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# ORACLE EXALYTICS IN-MEMORY MACHINE: A BRIEF INTRODUCTION



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## Introduction

Analytics is all about gaining insights from the data for better decision making. The business press is abuzz with examples of leading organizations across the world using data-driven insights for strategic, financial and operational excellence. A recent study by Harvard Business Review cited that top performing organizations use analytics five times more than low performers. Firms, more than ever, need to resolve their business challenges by turn high volumes of data into actionable insights that can enable them to advance their business objectives, achieve their revenue goals, and maintain a competitive advantage. This is not, however, easy to achieve when data resides in multiple and disconnected data sources. Organizations are struggling with accessing relevant data among various data sources and effectively producing a common version of the truth across the enterprise. According to a survey by the MIT Sloan Management Review, 44% of organizations say that integration, meaning connecting disparate data sources, is the number one data priority in their organization. In addition to data integration, 46% of respondents cited that reducing costs and increasing efficiencies are in their top three of primary challenges facing their organization in the next two years. The potential payoff for firms can range from higher shareholder value to a market leadership position.

However, the vision of delivering fast, interactive, insightful analytics has remained elusive for most organizations. Most enterprise IT organizations continue to struggle to deliver actionable analytics due to time-sensitive, sprawling requirements and ever tightening budgets. The issue is further exasperated by the fact that most enterprise analytics solutions require dealing with a number of hardware, software, storage and networking vendors, and precious resources are wasted integrating the hardware and software components to deliver a complete analytical solution.

Oracle Exalytics In-Memory Machine is the world's first engineered system specifically designed to deliver high performance analysis, modeling and planning. Built using industry-standard hardware, market-leading business intelligence software and in-memory database technology, Oracle Exalytics is an optimized system that delivers answers to all your business questions with unmatched speed, intelligence, simplicity and manageability.

Oracle Exalytics's unmatched speed, visualizations and scalability delivers extreme performance for existing analytical and enterprise performance management applications and enables a new class of intelligent applications like Yield Management, Revenue Management, Demand Forecasting, Inventory Management, Pricing Optimization, Profitability Management, and Rolling Forecast etc.

Requiring no application redesign, Oracle Exalytics can be deployed in existing IT environments by itself or in conjunction with Oracle Exadata and/or Oracle Exalogic to enable extreme performance and best in class user experience. Based on proven hardware, software and in-memory technology, Oracle Exalytics lowers the total cost of ownership,

reduces operational risk and provides unprecedented analytical capability for workgroup, departmental and enterprise wide deployments.

## Oracle Exalytics Overview

Oracle Exalytics In-Memory Machine is the industry's first engineered in-memory analytics machine that delivers no-limit, extreme performance for Business Intelligence and Enterprise Performance Management applications.

Oracle Exalytics In-Memory Machine hardware is a single server that is optimally configured for in-memory analytics for business intelligence workloads and includes powerful compute capacity, abundant memory, fast storage and fast networking options.

The Oracle Exalytics In-Memory Machine features an optimized Oracle Business Intelligence Foundation Suite and Oracle TimesTen In-Memory Database for Exalytics. Business Intelligence Foundation takes advantage of large memory, processors, concurrency, storage, networking, operating system, kernel, and system configuration of Oracle Exalytics hardware. This optimization results in better query responsiveness, higher user scalability and markedly lower TCO compared to standalone software. Oracle TimesTen In-Memory Database for Exalytics is an optimized in-memory analytic database, with features exclusively available on Oracle Exalytics platform.

