

# Oracle Fusion Architecture and Oracle Fusion Applications

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# Oracle Fusion Architecture and Oracle Fusion Applications

## **EXECUTIVE SUMMARY**

To achieve competitive superiority in business, organizations must often balance the need to maintain predictable levels of productivity and continuity with the desire to extend or evolve existing business processes or to create new processes. These changes can come from a myriad of sources: mergers and acquisitions, new partnerships, corporate reorganizations and expansions, changes in tax codes, new government regulations, or changes in corporate strategy, tactics, or priorities.

With business operations and information technology now inextricably linked, the ability to make effective changes to business processes is often dependent on the ability of an organization's information technology to enable this change. With most enterprises now employing literally thousands of individual hardware and software components, there is an ever-increasing need to develop and adopt an architecture that can deliver both predictability and responsiveness to change.

One of the main purposes of adopting an architecture is to streamline decision-making by agreeing on a set of standards, priorities, and practices. When the many departments of a business can agree on a technology and business process architecture, they can save significant time and costs.

Oracle Fusion Architecture provides a high-performance, highly available computing environment that delivers a rich catalog of standard business processes in a wide range of areas such as CRM, ERP, and supply chain management. Oracle Fusion Applications provide a dynamic business process portfolio that can evolve as a business evolves. Oracle Fusion Applications also have extensibility for integrating industry- or process-specific functionality from third-party, custom, and legacy applications.

This paper is divided into two parts. The first part provides a detailed description of the Oracle Fusion Architecture. It also describes the underlying technology that will power the next generation of service-oriented applications developed by Oracle, Oracle partners, and customers. The second part offers a detailed description of Oracle Fusion Applications and how they will take advantage of Oracle Fusion Architecture. It also outlines how Oracle Applications partners and customers can best use the software services and design principles of Oracle Fusion Applications.

## ORACLE FUSION ARCHITECTURE DESIGN PRINCIPLES

The Oracle Fusion Architecture is centered on a set of core design principles that drive the evolution of Oracle software products. These principles provide a long-term statement of direction for Oracle products to Oracle partners and customers. These design principles are as follows.

### Model-Driven

Some of the most dramatic developments in computing have been those that place more power in the hands of users, easily and transparently. The ability of good software development tools or user interfaces to hide technical complexity from information workers stems from a model-driven approach. By adopting a model-driven approach, organizations can enjoy more rapid application development, greater reuse of software components, and a much simpler maintenance and upgrade process. Key components of a model-driven approach include

- **Visual tools** that enable business analysts to effect changes to business processes, business rules, or event application functionality
- **A declarative development environment** that includes tools that understand business language instead of specialized technical knowledge
- **Systematic application extensibility** to provide underlying applications and the business processes with a standard mechanism for extensibility and modification
- **Lifecycle and change management** so that any changes in business operations enacted by business analysts will have simple and effective versions control, change tracking, approval processes, and testing processes.

### Service and Event Enabled

Software-as-a-service has long been a goal of the software industry because it offers lower cost, higher quality, and faster integration. Yet only in recent years, with the development and broad adoption of key Web services standards, has software-as-a-service become attainable.

In parallel, software infrastructure and applications also are increasingly required to respond quickly to changes in the business or computing environment. There are an infinite number of events that can cause change—a stock hitting a certain price, a spike in the temperature of a refrigerated food-handling facility, or low barometric pressure readings in the Caribbean. Thus, applications and information sources must be able to both interact with new software services as they come online and respond to expected and unexpected changes or sensor readings as they arise. Key components of a service- and event-enabled approach include

- **Enterprise application functionality delivered as Web services**—virtually any enterprise application can be designed as a collection of Web services. Thus, Oracle Fusion Applications can expose their capabilities as services that can run as global standard business processes, or they can be extended with industry- or process-specific functionality.
- **Modular application and business process design**—by creating applications in a modular fashion, business analysts can then use an ever-increasing catalog of process functionality to tailor business operations as circumstances dictate.
- **Web services and SOA infrastructure**—In order for a service-oriented approach to succeed, the underlying Web services and SOA infrastructure must be robust, scalable, and secure.
- **Unified event management**—Businesses must have a standard programmatic method of dealing with events of all types. This requires a standardized event-driven architecture (EDA) that can be used by both Oracle Applications and custom or third-party applications or Web services.

### **Information-Centric**

While it has become easier and less expensive to collect and manage large amounts of data, the creation of relevant, timely, and accurate information remains the most important challenge of any enterprise. High-quality information is the ultimate ingredient for progressively improving business productivity and competitiveness. Additionally, the ability for IT or business users to get the most out of information assets depends on how effectively that information is visualized, shared, and acted upon. Thus an information-centric approach requires

- **Analytic and collaborative context at the point of action**—Effective business processes are the result of the performance and productivity of the information workers that execute them. Individual productivity is achieved when employees know not only what to do, but in a broader sense, know why they are doing it. This sense of context, and the ability to make solid, informed decisions, can be greatly enhanced by appropriate analytical information or collaborative capabilities at the point of action. When your staff can get immediate, clear information analysis or immediately collaborate on an issue, organizational gridlock is avoided.

- **Insight-driven user interface**—the continued use of the modular enterprise portal as both a standardized and a personalized portal into all relevant business information or process steps means that packaged applications no longer completely dictate the look and feel of the user environment. Although orchestrated business flows with standard screens will continue to drive a lot of day-to-day business operations, the flexibility to add analytics, group collaboration, audio/video aids, and Web conferencing provides a much richer user experience and subsequently make for more self-sufficient employees.
- **Unified, consensus-driven data model**—One of the most common yet most costly results of complex business operations is duplicate, inaccurate, or conflicting business information in the form of customer lists, product lists, and financial transaction histories to name a few. A superior technology architecture establishes and maintains a single, high-quality repository of these critical information assets. This occurs because most enterprise applications are not designed to maintain data accuracy beyond their own internal operations. As organizations require increasing responsiveness from IT systems and enterprise applications, the establishment of a transparent information quality service built on a standardized data model and consensus-based master data lists will ensure that information quality will be high across all enterprise applications.
- **Common data management of operational, analytical, and collaborative information**—creating seamless, information-driven, adaptive business processes is only possible if the applications that drive these processes can effectively share and process information from many sources. Yet traditional barriers between transactional data and business intelligence data has meant that different skill sets, tools, and hardware are required for these two types of data. An information-centric approach requires that there be a single definition layer for all enterprise data in order to minimize data integration headaches and high costs associated with data transformations and scrubbing. This simplifies and enforces a consistent definition of key performance indicators (KPIs) and good corporate performance management practices.
- **Effective business activity monitoring**—Real-time feedback is key to managing a business. Organizations need real-time access to critical business performance indicators, along with supporting information, to improve the speed and effectiveness of business operations.

## Grid Ready

The Oracle Fusion Architecture bases its underlying infrastructure on modern grid computing technology because it is the most scalable, reliable and cost-effective IT

infrastructure deployment model today. To be grid-ready, Oracle Fusion Applications must use the following guidelines:

- Applications must be designed in a modular fashion so that individual data management or business logic execution can be assigned to pools of database or middleware servers for maximum performance, flexibility, and stability.
- Application developers must avoid “hard-coding” applications to specific server addresses or narrowly specified hardware characteristics.
- Applications must be based on open standards for security, management, and Web services functionality so that the performance and integrity of the applications can be tracked, audited, and verified using tools available from Oracle or third-party developers.

### **Standards-Based**

Like a strong technology architecture, systematic adoption of long-lived fundamental technology standards provides the ultimate basis for predictability at many levels of an IT or business environment. There is a vast range of standards that need to be considered. Here are some examples.

- **Web services**—widely adopted Web services standards such as SOAP, WSDL, and XML have greatly contributed to the rapid acceleration of adoption of a service-oriented approach to applications and IT services.
- **Business process**—to achieve some level of standardization in business process automation, the Business Process Execution Language (BPEL) has been developed and is rapidly becoming a key standard in the definition of an industry-standard approach to creating service-oriented applications.
- **Integration**—Integration standards are emerging both as horizontal specifications, such as OAGIS and UN/CEFACT, for large scale enterprise application integration, and as industry or functional specifications such as RosettaNet (for high tech industry), HL7 (for healthcare), and HR-XML (for human resources). Oracle provides technology and thought leadership for industry standards organizations and has an excellent track record for timely adoption of key open standards at many levels of the technology stack.
- **Security and identity**—Reliance on security standards such as Secure Socket Layer (SSL), Security Assertion Markup Language (SAML), and Security Provisioning Markup Language (SPML) ensure that security and privacy can be both established and verified by internal and external auditors.

## PART I - ORACLE FUSION ARCHITECTURE

### Service-Oriented and Event-Driven Architecture

Model-driven development and service-oriented and event-driven architecture (SOA and EDA) facilitate the development of enterprise applications as modular business services that can be easily integrated and reused. This creates a closer alignment of information technology and business operations so that an organization can respond more quickly to changing business conditions.

SOA-based applications are designed as a set of functions accessed through standard service interfaces. SOA-based applications can be orchestrated into a wide range of customized business processes that can be quickly redesigned as needed.

Oracle is using SOA to develop the next generation of Oracle applications because it provides a standard method of integrating and evolving business application functionality from the Oracle E-Business Suite, PeopleSoft applications, JD Edwards products, and other Oracle application product lines. SOA also will enable third-party developers to extend the capabilities of Oracle applications to add, for example, industry-specific functionality or custom services. For this reason, the resulting SOA application components created by Oracle developers, partners, and customers are called *Oracle Fusion Applications*.

