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Oracle Exadata: Statement of Direction

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Introduction

The **Oracle Exadata Database Machine** (Exadata) is engineered to deliver dramatically better performance, cost-effectiveness, and availability for Oracle databases. Exadata features a modern cloud-enabled architecture with scale-out high-performance database servers, scale-out intelligent storage servers containing state-of-the-art PCIe flash, unique storage caching using RDMA accessible memory, and a cloud-scale internal network fabric that connects all servers and storage. Unique algorithms and protocols in Exadata implement database intelligence in storage, compute, and networking to deliver higher performance and capacity at lower costs than other database platforms.

Exadata takes advantage of Oracle's decades of database experience and builds on Oracle's leadership position as the #1 database for Artificial Intelligence (AI), Analytics, Online Transaction Processing (OLTP), and Database Consolidation. Current Exadata offerings are the result of decades of customer validation and thousands of engineer years of effort. Exadata is a strategic platform for Oracle and can be deployed everywhere customers need it - on-premises, Cloud@Customer, Oracle Cloud, and multicloud (Microsoft Azure, Amazon AWS, and Google Cloud). **Exadata Cloud Infrastructure** (in the public cloud) and **Exadata Cloud@Customer** (hybrid-cloud) power **Autonomous Database**, and **Exadata Database Service**. Oracle SaaS applications run on Exadata utilizing Exadata Database Service and Autonomous Database. Exadata can also be deployed in Dedicated Region Cloud@Customer (DRCC) with the same Exadata performance and cloud capabilities within the Customers' premises.

With tens of thousands of Exadata deployments globally, including the top banks, telecoms, and retailers, one common question for customers invested and interested in Exadata is where the technology is headed. The following is intended to outline the general product architecture and direction for Oracle Exadata so that customers are reassured they will continue to get significant returns on their Exadata investment for the foreseeable future.

Exadata's Unique, Scale-Out Architecture

The Exadata architecture goes beyond the idea that customers should assemble database platforms from "best of breed" servers, storage, networks, and software from multiple vendors. Exadata was designed from the ground up to be the best Oracle Database platform, able to run database functions anywhere, optimizing algorithms around Oracle Database formats and protocols, and tightly integrating hardware and software components from the application to the database.

Exadata embraces modern scale-out principles at both compute and storage layers, unified connectivity based on optimized network protocols, tightly integrated flash, and in-memory technologies, as well as application-aware intelligence within storage. As workloads grow, database servers, storage, and networking can be added without scalability bottlenecks. This scale-out architecture accommodates any size workload and allows seamless expansion from small to extremely large configurations while avoiding performance bottlenecks and single points of failure.

Key to the success of the Exadata architecture is software that makes many scale-out servers look like a single system to an application. Applications do not need modification to take advantage of databases running on Exadata or to take advantage of additional database and storage servers as they are added.

Exadata's Hardware Update Strategy

Exadata leverages state-of-the-art components to build the fastest, most highly available, and cost-effective Oracle Database platform in the market. Each generation of Exadata adopts proven leading-edge processors, memory, flash, disk, and networking technologies. Since Exadata is built using industry-standard servers for both compute and storage, customers benefit from the rapid evolution and economics of high-volume hardware. Exadata offers superior database performance today, and future versions will continue to track state-of-the-art processors, storage, memory, flash, and networking technologies, delivering the best performance and price-performance.

The following table outlines how successive Exadata generations have evolved, along with corresponding enhancements in leading-edge hardware components.

