 data and Oracle Cloud Operations

Customers can use advanced access controls like Oracle Database Vault 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 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 platform security leverages virtual machine isolation. The operating system deployment for the Exadata platform includes:

- A minimal Linux distro 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

Exadata database security is based on the enterprise security features of the Oracle database. Autonomous Database subscriptions includes all Oracle Advanced Security features, such as Transparent Data Encryption (TDE), Database Vault, Label Security, Redaction, Subsetting, and Masking. BYOL customers are also entitled to use Transparent Data Encryption (TDE) and the Data Masking and Subsetting pack on any Oracle Database license they move to Autonomous Database.

Oracle Operator Access Control

Oracle Operator Access Control (OpCtl) is an Oracle Cloud Infrastructure access management service for Autonomous Database on Dedicated Exadata Infrastructure. OpCtl provides the customer interfaces to:

- Control access to Exadata infrastructure and Autonomous VM Clusters 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
- 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 Autonomous Dedicated on Exadata Infrastructure and are available at no extra cost to Oracle customers.

Backup and recovery

Autonomous Database on Dedicated Exadata Infrastructure provides automatic built-in database backup facilities, with weekly full backups and daily incremental backups that are available for a selectable timeframe up to 60 days or from 90 days to 10 years for long-term backups. Manual backups can be taken at any time and recovery can be done from a backup or any point in time in the backup retention window. Additionally, you can create new Autonomous Database instances from backups.

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

Exadata hardware

The Oracle Exadata Database Machine (Exadata) is built with powerful database servers, scale-out intelligent storage servers, Exadata RDMA Memory (XRMEM), NVMe PCIe Flash, and high-capacity disk drives. Internal connectivity between database and storage servers is enabled by a low-

Exadata Compute

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

Exadata Storage

- Up to 4.0 PB Database Size (High Redundancy, Without Compression)
- Up to 1.7 PB NVMe Flash
- Up 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

latency RDMA over Converged Ethernet (RoCE) fabric. External connectivity to the Exadata system is provided using standard 10 Gb/sec or 25 Gb/sec 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, NVMe PCIe Flash, offload of data intensive operations to storage, and algorithms optimized for databases.

Exadata 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 16 total servers in the initial rack and 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 Exadata Storage Server Software. This software powers the Exadata storage servers, providing an extremely efficient and database-optimized storage infrastructure.

One of the many unique features of Exadata Storage Server Software is Smart Scan technology, which minimizes data movement by offloading 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 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, Exadata includes a vast array of software capabilities that enable unparalleled scalability, performance, and availability. Some of these Exadata software features are:

- Exadata RDMA Data Memory 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

- 25 Gbps Ethernet shared for client and backup connections

Exadata Software

All Exadata Software features, such as:

- 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

Related Products

- Oracle Autonomous Database
- Oracle Exadata Database Service
- 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

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 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. Autonomous Database on Dedicated Exadata Infrastructure 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 (VM) clusters

Database services run securely in Virtual Machine (VM) Clusters running on the Exadata 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 2 database server minimum to better align resources to workload requirements.

In Oracle public cloud or your data centers

Many companies cannot simply move to the public cloud due to challenges involving the regulatory nature of their data, data residency laws requiring data to stay in the country of origin, and the complexities of systems entanglement present in enterprise architectures. Systems entanglement happens because individual applications are coupled to others in such a way that changes to one impact the others, thereby complicating a move to the public cloud. To mitigate these challenges while providing customers the benefits of cloud self-service and a pay-per-use financial model, Oracle introduced its Cloud@Customer offerings bringing the cloud to customers who cannot simply transform to public cloud.

Oracle Dedicated Region Cloud@Customer delivers an entire stack of Oracle Cloud Infrastructure (OCI) and its portfolio of Platform as a Service offerings to the customer data center, including Autonomous Database on Dedicated Exadata Infrastructure.

Oracle Exadata Cloud@Customer is a slice of Oracle Cloud delivered to the customer data center that is specific to Exadata based database Platform as a Service offerings and includes Autonomous Database. Autonomous Database on Exadata Cloud@Customer is a low-cost entry point for on-premises users providing all the feature functionality found in Autonomous Database on public cloud, but users also have the option of backing up their Autonomous Database to a local Zero Data Loss Recovery Appliance or local network-attached storage. The minimum term for an Autonomous Cloud@Customer infrastructure subscription is four years, and the same BYOL or license included (billed per second) models exist.