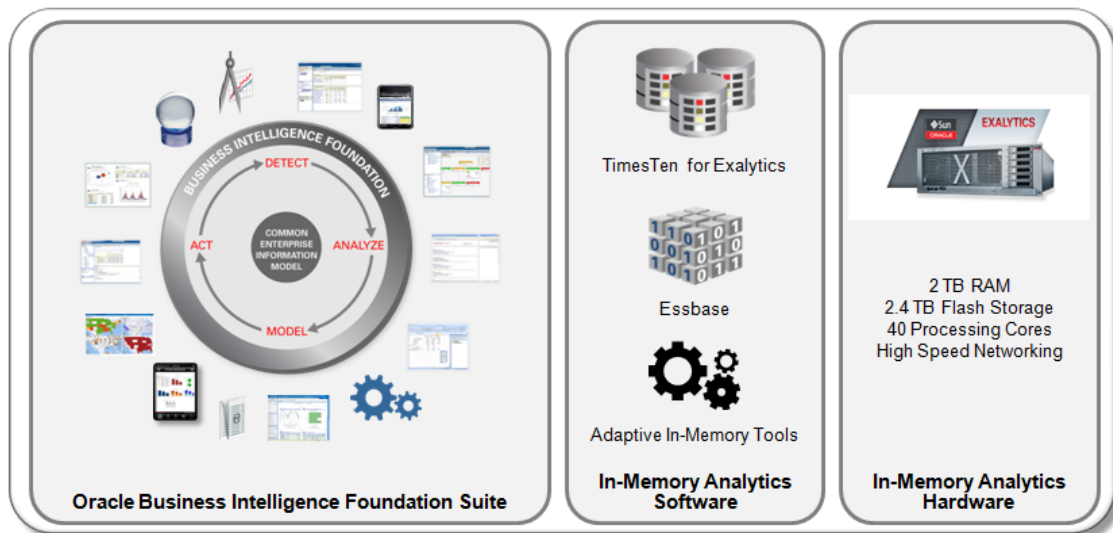


Figure 1: Oracle Exalytics consists of hardware and software engineered to work together

## Oracle Exalytics Hardware Architecture

Oracle Exalytics hardware is delivered in units of a single 3RU rack-mountable server that is optimally configured for in-memory analytics for business intelligence workloads. Multiple Oracle Exalytics machines can be clustered together to expand available memory capacity and to provide high availability. Oracle Exalytics includes powerful compute capacity, abundant memory, and fast networking options and is capable of direct attached storage options.

Oracle Exalytics is powered by four Intel Xeon<sup>®</sup> E7-4800 series processors and features high-speed interconnect technology between processors and I/O. Each processor supports 10 compute cores providing a total of 40 cores for computation. The compute power is matched with 2TB of memory to provide sufficient capacity for in-memory analytics and 2.4 TB of PCI Flash as storage for increased storage capacity and performance.

A high-performance business intelligence system requires fast connectivity to data warehouses, operational systems and other data sources. Besides, high-speed network connectivity is also required to create clusters which deliver high availability, load balancing and disaster recovery. Oracle Exalytics provides the following network interfaces to support the above requirements:

- **InfiniBand:** Two quad-data rate (QDR) 40 GB/s InfiniBand ports are available with each machine expressly for Oracle Exadata (only database machine that provides extreme performance for both data warehousing and online transaction processing (OLTP) applications) connectivity. When connected to Oracle Exadata, Oracle Exalytics becomes an integral part of Oracle Exadata private InfiniBand network and has high-speed, low latency access to the database servers. When multiple Oracle Exalytics machines are clustered together, the InfiniBand fabric also serves as the high-speed cluster interconnect.
- **10 GB Ethernet:** Two 10 GB/s Ethernet ports are available for connecting to enterprise data sources and for client access.
- **1 GB Ethernet:** Four 1 GB/s Ethernet ports are available for client access.
- **Dedicated Integrated Lights Out Management (ILOM):** Ethernet port for complete remote management.

All network interfaces support failover and can be used to setup a cluster without a single point of failure. Oracle Exalytics also includes redundant hot-swappable power supplies and fans.

Oracle Exalytics includes 2.4TB PCI Flash, a high-performance attached storage system and a high-performance RAID HBA and 5.4TBs of raw disk capacity. Optionally, clusters of Oracle Exalytics machines can leverage network attached storage for storing shared metadata and configuration data.