Database Platform Leadership Since 2008

	V1	V2	X2	X3	X4	X5	X6	X7	X8	X8M	X9M	X10M	X11M	V1 – X11M Growth
	Sep 2008 Xeon E5430 Harpertown	Sep 2009 Xeon E5540 Nehalem	Sep 2010 Xeon X5670 Westmere	Sep 2012 Xeon E5-2690 Sandy Bridge	Nov 2013 E5-2697 v2 Ivy Bridge	Dec 2014 E5-2699 v3 Haswell	Apr 2016 E5-2699 v4 Broadwell	Oct 2017 Xeon 8160 Skylake	Apr 2019 Xeon 8260 Cascade Lake	Sep 2019 Xeon 8260 Cascade Lake	Sep 2021 Xeon 8358 Ice Lake	Mar 2023 EPYC 9J14 Genoa	Dec 2024 EPYC 9J25 Turin	
CPU (cores)	64	64	96	128	192	288	352	384	384	384	512	1536	1536	24 X
Max Memory (GB)	256	576	1152	2048	4096	6144	12 TB	12 TB	12 TB	12 TB	16 TB	24 TB	42 TB	168X
Flash Cache (TB)	0	5.3	5.3	22.4	44.8	89.6	179.2	358	358	358	358	380	462.4 TB	87 X
Disk Storage (TB)	168	336	504	504	672	1344	1344	1680	2.35 PB	2.35 PB	3 PB	3.6 PB	4.4 PB	26 X
All Flash Storage (TB)	0	0	0	0	0	179.2	358.4	716.8	716.8	716.8	716.8	1.7 PB	2.08 PB	11 X
Network Fabric (Gb/s)	20	40	40	40	40	40	40	40	40	100	100	100	100	5 X
Ethernet (Gb/s)	8	24	184	400	400	400	400	800	800	800	800	800	800	100 X
Max Scan Rate (GB/s)	14	50	75	100	100	263	301	350	560	560	1050	1020[a]	8500[a]	607x
Max Read IOPS (M)	.05	1	1.5	1.5	2.66	4.14	5.6	5.97	6.57	16	27.6[c]	25.2[b]	25.2[b]	504x

Figure 1 Exadata hardware generational advances[1]

As can be seen in Figure 1 above, Exadata Database Machine generations closely follow update cycles of leading processors in the industry. This model maintains an innovation cadence that ensures the adoption of the latest microprocessor technologies. In addition to adopting new processors, every new generation of Exadata adopts state-of-the-art memory, flash, disks, and networking updates in a way that can enable corresponding gains in performance, reliability, and scalability for Oracle Database workloads. For example, Exadata X7 doubled the flash capacity compared to the previous version. Exadata X9M introduced 18TB disk drives compared to 14TB disk drives in X8M. Exadata X10M tripled the number of compute cores in database servers, from 64 to 192 per server. Exadata X11M introduced PCIe Gen 5 flash cards and the latest AMD EPYC™ processors. Exadata hardware updates bundle changes to many components together into a single generational update which embodies Oracle's expertise in selecting and configuring all components into an architecture that is more than the sum of its parts. This approach avoids cumbersome and risky changes to individual components. When releasing a new Exadata generation, the goal is to be timely enough to maintain leading performance and price-performance while being conservative enough to ensure the highest quality at the optimal cost.

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[1] Generational comparison made using an elastic configuration of 8 Database Servers and 14 Storage Servers in a single rack. Beginning in X10M, multiple racks are required to accommodate this configuration.
[a] Based on 2 Database and 17 Extreme Flash Storage Servers.
[b] Based on 9 Database and 9 Storage Servers
[c] Based on 10 Database and 12 Storage Servers

Exadata's Software Update Strategy

Oracle will continue to develop unique new Exadata software capabilities to optimize compute, storage, and networking, enabling even higher levels of performance, availability, and scalability for the Oracle Database.

Exadata software is released at periodic intervals, with each release incorporating customer feedback, new functionality, fixes, and priority updates (e.g., security updates) since the previous release. Exadata software is verified for compatibility with previous Exadata hardware generations, so that existing customers benefit from new functionality without requiring upgraded hardware. Similarly, each major Oracle Database software release is followed by the release of an Exadata software version that is fully compatible with that release of the Oracle Database.

Exadata software is developed by Oracle's core Database development teams. Many of its capabilities require algorithmic enhancements at several layers of the software stack, including core database, operating system, virtual machine, and storage. Such enhancements are provided by various Oracle product development teams working together in a tightly integrated manner. The majority of software in an Exadata system is owned, updated, or influenced by Oracle, unlike database systems built from a combination of unrelated vendors. Oracle is thus uniquely positioned in the industry to innovate across all software and hardware layers for all types of database workloads, realizing immense value to customers.