The Oracle Fusion Architecture's SOA and EDA technology consists of

- An integrated service environment (ISE) to develop services
- A multi-protocol enterprise service bus (ESB) to integrate applications
- A services registry for discovering and managing the life cycle of services
- A BPEL-based orchestration engine to tie services into business processes
- A business rules engine to enable business policies to be captured and automated
- A Web services management and security solution to enforce authentication and authorization policies on services and to monitor services and processes for compliance to SLAs

### Designing Services—Integrated Services Environment

Oracle JDeveloper, Oracle Application Development Framework (Oracle ADF), and Oracle TopLink are development components of the Oracle Fusion Architecture that form a comprehensive integrated services environment (ISE) to develop, compose, and orchestrate services into business processes that can be deployed, registered, and consumed from several types of user interfaces, including desktop clients, browsers, and mobile and telnet devices.

Oracle JDeveloper is an ISE that enables developers to model, create, discover, assemble, orchestrate, test, deploy, and maintain composite applications based on services. JDeveloper supports SOA principles and XML Web services standards,

as well as traditional Java, J2EE, and PL/SQL components and modular code mechanisms.

Oracle ADF is a model-driven SOA framework that automates and manages business and data services, and provides a standard data-and service-binding layer based on JSR 227 that can be used with process flows, page flows, and service invocations. Oracle ADF also implements SOA design practices and makes user interfaces as loosely coupled as services themselves.

Oracle TopLink is a data services framework that allows access to relational and XML data. It provides visual mapping tools for facilitating object to relational mapping, and object to XML mapping. Oracle TopLink and Oracle ADF frameworks simplify the creation of business and data services that can be invoked from rich Web interfaces of service-oriented applications.

Oracle JDeveloper, Oracle ADF, and Oracle TopLink provide a comprehensive integrated services environment and framework that enables developers to build model-driven applications and business processes that can then be deployed and registered as applications, services, or business processes. Key capabilities include

- **Creating business services**—Support for WSIF bindings that allow the publishing of Java, EJB, Java Message Service (JMS), and enterprise applications connected via Java Connector Architecture (JCA) adapters as services that can be invoked natively. Support for REST (Representational State Transfer)-based service. Oracle JDeveloper also features support for developing J2EE 1.4-compliant Web services, with the ability to create JAX-RPC clients and services. Support for WS-Security, WS-Reliability, and WS-Management. Support for developing bottom-up services via metadata tags and contract-driven development using the WSDL editor is also included.
- **Creating business and user interface logic**—Oracle JDeveloper includes support for EJB 3.0 that simplifies backend business logic and persistence mapping aspect. New JDeveloper wizards generate EJB 3.0 components, and property editors support the incremental development of business methods and mapping annotations. Support for JSF for building Web applications. Oracle JDeveloper provides several tools such as visual user interface component editing via JSF WYSIWYG editors, drag-and-drop capabilities for JSF components onto pages, and visual diagrammer for rapid development of JSF navigation.
- **Binding user interfaces to services**—Oracle JDeveloper includes support for JSR 227 that facilitates binding user interfaces to data sources and services. Support for drag-and-drop attributes, collections, and operations from the data control palette that is exposing back-end business systems, services, and business processes is also included. Also featured is support for data-binding Oracle ADF Faces components to back-end business services and business process.

## Integrating Services—Enterprise Service Bus

The Oracle Fusion Architecture features an enterprise service bus (ESB). As the “glue” for the enterprise application infrastructure, the architecture’s integration platform provides the basis for gathering the information that drives the organization, from all types of data sources. Oracle ESB, based on SOA and EDA principles, loosely couples distributed applications.

At its core, Oracle ESB integrates services by passing messages between them, both synchronously and asynchronously. Oracle ESB also incorporates routing so that messages can be routed to the appropriate services, based on rules governing both the message content and other external factors. Oracle ESB performs message transformation. Because Oracle ESB can enable routing and transformation logic to be changed at runtime, more maintainable applications can be built. This means service connections are less brittle when Oracle ESB is used. Key capabilities for Oracle ESB include

- **Reliable multi-transport bus**—Oracle ESB provides a flexible, real-time enterprise backbone capable of supporting industry-standard protocols such as SOAP, HTTP(s), or JMS. A special in-memory optimization is automatically used for service calls within the same virtual machine. It provides fast, scalable, guaranteed once-and-only-once message delivery using both point-to-point and publish/subscribe patterns. Oracle ESB can use Oracle’s own JMS or Oracle Advanced Queuing (AQ) as a message transport; it is also certified with other messaging providers such as IBM MQ, Sonic MQ, and Tibco.
- **Complex business data transformations**—Businesses require flexibility in combining data models from disparate systems. Oracle ESB utilizes standards-based data mapper functionality within JDeveloper to create transformation templates in the XSLT language for reuse across the enterprise. The auto-mapping feature increases user productivity by remembering and reusing common mappings from previous transformations.
- **Comprehensive management and deployment infrastructure**—At design time, Oracle ESB allows you to create virtual service names into lookup repositories, such as UDDI, that are later bound to real or physical application URLs defined during deployment. Oracle ESB Diagrammer and Topology Viewer allow you to build and visualize relationships between services and graph dependency charts or impact analysis for proposed changes to your systems. The viewer includes an ESB-wide search facility to locate components such as adapters, messages, and active process instances based on unlimited input criteria. Centralized management of distributed applications is a key component of Oracle ESB.
- **Pervasive enterprise system connectivity**—Adapters provide key connectivity and discovery into enterprise and legacy system metadata to enable mapping of objects to real-time events in your ESB. Oracle provides

built-in adapter wizards for Oracle Database, Oracle AQ, JMS, Email, FTP and Files, as well as enterprise applications such as the Oracle E-Business Suite, PeopleSoft, JD Edwards, and SAP, and legacy systems such as CICS, IMS, and even TPF. All adapters conform to the J2EE connector architecture (JCA) open standard adopted by all major integration vendors.

- **Flexible, content-based routing**—The ability to filter and route data based on message content is critical to optimal management of your ESB. Oracle ESB enables routing in design-time deployment descriptor definitions that can be modified at runtime for adjusting application efficiency. This minimizes the overhead of redeployment. For example, as system demand increases and you add servers to your cluster, you can dynamically route traffic based on content such as currency, region, product name, or any other contextual data. Oracle ESB supports a variety of rules capabilities for filtering, including Oracle Business Activity Monitoring, Oracle Business Rules, and external providers. Content filtering can also be implemented in messaging systems, such as JMS, by using configurable, filter-based subscriptions and message selectors.

### **Discovering Services—Service Registry**

Oracle Fusion Service Registry provides a configurable, scalable, and secure repository for Web services that can be provisioned, discovered, and governed by Oracle Fusion Architecture. The registry complements the SOA functionality provided by other Oracle Fusion components, supplying the enterprise with a mechanism for advertising and managing available service offerings. The registry is one of the first to fully support the OASIS Universal Description, Discovery, and Integration (UDDI) v3 standard.

- **Service provisioning**—the service registry enables providers of Web services to publish services and related artifacts, thereby making offerings available to service consumers. Services can be categorized or classified using a comprehensive taxonomy management feature, which allows the import of existing business taxonomies as well as the creation of custom classifications.
- **Service discovery**—the registry essentially serves as a directory of services, providing references to service descriptions and endpoints available on Oracle Fusion instances. The registry facilitates SOA adoption by enabling users to search for services that meet specific criteria, as well as browse offerings available from providers, without having to understand the underlying UDDI data structures. Controlled access to services ensures accountability and responsibility, while enabling users to limit the visibility of sensitive services.
- **SOA governance and life cycle management**—the registry serves a single point of control for SOA governance, ensuring quality and consistency of service offerings across the enterprise. A quality control

workflow feature is incorporated through which services are first published to a “staging” registry, and then moved to a “production” registry accessible to consumers after corporate-mandated checks have been performed. A subscription mechanism enables consumers to be notified when changes are made to a service, promoting reuse of services and preventing reinvention of existing functionality.

- **Integration**—the registry plans to be integrated with components of the Oracle Fusion Architecture: Oracle BPEL Process Manager, Oracle JDeveloper, Oracle Web Services Manager, and the broader Oracle Fusion Middleware and Applications software, with the ultimate goal of making it easier to discover, orchestrate, secure, and manage an SOA. In addition, the Oracle Application Server Service Registry provides comprehensive, Web-based user interfaces for publishing and discovering services, as well as for managing the installation.

### **Orchestrating Services—BPEL Process Manager and Workflow**

Oracle BPEL Process Manager enables business processes to be modeled, automated, and monitored. Unlike code-generation techniques for automating business process, Oracle BPEL Process Manager includes a native BPEL (Business Process Execution Language) engine that executes the processes. This approach not only enables reuse, but also enables visibility into in-flight business processes at the individual and aggregate level (the latter being provided by Oracle Business Activity Monitoring), and lays the foundation for close-loop business process management, process improvement, and compliance.

Oracle BPEL Process Manager provides a comprehensive, standards-based, and easy-to-use solution for creating, deploying, and managing cross-application business processes with both automated and human workflow steps. It provides high-performance, reliable execution of service-oriented business processes defined with the BPEL standard.

Oracle BPEL Process Manager’s native support for standards such as BPEL, XML, XSLT, XPATH, JMS, JCA, and Web services makes it an ideal solution for creating integrated business processes that are truly portable across platforms. It also provides audit trails for both completed and in-flight processes, and process history that enables process improvement.