Oracle Exalytics includes a complete server management infrastructure with Oracle Integrated Lights Out Management (ILOM). Oracle ILOM provides complete management and administration of the server hardware via remote (SSL, HTTPS) and serial connectivity.

### Oracle Exalytics Software Overview

Oracle Exalytics runs Oracle Business Intelligence Foundation Suite along with Oracle TimesTen In-Memory Database for Exalytics, Oracle Essbase and Oracle Endeca Information Discovery. Both Oracle Business Intelligence Foundation Suite and Oracle TimesTen In-Memory Database for Exalytics have been specifically enhanced to work together and have been optimized to provide exclusive features on Oracle Exalytics hardware.

#### **Oracle Business Intelligence Foundation Suite**

Oracle Business Intelligence Foundation Suite delivers the most complete, open, and integrated business intelligence platform on the market today. Oracle Business Intelligence Foundation Suite provides comprehensive and complete capabilities for business intelligence, including enterprise reporting, dashboards, ad hoc analysis, multi-dimensional OLAP, scorecards, and predictive analytics on an integrated platform.

Oracle Business Intelligence Foundation Suite includes the industry's best-in-class server technology for relational and multi-dimensional analysis and delivers rich end user experience that includes visualization, collaboration, alerts and notifications, search and mobile access.

#### **Oracle TimesTen In-Memory Database for Exalytics**

Oracle TimesTen In-Memory Database (TimesTen) is a proven memory-optimized full-featured relational database with persistence. TimesTen stores all its data in memory optimized data structures and supports query algorithms specifically designed for in-memory processing. Using the familiar SQL programming interfaces, TimesTen provides real-time data management that delivers blazing-fast response times, and very high throughput for a variety of workloads.

Oracle TimesTen In-Memory Database for Exalytics, based on Oracle TimesTen In-Memory Database, has been specifically enhanced for analytical processing at in-memory speeds.

**Columnar Compression:** Oracle TimesTen In-Memory Database for Exalytics supports columnar compression that reduces the memory footprint for in-memory data. Compression ratios of 5X are practical and help expand in-memory capacity. Analytic algorithms are designed to operate directly on compressed data, thus further speeding up the in-memory analytics queries.

### **Oracle Essbase**

Oracle Essbase is the industry leading multi-dimensional OLAP Server for analytic applications. Essbase on Exalytics has a number of optimizations for in-memory operation including improvements to overall storage layer performance, enhancements to parallel operations, enhanced MDX syntax and a high performance MDX query engine. Essbase on Exalytics provides up to 16X faster query execution as well as up to 6X reduction in write-back and calculation operations, including batch processes. Flash as storage provides 25X faster Essbase data load performance and 10X faster Essbase Calculations when compared to hard disk drives.

These enhancements are particularly important for advanced scenario modeling, forecasting and planning, management reporting and profitability analysis. New capabilities built within Oracle Hyperion Enterprise Performance Management Applications leverage Essbase optimizations. These pre-configured Oracle EPM applications running on Exalytics (For e.g. Hyperion Planning, Hyperion Profitability and Cost Management) empower organizations to plan for profitable growth and report with confidence.

### **Oracle Endeca Information Discovery**

Oracle Endeca Information Discovery running on Exalytics enables rapid insights into new sources of data including unstructured content in social media, websites, content management systems, raw text from documents, email, and more. By correlating this data to the structured data in data warehouses and enterprise applications, users will be able to more accurately manage data and meaning from unstructured sources, ultimately driving better business decisions and innovations. In-memory architecture, highly scalable, column oriented, multi-core parallelized and natively in-memory Endeca is built to optimally leverage Oracle Exalytics to deliver speed of thought performance

### **Clustering**

Oracle Exalytics In-Memory Machine also supports clustering to provide scalability and high availability. It supports both active-active and active-passive configurations. A cluster configuration also can be configured to pool the available memory resources to accommodate larger data sets in-memory.