While other database platforms may also be based on recent processors, network, flash, disk, and other hardware, they trail Exadata in the adoption of hardware advances such as RDMA-accessible memory, 100 Gbps RoCE fabric, etc. They also lack the deep database integration and unique optimizations between Exadata software, hardware, and the Oracle Database, such as Smart Scan, Storage Indexes, AI Smart Scan, Hybrid Columnar Compression, Database-aware flash, In-Memory fault tolerance, etc. These innovative software features create a fundamental gap in performance, capacity, price-performance, and availability between Oracle Database on Exadata vs. Oracle Database on generic integrated platforms. This gap is extremely large today and is growing at a very rapid pace, as shown in Figure 2 below.
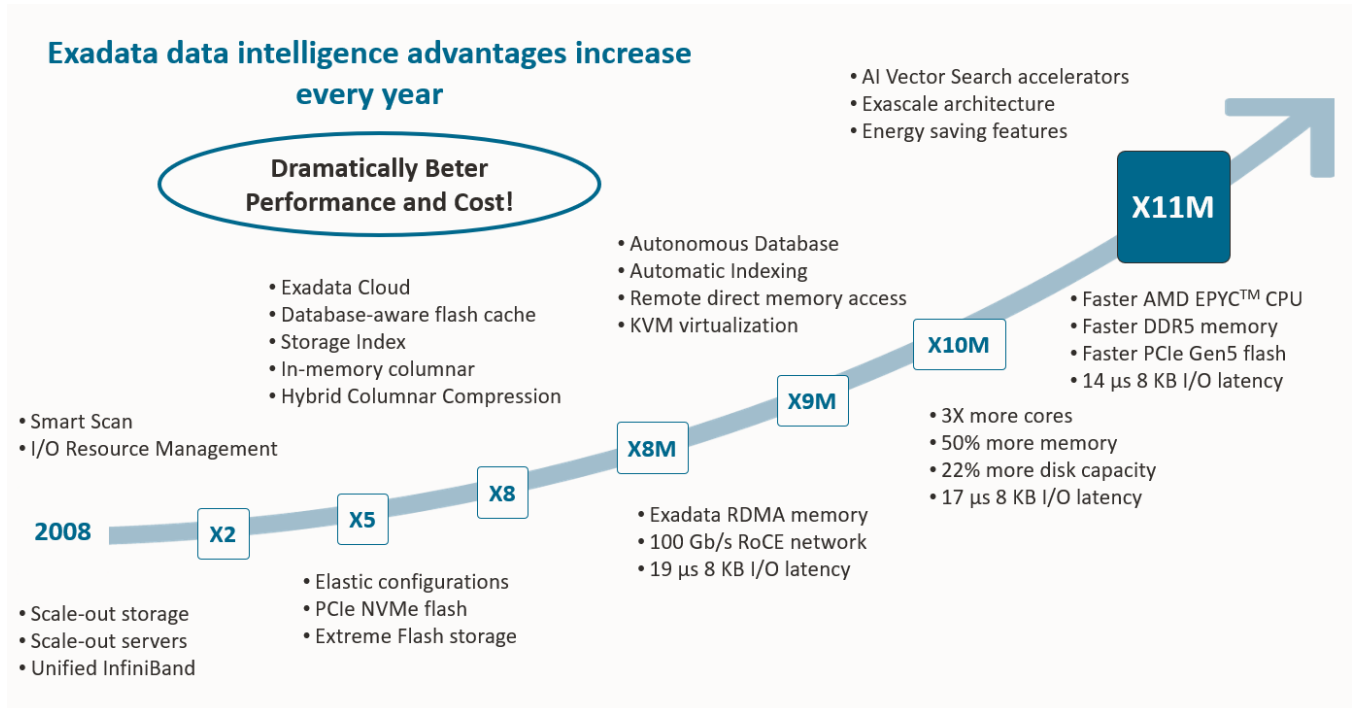

Figure 2 Exadata: continuous innovation

Oracle will continue to develop software capabilities that are unique to Exadata. Some of the new software capabilities may be tied to specific hardware advances, however many of these capabilities are pure software optimizations that will benefit new Exadata systems and previous Exadata generations. Therefore, Exadata customers benefit from a constant stream of software improvements that increase the performance and ROI of their existing and new Exadata platforms.

Investment Protection and Compatibility Guidelines

Exadata's hardware and software update methodology is consistent with the following compatibility guidelines that have been established over several generations of Exadata systems.

- Exadata protects customer investment by allowing newer generation compatible servers (i.e., X11M) to be deployed seamlessly into customers' existing Exadata Database Machines (e.g., X8M, X9M, X10M) or by inter-racking existing Database Machines with compatible Exadata systems. Newer generation Exadata servers can be added to a compatible Exadata system for a period of up to five years after the system was purchased.

- Due to native integration with RoCE, Exadata X8M and later database and storage servers cannot be used to elastically expand within a rack or multi-rack with previous generations of Exadata systems such as X7 or X8, that are based on InfiniBand network fabric. However, an Exadata X8M, X9M, X10M, or X11M system may be connected with a previous-generation Exadata system using Oracle Data Guard, and such a configuration may also be used for migrating databases into the new system.