Finally, the Oracle BPEL Process Manager is a 100 percent native BPEL engine that coexists happily with existing middleware technologies and platforms, and provides an unrivaled process portability and vendor flexibility. Key capabilities of Oracle BPEL PM include

- **Rich tooling for integration**—Oracle BPEL Designer is unique in that it uses BPEL as its native format. This means that processes built with the Designer are 100 percent portable. Oracle BPEL Process Designer comes as a plug-in to the Oracle JDeveloper environment, providing a unified design-time environment to develop user interfaces and orchestration

services. Built-in integration services enable developers to easily leverage advanced workflow, connectivity, and transformation capabilities from standard BPEL processes. These capabilities include support for XSLT and XQuery transformation, as well as bindings to hundreds of legacy systems through JCA adapters and native protocols using WSIF. The extensible WSDL binding framework enables connectivity to protocols and message formats other than SOAP. Bindings are available for JMS, email, JCA, HTTP GET, POST, and many other protocols, enabling simple connectivity to hundreds of back-end systems. This approach gives unparalleled performance, yet ease of development. User-friendly wizards to set up simple and complex human workflow steps, configure adapters, and define complex transformation maps are provided as standard services. Human workflow services such as task management, notification management, and identity management are provided as built-in BPEL services to enable the integration of people and manual tasks into BPEL flows.

- **Comprehensive monitoring and management**—Oracle BPEL Process Manager Console provides a user-friendly, Web-based interface for management, administration, and debugging of processes deployed to the BPEL server. Audit trails and process history/reporting information are automatically maintained and available through the BPEL Process Manager Console and via a Java API. The workflow task lists and historical process analysis reports are also integrated into the same console.
- **Unparalleled scalability and availability**—The core BPEL engine provides the most mature, scalable, and robust implementation of a BPEL server available today. The Oracle BPEL Process Manager executes standard BPEL processes and provides a “dehydration” capability so that the state of long-running flows is automatically maintained in a database, enabling clustering for both fail-over and scalability. The BPEL server leverages Oracle Containers for J2EE as an underlying J2EE application server, but also supports most major commercial application servers such as BEA WebLogic and JBoss.

### **Automating Business Policies—Business Rules**

Agility is one of the biggest promises of SOA and BPM: the ability to make rapid changes to processes in step with the changes that occur inside of your business. Such changes are not always changes to the process. Often they are changes to the rules that drive the process.

A typical business process often includes a number of decision points. These decision points generally have an effect on the process flow; for example, someone’s credit rating might determine whether he/she is approved for a low-cost loan. These decisions are evaluated based on certain conditions and facts, which can be internal or external to the business process, and predefined company policies or rules.

Business rules engines allow architects to easily define, automate, manage, and update the decision logic that directs enterprise applications from a single location without needing to write code or change the business processes calling them. Rules engines are naturally of interest to enterprise architects building out SOAs, because they contribute to agility by enabling reduced time to automate, easier change, and easier maintenance for business policies and rules.

BPM technology and rules engines naturally fit together: BPM enables automated and flexible business processes; rules engines enable automated and flexible business policies. Key capabilities of Oracle Business Rules

- **Capturing business policies across all applications**—In the past, rules engines were primarily used to solve highly complex problems requiring a great degree of inferencing. More recently, the rules market has evolved such that rules are now being used for the implementation of business policies. Oracle Business Rules enables business policies to be abstracted out of any application—not just applications that are designed to SOA. It is based on the Jess Rules Engine, but it conforms to JSR-94 and enables facts to be defined in Java.
- **Automation of business policies in business processes**— Business processes typically involve decision steps. Oracle Business Rules enables decisions and business policies to be abstracted out of the business process, providing a single location for policy management and change. Oracle Business Rules enables facts external to the business process to be asserted in the evaluation of business rules, unlike monolithic BPM suites. The rules are separated from the process logic and can be changed independently. This makes business processes less brittle because rule changes can be deployed without modifying or rebuilding rule-enabled processes and applications. In order to ease development, increase developer productivity, and enable more agile applications, developers can use Oracle JDeveloper to build *both* the business processes in Oracle BPEL Process Manager and related business policies using Oracle Business Rules.
- **Shared metadata across rules, processes, portal, and activity monitoring**—Rules have relevance to document flows, business processes, and activity monitoring. Oracle BPEL Process Manager, Oracle BAM, and Oracle Portal applications can leverage rules in Oracle Business Rules, including rules metadata. This eliminates the need to synchronize rules across multiple rules engines and allows a common set of rules to be used for integration, BAM, portal, and other applications. For example, a business rule that works out the interest rate on a loan application that has been implemented as a process in BPEL, can take into account the number of loans approved this month to similar customers—this data comes from the activity-monitoring solution.

## Managing Services

Oracle Web Services Manager enables IT to effectively monitor, manage, and secure services and interactions between these services in an SOA. It provides tools for building security and operations policies that can be layered over new or existing applications and Web Services; runtime facilities for intercepting calls to and from an application or service and then executing these policies; dashboards for monitoring these policies as they execute, to ensure service levels and potential problems; and alerting to enable corrective actions to be taken in a timely fashion.

Oracle Web Services Manager can centrally define policies that govern Web services operations such as access policy, logging policy, and content validation, and then wrap these policies around services, with no modification to existing Web services required. Also, Oracle Web Services Manager collects monitoring statistics to ensure service levels and security, and displays them in a Web dashboard. As a result, Oracle Web Services Manager brings enterprises better control and visibility over their Web Services. Key capabilities for Oracle Web Services Manager include

- **Policy management**—The Policy Manager in OWSM is a graphical tool for building new security and operations policies, storing policies, and managing distribution and updates to runtime agents and gateways. Policy Manager supports both client-side and service-side policy enforcement, and allows administrators to configure operational rules and propagate them to the appropriate enforcement components across an application deployment of any scale and complexity. OWSM has out-of-the-box support of authentication and authorization using HTTP basic authentication, COREid, Netegrity, LDAP, X.509 Certificates; Oracle COREid, LDAP and Netegrity for role-based invocation access; and Security Assertion Markup Language (SAML) for interoperability between different security systems.
- **Enforcement**—To ensure maximum deployment flexibility, OWSM provides two kinds of enforcement components: policy gateways and policy agents. Policy gateways are deployed in front of a group of applications or services. They can intercept inbound requests to these applications in order to enforce policy steps, adding application security and other operation rules to applications that are already deployed. Policy agents provide an additional, fine-grained level of security by plugging directly into an application or service. OWSM enforces true end-to-end message-level security, supports WS-Security for authentication and message-level security including encryption and signing, and supports full and partial encryption and decryption step.
- **Monitoring**—Monitoring Dashboard collects data from gateways and agents as they execute policies and displays results in a graphical format. This allows administrators to set quality of service levels for each application. Monitoring Dashboard will display alerts when the application

exceeds established targets. It also provides IT operations staff with real-time visibility into the health, performance, security, and utilization of crucial Web services, including end-to-end monitoring of business processes. By harnessing the real-time data collection capabilities of the enforcement components, Monitoring Dashboard enables administrators to analyze discrepancies between expected and actual performance, and to monitor compliance with IT operational best practices in real-time, such as audits on security violations on a per-Web-service, per-operation, and per-client basis. The result is best practice security and operations across all applications and services in an enterprise and its partners, regardless of how these applications and services were developed.

- **Comprehensive support for protocols and third-party platforms—**OWSM works with multiple Web services platforms and providers including BEA Systems, IBM, Microsoft, Netegrity, TIBCO, and VeriSign. For example, sites using TIBCO BusinessWorks can install OWSM agents to act as SOAP interceptors that enforce Web service policies. OWSM provides out-of-the-box, native support for multiple transports, including HTTP, HTTPS, JMS, IBM WebSphere MQ, and multiple messaging models, including synchronous and asynchronous messaging. Furthermore, it provides content-based routing and built-in failure handling, including message queuing, fail-over routing, and configurable message retry capabilities.

### **Monitoring Services—Business Activity Monitoring**

Oracle Business Activity Monitoring (BAM) provides real-time access to critical business performance indicators, along with the supporting information to improve the speed and effectiveness of business operation and enable proactive alerts. It enables you to monitor and optimize processes identifying bottlenecks in your business processes by integrating BAM with your existing systems to track processes and capture business events. It also enables you to deliver a superior customer experience through better management and real-time visibility of your service levels.

Oracle BAM provides users with an event aggregation and correlation platform that allows for building a state model defining relationships between various events that affect the operations business key performance indicators (KPIs). It also provides users with the ability to change the business processes and take corrective action if the business environment changes. The architecture utilizes messaging, data integration, advanced data caching, analytics monitoring, alerting, and reporting technology to deliver requested critical information within seconds of an event or change in status. Key capabilities of Oracle BAM include

- **Personalized real-time streaming dashboard—**Oracle BAM is a complete solution for building real-time operational dashboards, monitoring and alerting applications over the Web. Data is streamed to the dashboards in real time using Oracle's patented Active Data technology

that provides unparalleled scalability by sending incremental data updates to the dashboards. It can accept tens of thousands of updates per second into a memory-based persistent cache that is at the center of the architecture. Oracle BAM delivers complex event processing and business intelligence combined with advanced real-time reporting across historical, real-time data and events.