### **In-Memory Analytics**

Oracle Exalytics includes two in-memory analytics engines that provide the analytics capability - Oracle TimesTen In-Memory Database for Exalytics and Oracle Essbase with in-memory optimizations for Exalytics. These two data management engines are leveraged in the following four techniques to provide high performance in-memory analytics for a wide variety of business intelligence usage scenarios at workgroup, departmental and enterprise scale. These are:



- In-Memory Data Replication
- In-Memory Adaptive Data Mart
- In-Memory Intelligent Result Cache
- In-Memory Cubes

Each of these mechanisms is described in detail below.

#### **In-Memory Data Replication**

Many enterprise business intelligence implementations, including pre-packaged Business Intelligence Applications provided by Oracle, may be able to fit entirely in memory. In such cases, the Oracle Business Intelligence Server (BI Server) for Oracle Exalytics can replicate the entire data warehouse into the TimesTen In-Memory database.

This mechanism allows for in-memory analytics for all use cases including ad-hoc analysis and interactive dashboarding.

#### **In-Memory Adaptive Data Mart**

Most business intelligence deployments have workload patterns that focus on a specific collection of “hot” data from their enterprise data warehouse. In such cases, the most efficient way to provide sub-second interactivity is by identifying and creating a data mart for the relevant “hot” data. Implementing the in-memory data mart in TimesTen for Exalytics provides the most effective improvement in query responsiveness for large data sets. Tests with customer data have shown a reduction of query response times by 20X as well as a throughput increase of 5X.

**Automated Management:** Traditionally, creating a data mart for query acceleration has often required expensive and error prone manual research to determine what subject areas or cubes to bring into memory. Oracle Exalytics dramatically reduces and in many cases eliminates tuning costs by providing the necessary automation that identifies, creates and maintains the best fit in-memory data mart for a specific business intelligence deployment – thus dramatically reducing the costs of implementing and maintaining the fast query response and high throughput required for data intensive business intelligence deployments.

In cases where the entire ‘hot’ data cannot fit into the memory of a single machine, the data may be split across multiple Oracle Exalytics machines to increase the memory capacity available for in-memory analytics.

#### **In-Memory Intelligent Result Cache**

Oracle Exalytics Result Cache is a completely reusable in-memory cache that is populated with results of previous logical queries generated by the server. In addition to providing data for repeated queries, any result set in the result cache is treated as a logical table and is able to satisfy any other queries that require a sub-set of the cached data.

For best query acceleration, Oracle Exalytics provides tools to analyze usage, identify and automate the pre-seeding of result caches. The pre-seeding ensures instant responsiveness for queries at run time.

### **In-Memory Cubes**

Oracle Essbase with its in-memory optimizations for Oracle Exalytics provides another dimension for accelerating queries on specified subject areas. This contrasts with other in-memory techniques in that the cubes may be writable as well. The BI Server for Oracle Exalytics provides ways to create cubes out of data extracted from the semantic layer to provide advanced scenario modeling and what-if analysis, delivering an unprecedented and seamless modeling and reporting framework.

## Hardware Acceleration

Oracle Exalytics features an optimized version of Oracle Business Intelligence Foundation Suite, specifically tuned for Oracle Exalytics hardware and software combination. A result of the end-to-end software optimizations, Oracle Business Intelligence Foundation Suite components feature a hardware acceleration option that enables optimizations that specifically exploit the particular configuration of the Oracle Exalytics machine from the processor architecture to the concurrency and memory. These optimizations have shown to provide up to 3X improvement in throughput at high loads and thus can handle 3X more users compared to similar commodity hardware.