- Oracle will continue to support InfiniBand-based Exadata systems by following the hardware support policies outlined at https://www.oracle.com/support/lifetime-support.

- New Exadata Major software releases (Major Versions) are compatible and certified with previous generation Exadata Servers and Systems for at least five years.[2]

- Oracle will continue to support future versions of the Oracle Database on current Exadata Database Machines that are still under Premier Support.

- Oracle will continue to support both virtualized and bare-metal database deployments on Exadata Database Machines.

- Exadata is based on x86-based database servers and storage servers. The underlying operating system is Oracle Linux. Oracle has no plans to remove support for these technologies.

- As customer workloads change, Oracle will continue to evolve the Exadata architecture in the most non-disruptive manner to accommodate changing workload patterns. For example, with the advent of workloads such as In-Memory data analytics and all-flash OLTP, Oracle introduced the concept of elastic configurations, enabling an Exadata Database Machine to be configured with different ratios of database and storage servers, to satisfy specific workloads. Exadata's scale-out network fabric architecture and use of standard servers for both compute and storage is instrumental to this flexibility, allowing Exadata to innovate much more rapidly and effectively than the traditional server + SAN + storage array architecture.

- To enable consolidated database environments on Exadata, multiple Oracle Database versions can be deployed within a single Exadata Database Machine. Future Exadata software releases will be compatible with supported database releases.

Figure 3 below highlights the flexible hardware and software upgrades and expansions across generations of Exadata Database Machine, with no impact on existing production applications:

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[2] https://support.oracle.com/epmos/faces/DocContentDisplay?id=2075007.1

- New generation database and storage servers may be added to any compatible Exadata system to expand compute and/or storage capacity elastically.

- New Exadata software releases may be applied to any supported Exadata system for expanded functionality.

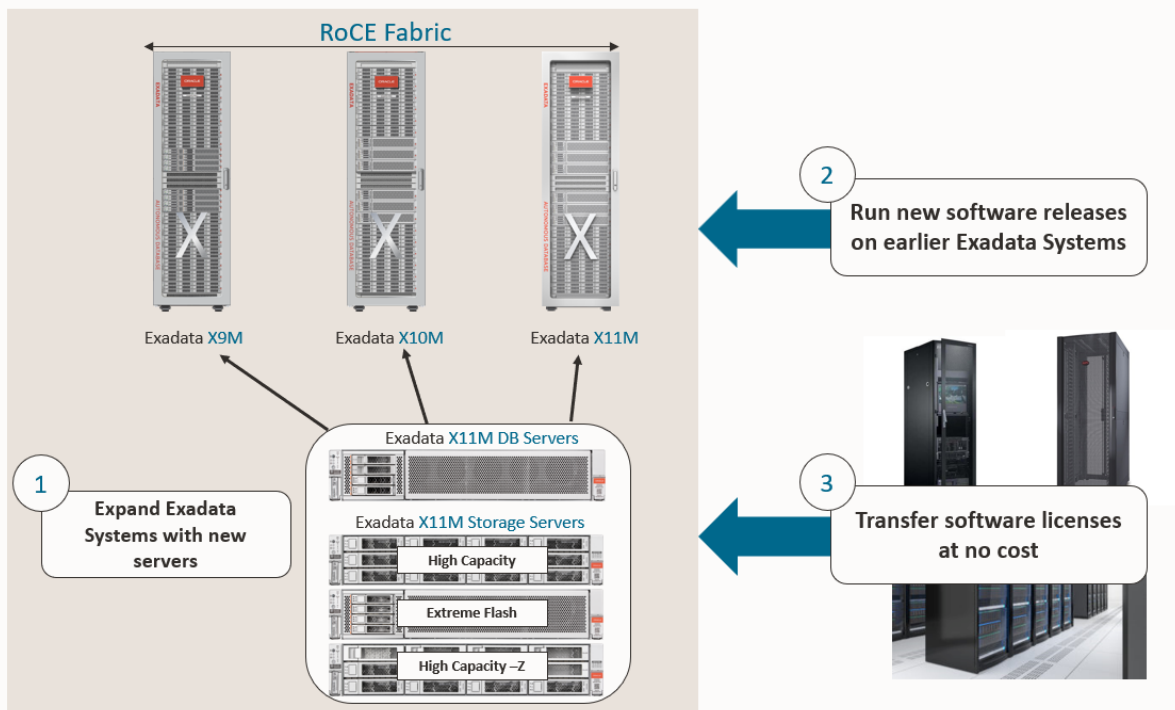- Oracle software licenses may be transferred to Exadata systems for no additional cost.