- **Rich visualization and ease of use**—Oracle Business BAM provides the ability to deliver actionable information on critical business parameters to business users through views, dashboards, and business alerts that help improve effectiveness of operations.
- **Layers easily on top of existing environments**—Oracle BAM provides rapid ROI for organizations implementing SOA. The solution enables developers to easily create event sources, and enables events to be collected from a host of databases, packaged applications, and external systems. It easily integrates into existing IT environments through a range of standards-based mechanisms such as Web Services, messaging (JMS, Oracle AQ, IBM MQ, SonicMQ, Tibco), databases, XML data sources, flat files, and packaged applications through standard-based JCA-based adapters. Oracle BAM delivers alerts to portals, mobile devices, and, through Web services, to other enterprise applications. Furthermore, Oracle BPEL Process Manager is pre-instrumented with a sensor framework that enables events to be collected from in-flight business processes. This enables proactive action to be taken in order to handle extreme cases and exceptions in business processes.

## **ENTERPRISE INFORMATION ARCHITECTURE**

In addition to having a systematic way of developing and delivering application services as business processes, organizations need a systematic way to create, deliver, manage, and protect the information used in those business processes. Today's monolithic applications create information that cannot be shared easily with other applications. Information tends to be fragmented across a company and is, therefore, underexploited.

In contrast, the Oracle Fusion Architecture treats information holistically as a resource, similar to application resources, and thus extracts more of the information's latent value. The Oracle Fusion Architecture describes uniform methods of storage and management, provisioning, analysis, and visualization of all information in the enterprise. This includes all data in the enterprise and all metadata required to make that data meaningful. This data may be structured, semi-structured, or unstructured, stored in any location, such as databases, local file systems, or email servers, and created by any application.

The Oracle Fusion Architecture provides a way for information resources to be "joined" with related information resources to greater exploit the value of the

inherent relationships among information, and then for new connections to be made as situations change.

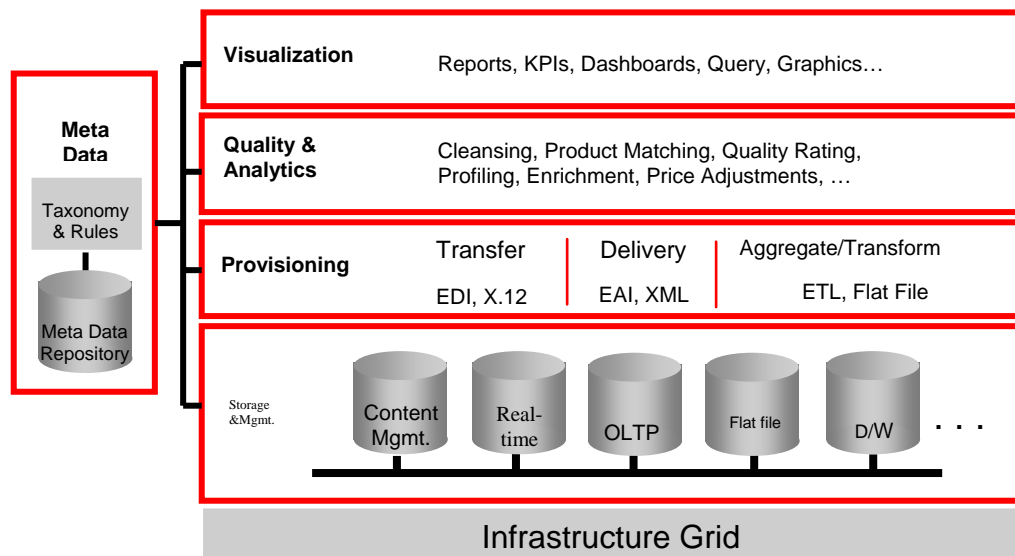


Figure 1. Information management architecture

### Data Storage and Management

The enterprise relational database is at the core of the Oracle Fusion Architecture’s data storage and management strategy. Oracle Database 10g manages all types of structured, semi-structured, and unstructured information, representing, maintaining, and querying each in its own optimal way while providing common access to all via SQL and XML Query (or Xquery).

Along with traditional relational database structures, Oracle natively implements OLAP cubes, standard XML structures, geographic spatial data, and much more. Combining these information types enables connections between disparate types of information to be made as readily as new connections are made with traditional relational data.

The Oracle Database has unlimited capacity for structured data, files, streaming media, XML documents, and so on. Oracle has become the industry-standard repository for data of all types as well as the largest, most scalable repository for XML data, business intelligence data, and analytics.

Oracle Content Services takes advantage of the underlying file management capabilities in the database to offer secure content management and records management.

However, Oracle recognizes that not all data will be stored in databases. Flat file systems, hierarchical databases, legacy systems, real-time data sources, and many other types of data sources will be used. The Oracle Fusion Architecture provides

distributed query capability of all these data sources to ensure that all information is available.

## Data Provisioning

Information starts with data, which must be provisioned wherever consumers need it. For example, users might be geographically distributed, and fast data access might be more important for these users than access to an identical resource. In these cases, data must be shared between systems, either in bulk or near real time. Information provisioning technologies include message queuing, data propagation, replication, extract-transform-load, and mapping and cleansing tools to ensure data quality. Oracle Database offers a rich set of functionality to enable efficient, reliable data provisioning. Oracle's bulk data movement technologies include the following:

- Transportable Tablespaces allow Oracle data files to be unplugged from a database, moved or copied to another location, and then plugged into another database.
- Data Pump provides high-speed, parallel bulk data and metadata movement of Oracle Database contents.
- Oracle Streams, a feature of Oracle Database, provides a fine-grained data sharing methodology. It captures database transaction changes and propagates them, thus keeping two or more database copies in sync as updates are applied. It also unifies traditionally distinct data sharing mechanisms, such as message queuing, replication, events, data warehouse loading, notifications, and publish/subscribe, into a single technology.
- Oracle Streams Advanced Queuing is a powerful application message queuing infrastructure. It provides a comprehensive set of messaging capabilities including message modifications, transforms, message ordering, and interoperability with message queuing technologies from IBM, Microsoft, TIBCO, and others.
- Oracle Streams Replication copies and maintains information in multiple databases that make up a distributed database system. Changes applied at one site are captured, forwarded, and applied at each remote location.

Data hubs, in which a central operational data store continually syncs with multiple live data sources, are emerging as a preferred model for establishing a single source of truth while maintaining the flexibility of distributed control.

Oracle Fusion Architecture's information quality layer includes more than a traditional batch ETL tool for creating data warehouses. It enforces rules to achieve data quality, does fuzzy matching to automatically overcome data inconsistency, and uses statistical analysis to infer data profiles. Metadata management provides for transaction-time data pushes from an Oracle database as well as scheduled data pulls.

Oracle's series of enterprise data hub products (for example, Oracle Customer Data Hub) provide real-time syncing of operational information sources so that companies can have a single source of truth while retaining separate systems and applications, which can include a combination of packaged, legacy, and custom applications. In addition to the data cleansing and scheduling mechanisms, Oracle also provides a well-formed schema, established from years of experience building enterprise applications, for certain common types of information, such as customer, financial, and product information.

The Oracle Fusion Architecture also offers data caching technology. As the cost of computer memory continues to drop, the use of various information-caching schemes to achieve real-time or near real-time performance has increased. Oracle has pioneered many important caching technologies.

- **In-memory database**—The Oracle TimesTen In-Memory Database is a memory-optimized relational database that can achieve very high data throughput and transparent interoperability with other database and grid infrastructure components. It also features high speed data replication and a cache connect feature that creates a real-time, updateable cache for data residing in Oracle Fusion Middleware servers.
- **Web Cache**—Oracle Application Server's Web Cache feature uses state-of-the-art caching and compression technologies to optimize application performance and more efficiently utilize hardware resources. Web Cache is capable of making caching and routing decisions based on administrator or application-defined caching rules providing "application-aware" caching for peak application performance.
- **Java Object Cache (JOC)**—The Oracle Application Server has a set of Java classes designed to manage Java objects within a process, across processes, and on local disk. The primary goal of Java Object Cache is to provide a powerful, flexible, easy-to-use service that will significantly improve server performance by managing local copies of objects that are expensive to retrieve or create.

Radio frequency identification (RFID) devices and sensor networks are introducing a new set of challenges for information systems. Not only will they produce a vast amount of new data for IT systems to process, but also the nature of the data itself is different from traditional transactional data. Sensors and RFID readers often make repeated readings that need to be captured, filtered, dispatched, secured, and managed. Oracle Sensor Edge Server, part of Oracle Application Server, provides a comprehensive set of capabilities to capture, manage, analyze, access, and respond to data from sensors such as RFID, location, and temperature.

## Quality and Analytics

With IT systems able to collect and manage a huge amount of data, questions about data relevance, context, quality, and usefulness become central. Just as companies have strategies to protect, secure, and maintain their business data, data quality and relevance must also be systematically verified as part of daily IT operations. Traditionally, data quality operations have been associated with data warehousing, but more recently, establishing good data quality is becoming a high priority throughout organizations' business processes and IT infrastructures. Oracle Fusion Architecture provides a comprehensive set of data quality and analytic capabilities.

Data cleansing technologies enable you to embed a data quality operator (for example, name and address information) in the data flow. During the execution of the mapping, the generated code for the operator will parse the data, standardize it, and validate it against name and address libraries from a third-party vendor. It also can detect duplicate entries as well as merge different data sets.

Metadata quality addresses the quality of the metadata that is entered into the metadata repository. All design information is metadata and potentially can be of poor quality. Some examples of poor metadata quality are incomplete database structure such as indexes, unconnected attributes in an ETL process, and nonexistent attributes use in an expression in an ETL process.