## An Entirely New User Experience

Oracle Exalytics delivers extremely powerful end user experience for best in class reporting, dashboards, ad hoc query, OLAP and scorecards. Every knowledge worker in the organization can gain better insight by consuming information in the format and delivery channel best suited to their role, preference, and experience level. Rich visualization capabilities, including a wide range of interactive chart types, maps, and tabular formats present information in more meaningful and compelling ways. Information can be delivered through dashboards, scorecards, or reports, within enterprise portals and collaboration workspaces, business applications, Microsoft Office tools, and mobile devices. The software components running on Oracle Exalytics like Oracle Business Intelligence Foundation Suite, Oracle TimesTen for Exalytics and Oracle Essbase have been specifically enhanced to take advantage of the compute capacity and in-memory capabilities of Oracle Exalytics.

## Interactivity and Responsiveness

Oracle Exalytics features a number of user interface enhancements to promote interactivity and responsiveness. Features like Google style auto-text complete, cascaded prompts, dynamic user interface refresh and contextual right-click interactions makes it easier for the end user to analyze data and for the first time deliver some of the most commonly used web style interactions to an enterprise software solution. Oracle Exalytics promotes self service analytics and makes it easier to develop analytics content by introducing a Presentation Suggestion Engine (PSE) which provides recommendations on type of visualizations to use to best represent a data set.

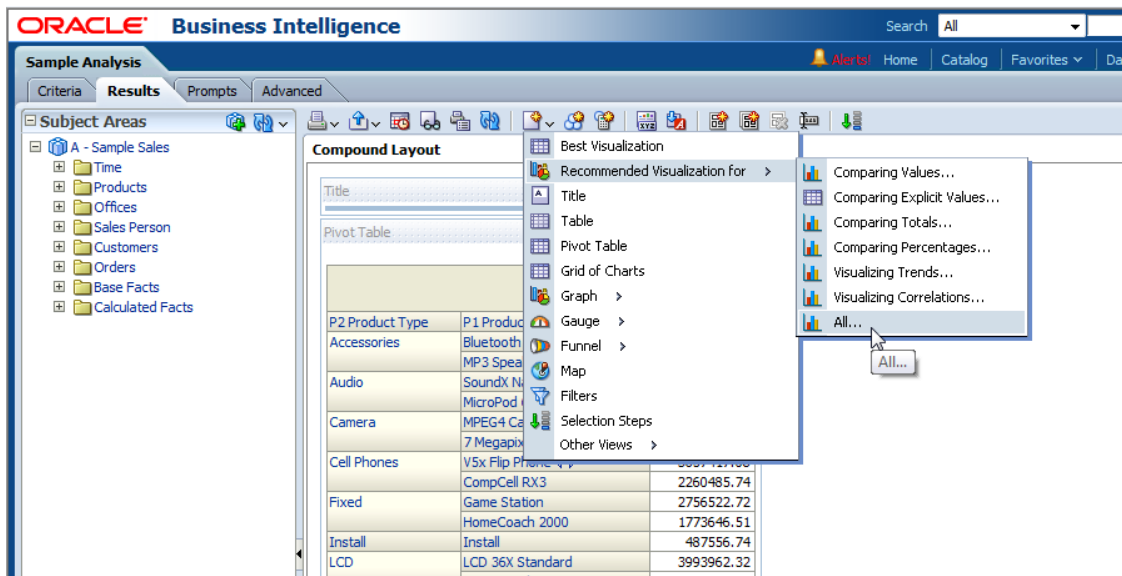


Figure 2: Oracle Exalytics Presentation Suggestion Engine promotes self service analytics

### Advanced Visualizations

Oracle Exalytics features new micro charts and multi-panel trellis charts to visualize dense multi-dimensional, multi-page data on a single screen. The multi-panel trellis charts are particularly effective at displaying multiple visualizations across a common axis scale for easy comparison, to see a trend and quickly gain insights.