The Cloud Control Plane used by Autonomous Database in the public cloud is also used by the Autonomous Database on Exadata Cloud@Customer. This allows customers to work with both Public Cloud and 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.

Secure access to Exadata Cloud@Customer

Platform control plane commands are sent to the Exadata Cloud@Customer system through a dedicated WebSocket secure tunnel between the Cloud Control Plane and the Exadata Cloud@Customer platform. Oracle Cloud Operations staff use the same tunnel to monitor Autonomous Database on Exadata Cloud@Customer for maintenance and troubleshooting. Two remote 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 platform to the Oracle Support Services infrastructure, and host images for service patching. The minimum network bandwidth from the Control Plane Server to the Cloud Control Plane is 50 Mbps.

The following diagram shows a typical access configuration of Autonomous Database on Exadata Cloud@Customer.

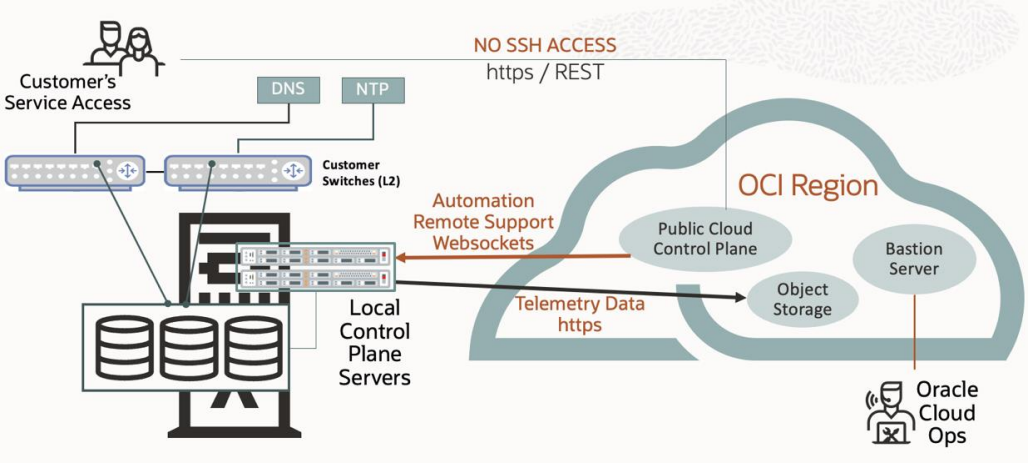

Figure 2. Access architecture for Exadata Cloud@Customer

Conclusion

Autonomous Database on Dedicated Exadata Infrastructure is an ideal solution for customers looking to leverage cloud-based database service to modernize the use of database for all database deployments, including for their most demanding and mission critical solutions. Autonomous Database will help to lower costs, reduce security risks, and enable customers to focus on adding business value instead of worrying about technology.

Table 1: Exadata Cloud@Customer X10M: Technical Specifications

Service item	Quarter Rack[1]	Elastic Configuration – Example 1[1,2]	Elastic Configuration – Example 2[1,2]
Number of Database (DB) Servers per System	2	8	2
Total Usable Cores in DB Servers per System	380	1,520	380
Min # of DB Cores per Autonomous VM	5	5	5
Total Standard Memory Available for VMs - Standard (GB)	2,780	11,120	2,780
Total Standard Memory Available for VMs - Large (GB)	4,180	16,720	4,180
Total Standard Memory Available for VMs – Extra Large (GB)	5,600	22,400	5,600
Max # of VMs per DB Server	8	8	8
Max # of VM Clusters per System	8	16	8
Max Usable Local Storage Per DB Server[3] (GB)	2,243	2,243	2,243
Max Usable Local Storage Per VM for /u02[3] (GB)	900	900	900
Number of Storage Servers per System	3	8	14
Total Cores in Storage Servers per System	192	512	896
Total XRMEM Capacity[4] (TB)	3.75	10	17.5
Total Flash Capacity (TB)	81.6	217.6	380.8
Total Usable Disk Capacity[5] (TB)	240	640	1,120
Max DB Size – No Local Backup[5] (TB)	192	512	896
Max DB Size – Local Backup[5] (TB)	96	256	448
Max SQL Flash Bandwidth[6] (GB/s)	135	360	630
Max SQL Read IOPS[4,7]	5,600,000	22,400,000	5,600,000
Max SQL Write IOPS[8]	2,748,000	7,328,000	4,000,000
Max SQL Disk Bandwidth[6] (GB/s)	5.4	14.4	25.0
Max SQL Disk IOPS[7]	7,800	20,800	36,000
Max Data Load Rate[9] (TB/hr)	7.5	20.0	7.5
Network Connectivity	Per Database Server: • 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: • 2x 10/25 Gb SFP28 Ethernet ports or 2 x 10Gb RJ45 Ethernet (Minimum internet connectivity of 50Mbps down and 10Mbps up required) Transceiver support for Quarter Rack and Elastic shapes: • 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 - 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 Capacity[5] (TB)
Storage	64	1.25	27.2	80.0