As mentioned previously, BAM has also emerged as a critical component of solutions that address the operationally focused business intelligence (BI) challenges. This is a convergence of the real-time functionality of BAM and a BI infrastructure, targeted at the business operations staff. Unlike traditional BI users, such as business planners and executives who monitor slow-moving indicators and trends, users of operationally focused BI applications cannot afford to make decisions based on stale data. Instead of understanding the past, they must understand the present.

The Oracle Fusion Architecture also provides integrated analytics. Oracle Database, Oracle OLAP, Oracle Data Mining, and Oracle Business Intelligence provide highly integrated, industrial-strength analytics that reduce the need to maintain complex custom hardware and software solutions for data analysis. For example, because Oracle OLAP services are fully integrated into the Oracle Database, all data and metadata is stored and managed from within the database, providing superior scalability, a robust management environment, and state-of-the-art availability and security.

Similarly, Oracle Data Mining services enable companies to extract information efficiently from the very largest databases and build integrated business intelligence applications. Data analysts can find patterns and insights hidden in their data. Application developers can quickly automate the extraction and distribution of new business intelligence—predictions, patterns and discoveries—throughout the organization. It provides data mining services such as classification, prediction,

regression, clustering, associations, attribute importance, feature extraction and sequence similarity searches and analysis.

### **Information Presentation**

Data becomes information when it can be visualized, comprehended, and used by information workers. Successful information architecture must provide a rich end-user environment that empowers users to effectively search, analyze, compare, and even play with business information.

For example, the enterprise portal has become the de facto presentation standard for information workers, and the ease and speed with which portal content and layout can be personalized determines how productive workers can be. Oracle Portal services enable organizations to set up a portal and get it running quickly, as well as providing easy Web page creation and management. Key components include

- Modular “portlet” design that provides for easier personalization and integration of content from enterprise applications and external Web services and information sources. Users or administrators can integrate application functionality and content from packaged applications like Oracle E-Business Suite, PeopleSoft Enterprise, and others with custom-developed or third-party applications.
- Single sign-on and security services ensuring that users only have to log into their environment once, and the portal infrastructure handles passing the users’ credentials to all required systems. Oracle Portal uses the security services available with Oracle Application Server to authenticate users, support single sign-on (SSO), and manage users and user group information.
- Built-in content management services including browser-based wizards and integrated editing dialog boxes, making it easy for page designers to publish and manage the content that appears on their pages. Business-level users also can use this publishing environment to easily define collaborative work areas and to publish their business document.
- Extensibility through open standards and third-party portlets. One of the primary strengths of any portal solution is the ability to use pre-built components (portlets), whether developed internally or by partners. There are hundreds of members of the Oracle PartnerNetwork that provide pre-built portlets.

Although a good architecture depends on open standards, it is also important that end users can extend the power of their familiar desktop tools from Microsoft and other vendors. To ensure this, Oracle has developed tight linkages with Microsoft Windows environments and Microsoft Office tools. Some examples of this integration include the following:

- The Oracle Business Intelligence spreadsheet add-in enables end users to display and navigate Oracle OLAP data from within Microsoft Excel spreadsheets. Users can create the Oracle OLAP data as regular Excel data. For example, they can create formulas and graphs, which enable them to combine the powerful analytic capabilities of Oracle OLAP with standard Excel functionality.
- Oracle provides integration between Oracle Internet Directory services, Microsoft Active Directory, and Windows native authentication in order to simplify and centralize administration on Windows. This integration permits single sign-on and flexible security management.
- Oracle has developed over 150 integration points between Oracle E-Business Suite, PeopleSoft applications, and Microsoft Office programs in areas such as human resources, financials, projects, general ledger, and more.
- Oracle Business Intelligence Discoverer is an intuitive ad hoc query, reporting, analysis, and Web-publishing tool that empowers business users at all levels of the organization to gain immediate access to information from data marts, data warehouses, online transaction processing systems, and the Oracle Applications. It also exploits the combined OLAP and relational forms in the database by offering the first business intelligence tool with integrated OLAP and relational access. Oracle's method for delivering these capabilities is enhanced because more of the inherent relationships among information, such as e-mail, calendar entries, and instant messages, for example, are exploited.

Oracle XML Publisher services is a flexible publishing solution that provides a new approach to report design and publishing by integrating familiar desktop tools with enterprise application reporting. The flexibility is the result of the separation of the presentation of the report from its data structure, thus enabling the use of XML and desktop tools to present the report as a PDF, an HTML Web page, an Excel spreadsheet, or other predefined document formats.

Oracle Application Server Wireless services provide a comprehensive platform for extending the reach of enterprise applications. Messaging applications (one-way and two-way, and SMS/MMS/IM/email/voice alerts), location-based services (mobile positioning, mapping routing), interactive voice access (VoiceXML), and mobile browser applications (WML, XHTML MP) all can be developed, deployed, and managed with Oracle Application Server Wireless.

Oracle Enterprise Search crawls all information sources in the enterprise, whether public or secure, including e-mail servers, document management servers, file systems, Web sites, databases, and applications, and then returns information from all of the most relevant sources for a given search query. This crawl and index process uses a series of heuristics specific to each data source to infer metadata about all enterprise information to return the most relevant results to any query.

## **Metadata Management**

Metadata management has traditionally been associated with data warehousing, yet many applications, file systems, content management systems, operating systems, and more create metadata. Storing, exchanging, modifying, and managing the life cycle of metadata can be accomplished by using the enterprise metadata management services of the Oracle Fusion Architecture, found in Oracle Warehouse Builder. Although the name implies data warehousing, the application of metadata management functions now goes far beyond data warehousing.

The core to Oracle Warehouse Builder is its enterprise-class metadata store, the MetaBase. The repository stores metadata in an Oracle database, making it highly scalable and secure.

Another key characteristic of the MetaBase is open standards. The MetaBase is built around the Common Warehouse Model (CWM) that is maintained by the Object Management Group. Endorsing this standard makes the MetaBase open and accessible to all CWM-compliant tools.

The MetaBase also is extensible. The repository has user-defined properties that can be extended with custom attributes. The attributes can be viewed through the reporting capabilities showing, for example, business metadata combined with structural metadata. The extensibility makes the repository versatile, which, combined with the repository's scalability, makes this a high-caliber solution for metadata storage and retrieval.

Metadata stored in the MetaBase can be exchanged with other repositories by using a variety of mechanisms, which enables metadata integration and distribution.

## **GRID COMPUTING ARCHITECTURE**

The Oracle Fusion Architecture is powered by a grid computing infrastructure. Grid computing is a method of deploying and managing the technology infrastructure (hardware and software) that powers enterprise applications and information services.

Successful grid implementations feature highly standardized hardware and software components (typically clusters of shared database and middleware servers and storage) and highly automated management of those components. This automation is used to virtualize computing and storage resources and to facilitate user, software, information, and server provisioning. The grid style of computing offers more reliable service, more flexible deployment, and lower operational costs.

### **What is Grid Computing?**

Two core tenets uniquely distinguish grid computing from other styles of computing, such as mainframe, client-server, or multi-tier: virtualization and provisioning.

- With **virtualization**, individual resources (computers, storage, and networks) are pooled together by type, and then made available to consumers (people or software programs) through an abstraction. Virtualization means breaking hard-coded connections between providers and consumers of resources, and preparing a resource to serve a particular need without the consumer caring how that is accomplished.
- With **provisioning**, when consumers request resources through a virtualization layer, behind the scenes, a specific resource is identified to fulfill the request and then it is allocated to the consumer. Provisioning as part of grid computing means that the system determines how to meet the specific need of the consumer, while optimizing operation of the system as a whole.

Oracle's grid infrastructure resources include hardware resources such as storage, processors, memory, and networks, as well as software designed to manage this hardware, such as databases, storage management, system management, application servers, and operating systems.

Virtualization and provisioning of infrastructure resources mean pooling resources together and allocating to the appropriate consumers based on policies. For example, one policy might be to dedicate enough processing power to a Web server to ensure that it can always provide sub-second response time. That rule could be fulfilled in different ways by the provisioning software in order to balance the requests of all consumers.

Treating infrastructure resources as a single pool and allocating those resources on demand saves money by eliminating underutilized capacity and redundant capabilities. Managing hardware and software resources holistically reduces the cost of labor and the opportunity for human error. Spreading computing capacity among many different computers and spreading storage capacity across multiple disks and disk groups removes single points of failure so that if any individual component fails, the system as a whole remains available. Furthermore, grid computing affords the option to use smaller individual hardware components, such as blade servers and low cost storage, which enables incremental scaling and reduces the cost of each individual component, thereby giving companies more flexibility and lower cost.

## Server Virtualization

Oracle 10g software supports virtualization of all types of infrastructure resources. Oracle Application Server runtime services can be pooled and virtualized via application server clusters. Every service within the Oracle Application Server—HTTP server, J2EE, Web cache, Web services, LDAP, portal, and others—can be distributed across multiple machines in a grid. Performance thresholds can be defined beyond which new application server instances can automatically be added and started (or relinquished) to process additional work on new nodes of a grid.

Workload allocation across nodes can be controlled by resource consumption metrics, such as CPU or memory usage, or application-specific metrics, such as transaction throughput or JDBC connections, or workload can be provisioned based on schedules, such as peak times of day or end of quarter. This is carried out through a feature in Oracle Application Server called the Dynamic Resource Manager, which consists of the following three components:

- **Dynamic monitoring service**—this component monitors resource usage and performance of the Application Server and individual Applications. DMS statistics are placed in a workload repository against which an expert system runs to recommend a best-practice workload distribution policy.
- **Oracle Enterprise Manager**— this component collects the information generated by DMS and also visualizes the different workload distribution policies including the Oracle recommended best-practice policy.
- **OPMN and mod\_OC4J**—these components work together to implement the chosen workload distribution policy and automatically start new Application Server instances or shut them down as required by individual applications. They also route requests to them based on their resource consumption levels and the workload distribution policy.