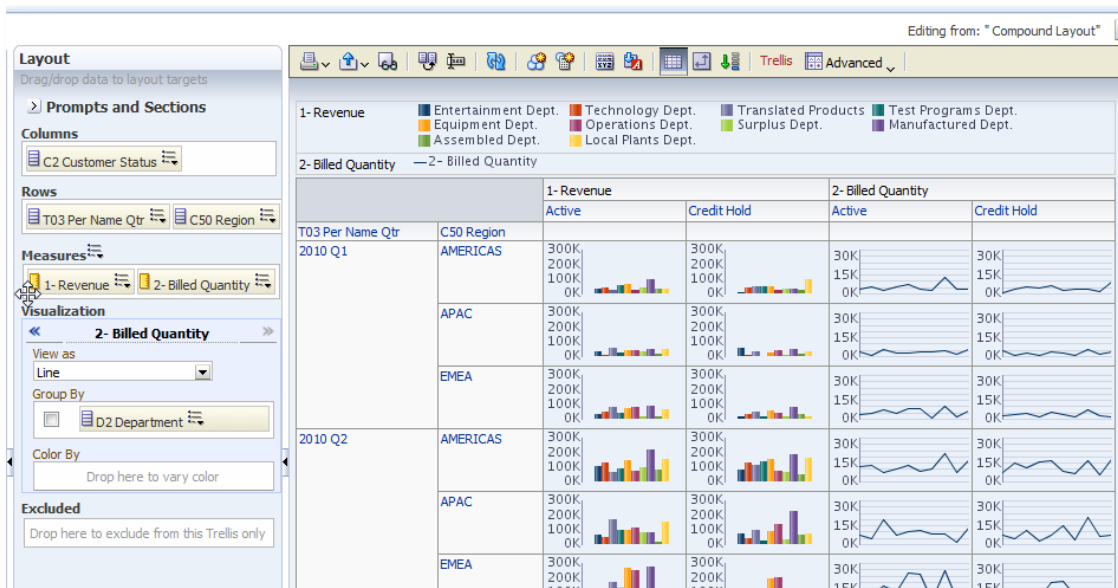


Figure 3: Oracle Exalytics Trellis Charts View provide better visual data discovery.

Mobile

Oracle Business Intelligence Foundation Suite supports Mobile BI for Apple iOS devices, including iPad and iPhone. Any content available in Oracle BI Enterprise Edition is made available to mobile users without any change or redevelopment, allowing users to perform analytics anywhere, anytime.

The visualization and interactivity enabled by Exalytics will also be available on supported mobile devices. With Exalytics, organizations can scale to larger populations of mobile users without extra servers to maintain or content to redevelop, making analytics on Exalytics truly pervasive.