Individual Server	Maximum SQL Flash Bandwidth[6]	Maximum SQL Read IOPS[4,7]	Maximum SQL Write IOPS[8]
Database Server - Standard, Large, Extra Large	n/a	2,800,000	2,000,000
Storage	45 GB/s	2,800,000	916,000

[1] Elastic configurations allow adding database or 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.

[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 usable local storage per database server is 2,243 GB. Each VM requires an image of 184 GB. The /u02 filesystem mount used for Oracle homes can be up to 900 GB per VM. The maximum /u02 size may be less than 900 GB as it is limited by the amount of local storage used by the VM images and /u02 filesystems of all VMs.

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

[5] 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.

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

[7] Based on 8K I/O requests running SQL.

[8] 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.

[9] 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) Base System is available with Exadata Cloud@Customer X9M. Refer to the data sheet and documentation for more information.

2) 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.

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

Table 2: Exadata Cloud@Customer X10M Environmental Specifications

Metric	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	9.4 B
Weight	1,035.8 lb (469.8 kg)	1,035.8 lb (469.8 kg)	1,035.8 lb (469.8 kg)
Maximum power usage	7.3 kW (7.5 kVA)	7.6 kW (7.8 kVA)	7.8 kW (7.9 kVA)
Typical power usage[1]	5.1 kW (5.2 kVA)	5.3 kW (5.4 kVA)	5.5 kW (5.6 kVA)
Cooling at maximum usage	25,069 BTU/hour	25,929 BTU/hour	26,570 BTU/hour
	26,448 kJ/hour	27,355 kJ/hour	28,032 kJ/hour
Cooling at typical usage	17,548 BTU/hour	18,150 BTU/hour	18,599 BTU/hour
	18,513 kJ/hour	19,148 kJ/hour	19,622 kJ/hour
Airflow at maximum usage[2]	1,161 CFM	1,200 CFM	1,230 CFM
Airflow at typical usage[2]	812 CFM	840 CFM	861 CFM

Individual Server Metric	Database Server - Standard	Database Server - Large	Database Server – Extra Large	Storage Server
Height	3.42" (86.9 mm)			
Width	17.52" (445.0 mm)			
Depth	30.51" (775.0 mm)			
Acoustic noise (operating)	8.4 B	8.6 B	8.6 B	8.4 B
Weight	53.0 lb (24 kg)	53 lb (24 kg)	53 lb (24 kg)	74 lb (33.6 kg)
Maximum power usage	1.3 kW (1.3 kVA)	1.4 kW (1.4 kVA)	1.5 kW (1.5 kVA)	1 kW (1.1 kVA)
Typical power usage[1]	0.9 kW (0.9 kVA)	1 kW (1 kVA)	1 kW (1.1 kVA)	0.7 kW (0.7 kVA)
Cooling at maximum usage	4,299 BTU/hour	4,729 BTU/hour	5,050 BTU/hour	3,559 BTU/hour
	4,536 kJ/hour	4,989 kJ/hour	5,328 kJ/hour	3,755 kJ/hour
Cooling at typical usage	3,010 BTU/hour	3,310 BTU/hour	3,535 BTU/hour	2,491 BTU/hour
	3,175 kJ/hour	3,493 kJ/hour	3,729 kJ/hour	2,628 kJ/hour
Airflow at maximum usage[2]	199 CFM	219 CFM	234 CFM	165 CFM
Airflow at typical usage[2]	139 CFM	153 CFM	164 CFM	115 CFM

1) Operating temperature/humidity: 5 ºC to 32 ºC (41 ºF to 89.6 ºF), 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.*

Specifications of previous Exadata generations available in: https://docs.public.oneportal.content.oci.oraclecloud.com/en-us/iaas/exadata/doc/ecc-system-config-options.html#GUID-9E090174-5C57-4EB1-9243-B470F9F10D6B

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