Oracle Real Application Clusters (RAC) enable a single database to run across multiple clustered nodes in a grid, pooling the processing resources of several standard machines. Oracle is uniquely flexible in its ability to provision workloads across machines because it is the only database technology that does not require data to be partitioned and distributed along with the work.

### **Storage Virtualization**

The Automatic Storage Management (ASM) feature of Oracle Database 10g provides a virtualization layer between the database and storage so that multiple disks can be treated as a single disk group, and disks can be dynamically added or removed while keeping databases online. Then data will automatically be spread across these disks for performance and utilization optimization. ASM supports multiple databases, which could be at different version levels, accessing the same storage pool.

### **High Availability and Recovery Services**

A major enhancement in Oracle Application Server and Oracle Database is the availability of a comprehensive range of high-availability services. No other vendor provides even a small fraction of the high-availability solutions that Oracle provides. Oracle offers a comprehensive range of solutions to reduce planned and unplanned downtime. These include

- **Zero planned downtime**—Oracle Application Server and Database provide a range of services to reduce the need to shut down systems for planned maintenance. For example, OC4J does not need to shut down

for operations including deployment of applications; making configuration changes; or upgrading the system.

- **Zero unplanned downtime**—Oracle Application Server and Database provide a range of services to reduce downtime from all kinds of failures. These include:
  - An Automated Backup and Recovery tool to take backups of the Application Server and Database and all of their components
  - Flashback to correct administrative or human errors
  - Clustering to protect against software failures
  - Support for vendor clusterware and Oracle CRS (Cluster Ready Services) to protect against hardware failures
  - Oracle Application Server Guard and Data Guard to protect against site failures or for disaster recovery

### **Grid Management and Security Services**

Because grid computing pools together multiple servers and disks, and allocates them to multiple purposes, it becomes more important that individual resources are largely self-managing and that other management functions are centralized.

The Grid Control feature of Oracle Enterprise Manager 10g provides a single console to manage multiple systems together as a logical group. Grid Control manages provisioning of nodes in the grid with the appropriate full stack of software, and enables configurations and security settings to be maintained centrally for groups of systems.

Oracle Enterprise Manager provides automated provisioning, patching, and cloning of operating system, software, and applications. Central configuration management database and image library enable on demand bare metal provisioning to stay on top of changing business demand. It also provides tools to manage large grids including clusters of application servers, databases, and storage. New host, network, storage, and non-Oracle product monitoring and management dramatically reduce the cost and time for managing complex systems.

Oracle Enterprise Manager provides comprehensive management policies, templates, risk assessment, change management, and reporting to enable businesses establish a common foundation for IT management processes and procedures. Businesses will be able to attain regulatory and legislative compliance objectives in less time and with fewer resources.

Grid management includes security services for all IT resources. The Oracle security model protects, defends, and audits enterprise data, processes, and privacy. Oracle's security is applied at a detailed level using the role-based access control (RBAC) standard. This methodology, implemented across the software, allows extreme control of data and system elements while allowing flexibility and ease in managing permission schemes. For example, data can be protected at the

data element level within a record, allowing for data creation and data access control.

### **Federated Identity Management**

One aspect of security is managing user identities across different companies or organizations in a way that is both highly secure and easy to maintain. Oracle Identity Management 10g includes an LDAP-compliant directory with delegated administration and federated identity management so that single sign-on capabilities can be securely shared across security domains. Oracle Identity Management utilizes a central point for applications to authenticate users—the single sign-on server—while behind the scenes; it is distributing control of identities via delegation and federation to optimize maintainability and overall operation of the system.

Changes in business governance policy have raised the likelihood of a significant identity management impact due to additional regulatory requirements. Oracle federated identity management solutions provide the basis for an enterprise-wide identity mechanism that provides a tailored auditing process that encourages better reporting transparency without overburdening IT staff.

Federated identity across multiple companies or organizations can mean managing many thousands or even millions of users. Identity management must also scale to the heights that your organization hopes to achieve. Oracle's federated identity management enables cross-domain single sign-on that can be used to manage multiple business partners and provide them with policy-based access to corporate portals or extranets, securely and quickly. This federation capability can be used to integrate Oracle Fusion Applications or other third-party applications into your existing application infrastructure. Continued support for key open standards such as LDAP, XML, and SAML ensure interoperability in both commercial and public sector environments.

Support for these standards enabled Oracle to provide a virtual directory service that can access identity information from disparate systems and directories and present it as a unified directory view in real time.

### **Provisioning Users**

Enterprise provisioning involves the management of activities, business processes, and technologies governing the creation, modification, and deletion of user access rights and privileges to an organization's IT systems, applications, and physical assets. To gain better control over user access rights, enterprises are turning to automated provisioning systems to enforce organizational security policies and ensure regulatory standards are being followed.

Oracle Fusion Middleware provides user identity provisioning built on a state-of-the-art, N-tier deployment architecture that separates the platform's presentation, business logic, and data tiers. This separation of tiers means that user provisioning can rapidly scale with the performance needs of the deployment.

## **Oracle Fusion Architecture Benefits**

The Oracle Fusion Architecture delivers the combined benefits of service-oriented and event-driven architecture, enterprise information architecture, and grid computing technologies to Oracle customers and partners.

### **Oracle Fusion Architecture and Oracle Customers**

The Oracle Fusion Architecture provides better real-time and personalized business intelligence than existing IT architectures, which means that organizations can quickly see new revenue opportunities or ways to provide better customer service. The architecture also offers greater business flexibility, which helps organizations respond to customers needs and become more competitive. The Oracle Fusion Architecture also significantly lowers the cost of existing IT infrastructure, which improves profitability.

### **Oracle Fusion Architecture and Oracle Partners**

Oracle technology partners benefit from building solutions that use and interoperate with other software based on the Oracle Fusion Architecture. Software partners that create applications based on Oracle Fusion Architecture gain synergies with the thousands of Oracle and third-party applications in the Oracle ecosystem. Software developers can gain insight into how the tools and techniques they have been using can best exploit the rich capabilities of Oracle applications and infrastructure software products.

### **Oracle Fusion Architecture and Oracle Product Development**

Oracle has a long heritage of introducing software innovations. With the expansion of Oracle's product offerings through acquisition or partnership, Oracle Fusion Architecture serves as unifying product design blueprint for various Oracle product development groups. Any technology architecture requires on open standards to be successful. Yet complying with standards is not sufficient; because compliance does not speak to how a standard is implemented. The growing interdependence of Oracle applications, middleware, and other software must also be balanced by the inherent openness of public standards.

## **PART II - ORACLE FUSION APPLICATIONS**

The key goal of Oracle's enterprise software portfolio (Oracle E-Business Suite, JD Edwards EnterpriseOne, PeopleSoft Enterprise, Retek, and i-flex) is to deliver the best total investment alternative for our customers. Oracle Fusion Architecture's next-generation enterprise service and event-based, information, and grid architectures offer a unique opportunity to drive IT organization responsiveness to their business communities through WS-based integration, real-time intelligence, service oriented and event driven development, business process management, distributed role-based security, life cycle management, and

collaboration. With the Oracle Fusion Middleware certification, and embedded functionality, you can extend the value of your current Oracle investment.

In addition, Oracle is developing a unified next generation of Oracle Fusion Applications by integrating the “best of the best” software capabilities and business practices across Oracle's portfolio. Oracle Fusion Applications will revolutionize the way both developers and end-users will manage, adapt, and extend their business processes, business intelligence, and systems management. The process of integrating application functionality from these product lines is directly akin to the challenges facing all our customers with heterogeneous applications environments. Oracle created the Oracle Fusion Architecture both as a unifying technology base for its own Oracle Fusion Applications and as an open, extensible architecture for Oracle partners and customers to integrate their packaged or custom applications or Web services with Oracle software.

## ORACLE FUSION APPLICATIONS DESIGN PRINCIPLES

### Model-Driven

The Oracle Fusion Architecture is unique in the comprehensiveness of its integrated, standards-based developer and business analysis tools. These tools consolidate enterprise applications metadata across a wide variety of application design elements. The Oracle Fusion Applications plans to take full advantage of these tools to deliver a richer user experience, an empowered user community, enterprise-wide interoperability and security, and a lower cost of ownership. Key components of the Oracle Fusion Applications model-driven approach include:

- **Visual tools for business analysts**—Business analysts are able to model and adapt business process flows at the process and task level, making it more natural to modify the end to end process in a single tool, rather than having to use a number of point designers to modify individual application elements, such as the user interfaces, page flows, process orchestration, rules, and events.
- **Declarative development environment**—the developer and business analyst tools are enabled for rapid development using wizards, templates, and application activity guides.
- **Systematic Application Extensibility**—a unified suite of design, development, and execution tools rely upon a common metadata store for all application, process, integration, intelligence, and presentation components.
- **Lifecycle and Change Management**—configurations, customizations, and extensions to metadata are tracked and managed for runtime personalization, install-time localization, implementation-time industry specialization, and upgrade-time reapplication. Life cycle management workbenches evaluate metadata and predict upgrade impacts.