Figure 3 Expand existing Exadata systems with new servers and software releases

Investment Protection with Exadata On-premises and Public Clouds

While Exadata Database Machine on-premises will continue to be a significant focus, Exadata technology in all major clouds offers customers powerful deployment options, as shown in Figure 4. The investment protection Oracle has provided through multiple Exadata generations on-premises continues with Exadata **Cloud@Customer** and **Exadata Cloud Infrastructure**. Exadata cloud platforms offer the additional advantage of supporting both **Exadata Database Service** and **Oracle Autonomous Database**.

Exadata Deployment Models

| Exadata On-premises | Exadata Cloud@Customer | Exadata Dedicated Region Cloud@Customer | Exadata Cloud Infrastructure (Public Cloud) | Exadata Multicloud @OCI, @Azure, @Google, @AWS |

Figure 4 Exadata advantages are available on-premises and in public clouds with 100% compatibility

With Exadata Cloud Infrastructure, customers run Oracle databases on Exadata in Oracle's public cloud (OCI) with the same exceptional performance and availability enjoyed by thousands of organizations deploying Exadata on-premises. Customers can also run Oracle databases on Exadata in other partner clouds (Microsoft Azure, Google Cloud, or Amazon AWS) with the same exceptional performance as other Exadata deployments.

Exadata, in any of the above deployment settings, provides a unified platform for all workloads – Artificial Intelligence, analytics, OLTP, consolidation, and mixed workloads. Cloud customers may choose to deploy Exadata Database Service, a flexible service where the customer manages the database virtual machine, or Autonomous Database, which is fully managed. Since both database services can be run on the same Exadata cloud platform, on-premises production applications can easily move to the Exadata Database Service, while new applications are developed and deployed using Autonomous Database.

With **Exadata Cloud@Customer**, the same Exadata infrastructure and related database services that run in the Oracle public cloud are deployed in customer data centers, enjoying most of the same economic benefits of the public cloud, while still retaining on-premises security and proximity. Customers enjoy the benefits of agile cloud-based provisioning, while the associated Exadata infrastructure is maintained by Oracle.

Exadata cloud is the underlying platform for both **Exadata Database Service** and the **Oracle Autonomous Database**. Exadata Database Service is a flexible cloud service where the customer retains complete control of the customer VM and can log in as root and perform many customizations. Oracle Autonomous Database is a cloud database that uses machine learning to eliminate the human labor associated with database tuning, security, backups, updates, and other routine management tasks traditionally performed by database administrators (DBAs). With Oracle Autonomous Database, Oracle is responsible and accountable for the health and administrative lifecycle of the database providing the customer with a simple-to-use service level API. Oracle Autonomous Database brings together decades of database automation, decades of automating database infrastructure, and new cloud technology to deliver a fully autonomous database that is self-driving, self-securing, and self-repairing.

Both the Exadata Database service and Autonomous Database service can be licensed to include all Oracle Database options and features – such as Oracle Multitenant, In-Memory Database, Real Application Clusters (RAC), Active Data Guard, Partitioning, Advanced Compression, Advanced Security, etc. They also include all Oracle Database Enterprise Manager (EM) packs. Alternatively, customers may bring their on-premises database licenses to their Exadata cloud deployments in a Bring Your Own License (BYOL) model.

Oracle will continue to enhance the Exadata-based cloud services with exciting capabilities to meet the demanding requirements of enterprise customers. In addition, Oracle will also continue to enhance and support the core Exadata platform for the foreseeable future to address the requirements of on-premises customers.

Conclusion

Exadata is Oracle's strategic database platform and a cornerstone of Oracle's database strategy. Oracle will continue making significant investments in Exadata – for on-premises (Exadata Database Machine), hybrid cloud (Exadata Cloud@Customer), Oracle public cloud (Exadata Cloud Infrastructure), and multi-cloud (Database@Azure, Database@Google Cloud Platform, Database@AWS) deployments.

Exadata is designed to run all database workloads better than any other database platform while remaining 100% compatible with existing Oracle Database applications. There is no database lock-in with Exadata - existing databases can move to or from Exadata without change, and applications remain unchanged as well. Exadata incorporates leading-edge hardware and software using proven, cost-effective technologies to maximize stability and return on investment.

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