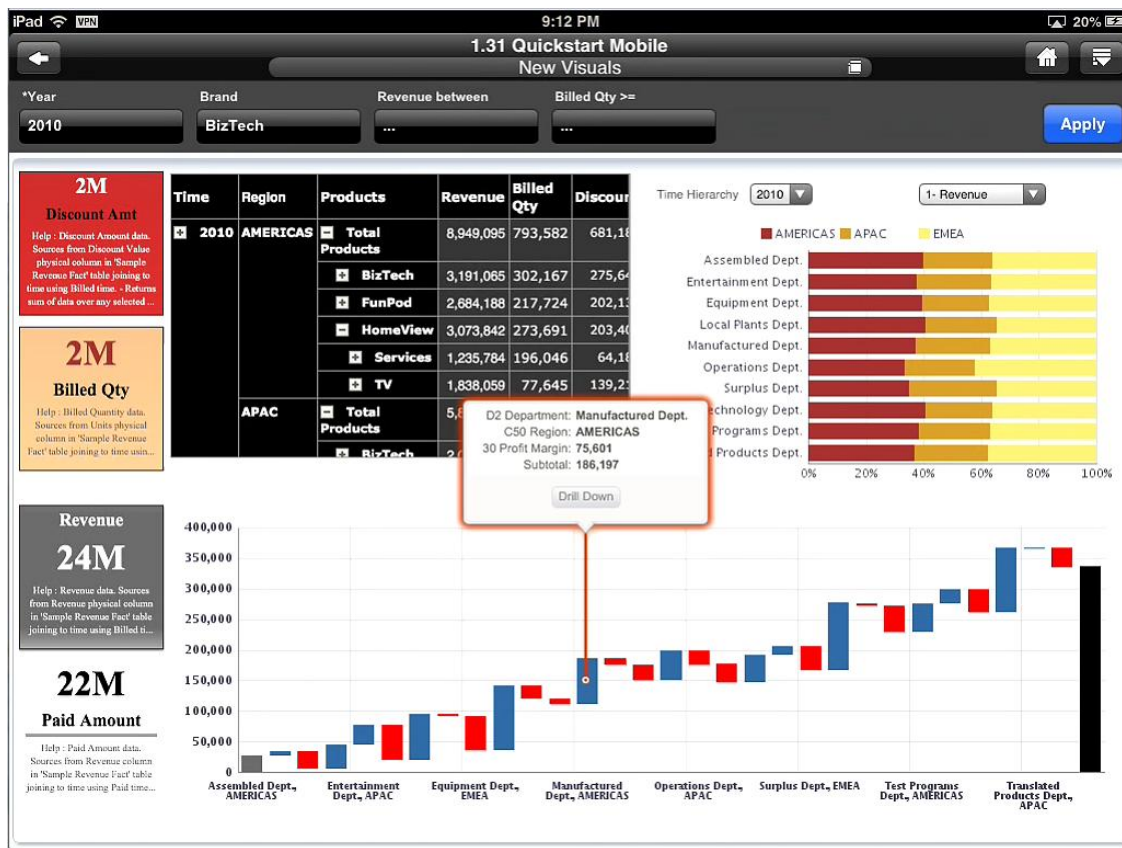


Figure 4: Oracle Exalytics delivers interactive visual analysis to Apple iPad and iPhone.

## Oracle Exalytics and Oracle Exadata: Better Together

Oracle Exadata Database Machine is the only database machine that provides extreme performance for both data warehousing and online transaction processing (OLTP) applications, making it the ideal platform for consolidating onto grids or private clouds. It is a complete package of servers, storage, networking, and software that is massively scalable, secure, and redundant. With Oracle Exadata Database Machine, customers can reduce IT costs through consolidation, manage more data on multiple compression tiers, improve performance of all applications, and make better business decisions in real time.

Oracle Exalytics complements Oracle Exadata's high performance query processing capabilities by delivering best in class user experience for analytical workloads including reporting, dashboards, ad-hoc and OLAP. Oracle Exalytics has been designed from the ground-up to be complementary to Oracle Exadata. Starting from the network interfaces, protocols to middleware to database interaction, Oracle Exalytics provides the best overall cost of ownership when connected to Oracle Exadata. Oracle Exalytics comes with pre-configured and pre-tested options to get the best performance, and the lowest total cost of ownership (TCO) without extensive tuning with Oracle Exadata.

### InfiniBand Interconnectivity

Oracle Exalytics provides a dedicated 2-port InfiniBand interface that is designed to provide redundant connectivity to Oracle Exadata's private InfiniBand network. This connection allows 40Gb/s of dedicated connectivity to Oracle Exadata, unfettered by external interference. For clusters of a few Oracle Exalytics nodes, no additional switching infrastructure is needed to connect to Oracle Exadata. In addition, the Oracle Exadata switching network provides a high-speed, fully redundant cluster interconnect between Oracle Exalytics systems.

The high-speed InfiniBand network allows for extremely low latency, high capacity pipe for replicating/populating the in-memory database as well as for querying data warehouses and operational data sources on Oracle Exadata.

### Oracle Exalytics Optimizations for Oracle Exadata

Oracle Exalytics In-Memory Machine supports optimum SQL generation for Oracle Exadata. For large analytics deployments where the data warehouse can't entirely fit into Oracle Exalytics in-memory cache, Oracle Exalytics deployments can benefit by leveraging Oracle Exadata's massively parallel processing and extreme performance capabilities.