## Service and Event Enabled

Service and event-enabled architectures emerged to dramatically improve IT responsiveness to dynamics of continuously changing business requirements. Key among IT's challenges has been the high cost of managing their overall applications portfolio, spending time changing everything from simple functionality to integration, intelligence, governance, security, access, and collaboration. So much so that 80 percent of software ownership costs are in its maintenance, customization, integration, and ongoing maintenance. Because of the dramatic opportunity to radically cut costs and be more responsive to the business, Oracle plans to adopt these architectures to service-enable our existing portfolio and also serve as the foundation for our next generation service-based family of applications.

Key components of the Oracle Fusion Applications service and event enabled architecture include:

- **Enterprise application functionality delivered as Web services**—Today, each product line exposes Web services in their service repositories and to third party registries. In Oracle Fusion Applications, the most leveraged application functionality plans to exist as Application Services. Oracle Fusion Applications has established an Applications Service Component methodology for the development of services across each application family. Applications Services are loosely coupled, business objects, discoverable, orchestrated, and consumable in composite portal applications and business processes.
- **Modular application and business process design**—Oracle Fusion Applications plans to use a resource catalog that contains applications components and services, such as user interface elements, activity guides, business objects, services, processes, rules, and actions. Developers and business analysts use appropriate tools to use these elements to assemble applications and adapt business processes.
- **Unified event management**—Oracle Fusion Applications rely on Oracle's open, standards-based enterprise service bus to capture business events from within and outside the applications. Business events represent major steps within a business process, and they not only move the business process along, they provide an opportunity to evaluate its progress against business rules and quality of service policies. A key design point in Oracle Fusion Applications is to evaluate *active* processes and take consequential actions (human collaborations, initiate applications services, or manage infrastructure). In addition, business analysts can add temporary or permanent steps, and developers can layer in new development. Event management also supports KPI performance target evaluation throughout business intelligence.
- **Web services and SOA infrastructure**—The widespread encapsulation of business logic as Web services provides an excellent opportunity to provide

access control, prioritize and manage workloads, and develop quality of service operational policies.

## Information-Centric

Traditionally, business intelligence and transaction system architectures are developed independently from one another. This independence is the frequently the reason for dissatisfaction in the timeliness, accuracy, and completeness of analytical and reporting results. In addition, the traditional scope of information analysis has been limited to summaries of transaction data.

The business intelligence architecture in Oracle Fusion Applications introduces three strategic breakthroughs that plan to dramatically improve performance, manageability, and user experience, and lower overall costs. First, all global master, transaction, summary, and multidimensional data can be managed in a single database. Second, due to our unified development environment, both analytical and transactional applications can coexist. Third, an entirely new class of intelligence is being introduced: process intelligence. Key components of the Oracle Fusion Applications information-centric architecture include

- **Common data management of operational, analytical, and collaborative information**—Oracle has chosen a unique and innovative strategy to simplify enterprise data management within its Oracle Fusion Applications and across your portfolio. The applications are built on a single, unified, non-redundant, global schema that includes master data, transaction data, business intelligence summary, and modeling data. The data schema uses Oracle's specialized intelligence data structures, materialized views, and analytical workspaces for summary and multidimensional data. Oracle Warehouse Builder enables importing external data from other data sources.
- **Unified, consensus-driven data model**—Data quality processes around master data are essential to meaningful information, yet most companies do not address this need actively with appropriate business practices, tools, and applications. Oracle Fusion Applications plans to include master data management applications to find and resolve duplicates, enrich data from third parties, and synchronize data among multiple data sources and targets.
- **Seamless transaction, analytic, and collaborative context at the point of action**—A planned unique architectural advantage is that Oracle Fusion Applications use the same service-oriented development and presentation environment for both transaction and analytical applications. This means a single runtime environment. For the user, this innovation results in a unique, more informative and action-oriented user experience. For example, contextual summarized or analytical information can add value in a transaction application, and the transactional ability to take action can coexist in an analytical application.

- **Effective business activity monitoring**—Oracle Fusion Applications plan to use real-time activity monitoring to evaluate processes, KPI performance and system events. Once triggered, business rules can take planned corrective actions or simply initiate a collaborative communication. Business activity monitoring is also the core architecture underpinning a new class of real-time analytical and action applications: role-based operational dashboards.
- **Insight driven user interface**—Oracle Fusion Applications plan to use Oracle Portal as the framework for running pre-built applications and assembling analytical, transactional, and collaborative composite applications.

### Grid Ready

Oracle's grid infrastructure provides an automated reliable, scalable, secure IT infrastructure that is able to take advantage of low cost commodity servers. To get the full value from Oracle grid computing, you need to use all the infrastructure components that are managed by the grid control manager. The Oracle Fusion Application's optimal global single database architecture plans to use a coordinated database and application server infrastructure, and it can be fully monitored and serviced with a single management tool. As a result, Oracle Fusion Applications are being designed to deliver higher service levels for continuous operations at lower cost. With Oracle 10g providing a self-managing and highly reliable infrastructure, new high-availability strategies are also possible. Deployed in an Oracle Grid configuration, the Oracle Fusion Applications can also provide continuous uptime during systems management activities such as database patching and upgrades.

- **Business-oriented system monitoring**—when applications use Oracle Grid Computing, complete user-to-database process monitoring is possible. Alerts can be identified for database administrators to monitor workloads, ensure allocation of resources for priority workloads, and project future resource utilization.

### Standards-Based

Oracle Fusion Applications will leverage industry leading standards to future proof your application investments and dramatically improve interoperability. All core operational components will be exposed through Web Service Standards encompassing design, discovery, security, reliability, and transaction integrity. Beyond the infrastructure and middleware standards, Fusion Applications plan to support many horizontal and industry-specific standards to drive interoperability.

## **ORACLE FUSION APPLICATIONS DEVELOPMENT ENVIRONMENT**

Oracle Fusion Applications are being designed with Oracle JDeveloper leverage the Oracle's Application Development Framework (ADF). ADF Applications Services are loosely coupled services with encapsulated business logic and abstracted implementation allowing re-usable components that are easily modified and extended. For example, an Oracle service is assembled starting at the physical data layer. Entity objects manage the data structures with insert, update business logic. Business objects (also known as a Service Data Object JSR135) are defined to perform unified cross-entity tasks, such as updating a multi-entity relation. Finally, the Business objects service is a thin, common interface to the business object. These well-defined services are registered in the Fusion Services Repository and become automatically discoverable to developers and business analysts in various Oracle and non-Oracle tools. These standards-based services are used in conjunction with templates and other repository objects to build application page layouts, BPEL process flows, reporting, intelligence, and integration, as well as custom J2EE business logic, which improves their productivity and enables them to focus on delivering applications, not on learning how to jump from tool to tool.

### **Oracle Fusion Applications Deployment Services**

#### **Application Services**

The promise of service-oriented architecture is that it enables businesses to construct new business processes based on a combination of packaged software, custom-developed processes, and an ever growing catalog of commercial Web services. It also promises to provide new user interfaces that combine these elements into a more personalized, and thus more powerful, view. Using Fusion Application Services business process architects plan to create a single page that can contextually combine transaction, process, reporting, analytical, and collaborative content.

#### **Integration Services**

Oracle Fusion Applications are exposed as a set of web services that Oracle terms "enterprise services." Enterprise services provide business-defined functionality with enterprise-level scalability, robustness, security, manageability, and supportability. In contrast to traditional web services, enterprise services possess a more complex collection of business rules. For instance, in advanced pricing, rules regarding pricing can relate to the entity being sold to, date sold, volume ordered, and type of product ordered. An enterprise service would process all the rules to provide the resulting correct price in a given situation.

Enterprise services offered by Oracle Fusion Applications plans to embrace interface standardization by utilizing WSDL to describe the service, and SOAP for binding that ties directly into the Oracle ESB. Alternatively, Oracle Fusion

Applications plans to be able to connect to almost any messaging system, including third-party messaging systems such as IBM MQSeries.

Oracle Fusion Applications plans to include many different APIs and integration technologies such as PL/SQL procedures, Java classes, electronic data interchange (EDI) messages, open interfaces, business events, Web services, and more.

The Oracle Fusion Service Registry is being designed to act as a comprehensive online directory and service broker of Web services, interfaces, and integration points for Oracle Fusion Applications. The registry plans to function as a catalog of all Oracle Fusion Application interfaces including Web services, business-to-business (B2B) protocols, application programming interfaces (APIs), legacy integration technologies, and business events.

The registry is more than a simple compilation of call syntax; it is an actual service broker that enables you to discover available services in the Oracle Fusion Applications. It includes screens for searching and viewing all available interfaces with just a Web browser. With its advanced search capabilities, developers can easily find the exact Web service they need. In turn, this allows the registry to facilitate the easy development of business flows and reduces the cost of ownership. At run-time, these potentially federated registries, also trigger security and provisions the service.

But just as important, the registry allows for programmatic interrogation of its APIs by external programs (such as EAI tools) to expose and administer interface points as Web services. Any messages defined in Oracle XML Gateway, and properly formed Application Services, can be interrogated by external EAI tools and exposed as Web services. This enables Oracle Fusion Applications to offer value even if you have selected middleware other than Oracle's middleware.

### **Process Services**

Most business process life cycles evolve through three steps:

- Specialization to exploit a new opportunity
- Optimization for performance and economies of scale
- Standardization to ensure maximum efficiency and productivity

Oracle Fusion Process Services provide programmatic support for each phase of business process evolution. Oracle Fusion Applications are being based on the concept of business events. Oracle BPEL Process Manager interacts seamlessly with Oracle Fusion Application business events and enterprise services, easily receiving business events from Oracle Fusion Applications. These events can start a process within Oracle BPEL Process Manager or send a signal to Oracle BPEL Process Manager to continue a process. Oracle BPEL Process Manager can also invoke enterprise services from within Oracle Fusion Applications.

## Oracle Fusion Applications Information Management

### Data Services

Oracle Fusion Applications are being designed on a single, unified, non-redundant, global schema that includes master data, transaction data, and business intelligence summary and modeling data. Oracle Fusion Data Services make it easier to tackle ongoing challenges of unifying, reconciling, reporting, and analyzing data within a single implementation. Whether customers are using Oracle Fusion Applications as the centerpiece of their business applications strategy or as part of a larger applications portfolio, Oracle and non-Oracle applications can maintain high data quality across transactional applications, business intelligence applications, and crucial master lists of customers, products.

For simpler environments in which Oracle Fusion Applications is the centerpiece of your enterprise portfolio, or in a shared service center, this design plans to simplify the ongoing challenges of unifying, reconciling, reporting, and analyzing data within a single implementation. Analytical data combined with transaction data allows for key management objectives to be met: complete drill down and drill across, implicitly up-to-date reference data (classifications, hierarchies, master data), no data movement resulting in near-immediate summarization, business areas can be included, shared planning assumptions and KPIs across analytical models, and a single security model for role based access policies.

For more complex environments in which Oracle Fusion Applications is one of many portfolio products or operational concerns prevail, there will be a variety of deployment scenarios:

- Separate all components: master data, transactions, and intelligence
- Synchronize master data among multiple Oracle Fusion Applications and other Oracle and non-Oracle data sources
- Import intelligence data among multiple Oracle Fusion Applications and other Oracle and non-Oracle transaction sources

### Data Hub Services

Most companies do not intentionally build systems and business processes that encourage multiple versions of master data (customer, suppliers, products, assets, and more), but as companies evolve, systems proliferate, and there is a natural fragmentation of data, data quality practices, and contributing business processes. Pro-actively managing data quality is critical for operational and analytical systems integrity.

Data Hubs are an Oracle innovation that manages distributed master data, such as customers, products, and more. Data Hubs manage a centralized, trusted master registry, and automatically manage cross-references to any data source. As new data is introduced into the hub, it is matched, de-duplicated, and enriched. Data events such as updates and merges trigger business events that enable near-real

time synchronization back to the originating data sources and other targets, such as intelligence repositories. Data Hubs are more than a database schema and integration technologies, they also include a data stewardship application and an enterprise reporting application that leverages the multi-system cross reference to deliver a unified enterprise view of master data.

Data Hubs allow your entire software portfolio to be assured that master data is unique, certified, and unified. With information you can trust, you can run your business better.

The Oracle Data Hub can be deployed as an embedded application service within Oracle E-Business Suite and Oracle Fusion Applications or as a loosely coupled architectural component.

### **Metadata Services**

Metadata is information about information. In an applications context, metadata is useful for describing the components of an application. Metadata creates an abstraction layer over explicit coding to facilitate a service-oriented approach to application development, configuration, customization, execution, and management.

Oracle Fusion Applications plans to use metadata extensively for table and view definitions, user-defined data elements, Web services, process assembly, business intelligence business views, KPIs, and more. By having the application and intelligence capabilities defined in an abstraction layer, additional business analyst tools can be developed to allow controlled changes to business rules, events, and actions without IT guidance. For system administrators, changes to metadata are precisely tracked so that impact analysis can be quickly visualized for maintenance, patching, testing, and performance.

Oracle's metadata repositories can exchange data with other standards-based repositories so that a complex software portfolio can be kept in sync. With Oracle Fusion's metadata-driven architecture, development and integration effort is dramatically reduced, operations can fine tune performance without changing the underlying application, and additional "nonprogrammer" tools can be used so that authorized business analysts can initiate changes without writing code or needing deep knowledge of arcane technical concepts. This way, impact analysis can be quickly visualized for software maintenance, operational management, and testing.

In addition, Oracle Fusion Application enterprise services plans to support a shared semantic framework through adoption of the Open Application Group (OAG) definition of business documents, known as Business Object Documents (BODs). Oracle supports more than 150 BODs today and will continue to expand its use of OAG BODs as they become available.

### **Oracle Fusion Applications and Fusion Middleware**

Many of the capabilities of Oracle Fusion Applications architecture rely on Oracle Fusion Middleware products. These include technology and applications

infrastructure components and tools such as Oracle's Application Development Framework (ADF), Oracle JDeveloper, Oracle BPEL Process Manager, and Oracle Workflow. These tools are used both to deliver Oracle Fusion Applications and to enable developers of standalone applications or Web services. Thus, customers and developers that do not run Oracle Applications can gain great advantage by adopting Oracle Fusion Architecture.

### **Oracle Fusion Applications and Grid Computing**

To get the full value from Oracle grid computing, applications need to use both middleware and database grid features. The Oracle Fusion Application's planned optimal global single database architecture uses a coordinated database and application server infrastructure, can be fully monitored, and serviced with a single management tool. As a result, Oracle Fusion Applications plan to be able to deliver higher service levels for continuous operations at lower cost. With Oracle Fusion Architecture providing a self-managing and highly reliable infrastructure, new high availability strategies are also possible. Deployed in an Oracle grid configuration, the Oracle Fusion Applications are being designed to provide continuous uptime during systems management activities such as database patching and upgrades.

### **CONCLUSION**

Different organizations have different requirements for how quickly and frequently internal processes can and should change. For example, smaller enterprises, start-ups, and high-tech companies might require frequent operational changes simply to compete and survive, whereas larger, more conservative organizations, government agencies, and highly regulated industries might have significant constraints on their ability to change. Yet literally every organization can greatly benefit from a comprehensive technology architecture in general and Oracle Fusion Architecture in particular.

### **Getting Started with Oracle Fusion Architecture and Oracle Fusion Applications**

The discussion of technology or business process architecture is by definition a discussion about the future. Oracle's own goals for the establishment of our next-generation projects are heavily dependent on the ongoing development of the Oracle Fusion Architecture. Yet many important elements of the Oracle Fusion Architecture are based on mature, production-ready products and best practices that are available today. Partners and customers can take significant steps right away to create the ideal architectures:

- **Evaluate and adopt grid computing practices**—IT organizations are already familiar with grid computing concepts and have in many cases already begun adopting grid computing practices. The Oracle Grid Index document on [oracle.com](http://oracle.com) can be a helpful resource for understanding some

of the key questions you should be considering in your IT planning meetings. Some specific areas of consideration include

- Storage virtualization through storage area networks (SANs) or network attached storage (NAS). Customers should evaluate Automatic Storage Management (ASM).
  - Management by exception, managing groups of servers and applications from Oracle Grid Control or other management consoles. Customers should evaluate Oracle Enterprise Manager Grid Control.
  - Deploy pools of clustered, high-volume servers and storage. Customers should evaluate Oracle's database and middleware cluster offerings.
- **Rationalize your middleware strategy and investment**—It is often helpful for IT or business architects to map out how their various software components interact with each other. This evaluation often uncovers many of the costly redundancies and inefficiencies of an ad hoc approach to middleware and integration implementations. Customers should consider consolidating middleware technologies and evaluate Oracle Fusion Middleware.
  - **Pilot service-oriented business flows**—Most companies will adopt service-oriented applications when there is a compelling need to do so. For example, if a strategic business process, an order entry system for example, is too slow or expensive to adapt to changing operational or market conditions, this might be a good candidate to pilot of service-oriented approach. There are many useful links on the oracle.com SOA Web pages, including a three-step guide to getting started with SOA. Customers should also evaluate Oracle development tools and integration solutions.
  - **Establish a cohesive data model, metadata and master data strategy**—Customers should evaluate the key master data (for example, customer lists, product information, and financial information) that is most valuable to the current and future success of their organization. They should consider the steps to take to ensure high-quality, consistent master data and a unified data model for their key business resources (customers, employees, inventory, etc). They should also evaluate Oracle data hubs during this process because they can provide invaluable insight into how this can be achieved.
  - **Plot key business intelligence and data quality goals**—The creation, collection, and management of information has become increasingly easy and inexpensive. But as new data such as XML documents, RFID, sensor data and events, and syndicated information services come on the grid, the creation of high-quality, relevant, context-sensitive information becomes a central problem to both IT analysts and business analysts. To this end,

technology architects should evaluate business intelligence at the applications level as well as the system and middleware level. Customers should evaluate Oracle's data warehousing products including Oracle Warehouse Builder.

- **Plan for a myriad of publishing and presentation options**—The enterprise portal has already claimed its place as a corporate desktop standard. But with the rapid increase of wireless and mobile device users, and new and varied document and screen formats, a more comprehensive approach is required. Customers should evaluate Oracle Portal, offering mobile and wireless capabilities, and Oracle's groundbreaking XML Publisher.

### **A Customer Architecture**

Customers who have made significant investment in information technology and enterprise applications have by default chosen a technology architecture. This might have been a deliberate process or the inevitable result of the integration and interoperability of the various information technology components they have committed to using over the years. Yet each year a larger proportion of Oracle customers and partners employ dedicated technology architects and spend significant time and energy designing and implementing IT and business process architectures. For those people, and for those companies, Oracle Fusion Architecture and Oracle Fusion Applications can provide an immeasurable head start toward realizing their own unique technology and business process architecture. With that in place, exciting new synergies between people, technology, and business processes can be achieved.





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