In addition, Oracle Exalytics can use Oracle Exadata as an extension to its in-memory cache/data mart. Such a configuration boosts the capacity of the in-memory cache/data mart and is especially suited for providing uniform responsiveness over large federated deployments.

## Performance with Compatibility

Though Oracle Exalytics represents a breakthrough in performance and usability, it supports the broad portfolio of Oracle BI and EPM applications right out of the box. In addition, customers that have existing applications built on OBIEE and Essbase can migrate their applications seamlessly to exploit the power of Oracle Exalytics and are fully enabled to exploit the in-memory analytics technologies without changes to the applications.

## Foundation for a New Class of Applications

The breadth of functionality and the level of performance provided by Oracle Exalytics enable a new class of applications that were not possible before. Oracle Exalytics provides the best platform for business intelligence and enterprise performance applications that scale from workgroups to largest combinations of users, data and analytical complexity.

### **Highly Interactive Applications on Federated Data Sources**

Federated data sources pose a particular challenge to business intelligence applications as data sources vary widely in performance characteristics. Having an in-memory data mart in the middle tier allows moving the common ‘hot’ data to the middle tier to provide impressive improvement in the overall responsiveness of applications.

### **Dramatically Faster Planning Cycles**

Oracle Exalytics is uniquely suited to deploy rich, iterative financial and operational planning applications. Features like dramatically reduced planning and budgeting cycle times, improved plan accuracy by adding finer grained operational data, richer dimensionality in planning models and scalability for planners across the extended enterprise extends traditional planning applications outside the Office of Finance and into the Line of Business. Oracle Exalytics enables broad new classes of applications like Demand Forecasting, Inventory Management, Pricing Optimization, Profitability Management, and Rolling Forecast etc.

### **Conquer Analytical Complexity**

In-memory analytics in Exalytics is well suited to address high workload solutions which frequently hit up against processing or data volume limitations where traditionally customers have had to invest extensively in hardware, tuning and maintenance. Oracle Exalytics with its optimized hardware and software combination take away the challenge of repeated tuning and maintenance.

**Pre-Packaged Business Intelligence Applications**

Oracle's prepackaged business intelligence applications offer the best value on Oracle and competing ERP and CRM applications. Through certified support for all Oracle BI & EPM applications, Oracle Exalytics takes it to the next level in performance, ROI, scalability and manageability by delivering pre-tested and pre-engineered systems.

**Enable Intelligent Decision Cycle – Detect, Analyze, Model, Act**

The combination of the state of the art analytics and modeling infrastructure in Oracle Exalytics expand the ability of business intelligence users from historical and situational awareness to ask forward looking questions and compare models to help decision making. Oracle Business Intelligence Foundation Suite Action Framework accelerates decision making by turning insights into actions through the ability to invoke business processes from within the business intelligence dashboards and reports.

**Scalable and Unified Management Reporting**

Oracle Exalytics provides rich and consistent reporting on all enterprise performance management applications via Oracle Essbase and Oracle Essbase Analytics Link thereby enabling scalable and unified management reporting applications.

**Visual analysis of large volumes of information**

Oracle Exalytics features advanced visualizations allowing business users to analyze large volumes of information easily and expands the use of analytics beyond the highly trained analysts and statisticians.

In summary, Oracle Exalytics In-Memory Machine is an engineered system pre-integrated to reduce the cost and complexity of an organization's IT infrastructure, while dramatically increasing productivity and performance. By integrating best-of-breed software and hardware, customers are able to reallocate their resources from maintaining their data center operations, to focusing on achieving their growth and profitability objectives. As the industry's first engineered system for business analytics, Oracle Exalytics cements Oracle's position as the #1 vendor in business analytics, continually leading the way to help organizations gain more insight, across more data, and drive better outcomes in every aspect of their business.

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REMAINS AT THE SOLE DISCRETION OF ORACLE.

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