

An Oracle White Paper
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Oracle Cloud Computing

Executive Overview

Cloud computing is a significant advancement in the delivery of information technology and services. By providing on demand access to a shared pool of computing resources in a self-service, dynamically scaled and metered manner, cloud computing offers compelling advantages in cost, speed and efficiency.

Today, cloud computing is at an early stage in its lifecycle, but it is also the evolution and convergence of technology trends that have been driving enterprise data centers and service providers over the last several years, such as grid computing, clustering, server virtualization, SOA shared services and large-scale management automation. For more than a decade, Oracle has been a leader in these areas with thousands of customer successes and a high level of investment. Today, Oracle powers the cloud and is the foundation for many of the world's public and private clouds.

Oracle's strategy is to offer a broad portfolio of software and hardware products and services to enable public, private and hybrid clouds, enabling customers to choose the right approach for them. Unlike competitors with narrow views of the cloud—for example, Software-as-a-Service (SaaS) only, virtualization only, or hardware only—Oracle provides the broadest, most complete and integrated cloud offerings in the industry.

For private clouds, Oracle offers an extensive portfolio of horizontal and industry applications that run on a standards-based, shared services platform; leading middleware and database products, including Oracle Exadata Database Machine and Oracle Exalogic Elastic Cloud, for private Platform-as-a-Service (PaaS); and leading hardware products for private Infrastructure-as-a-Service (IaaS). For public clouds, Oracle On Demand is a cloud service provider delivering application and platform services to customers. Customers can also choose to run Oracle products in third party public clouds. Many third party SaaS ISVs and other public clouds are powered by Oracle technology. Finally, Oracle also offers software to integrate across public and private clouds.

This white paper provides an overview of Oracle's cloud computing strategy and how Oracle helps customers and partners plan their evolution and adoption to cloud computing.

Introduction to Cloud Computing

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This definition from the National Institute of Standards¹ has gained broad support from the industry.

The NIST definition of cloud computing describes five essential characteristics, three service models and four deployment models.

Five Essential Characteristics

- **On-demand self service** – Users are able to provision, monitor and manage computing resources as needed without the help of human administrators
- **Resource pooling** – IT resources are shared across multiple applications and users in a non-dedicated manner
- **Rapid elasticity** – IT resources are able to scale out and in quickly and on an as-needed basis
- **Measured service** – IT resource utilization is tracked for each application and user, typically for public cloud billing or private cloud chargeback
- **Broad network access** – Computing services are delivered over standard networks and heterogeneous devices

Three Service Models

- **Software as a Service (SaaS)** – Applications delivered as a service to end-users typically through a Web browser. There are hundreds of SaaS service offerings available today, ranging from horizontal enterprise applications to specialized applications for specific industries. *Oracle CRM On Demand* is an example of a SaaS offering that provides both multi-tenant as

¹ [NIST Definition of Cloud Computing \(SP-800-145 Draft\)](#)

well as single-tenant options, depending on the customer's preference. Oracle also offers an enterprise-grade middleware and database platform to Independent Software Vendors (ISVs) who build their own SaaS offerings. Hundreds of ISVs have built their SaaS offering using Oracle technologies.

- **Platform as a Service (PaaS)** – An application development and deployment platform delivered as a service to developers who use the platform to build, deploy and manage applications. The platform typically includes database, middleware, development and management tools, all delivered as a service via the Internet. PaaS offerings are often specific to a programming language or APIs, such as Java, Python or Ruby. A virtualized and clustered computing architecture is often the basis for PaaS offerings, because virtualization and clustering enable resource sharing and ability to scale on-demand, which are key requirements for clouds. Oracle offers a comprehensive PaaS solution for enterprise private clouds as well as service provider public clouds.
- **Infrastructure as a Service (IaaS)** – Compute servers, storage, and networking hardware delivered as a service. This infrastructure hardware is often virtualized, so virtualization, operating system and management software are also part of IaaS as well. A well-known example of IaaS is Amazon's Elastic Compute Cloud (EC2) and Simple Storage Service (S3). Oracle does not offer IaaS cloud services, but Oracle provides hardware and software products to other IaaS providers to enable their public cloud services, and also offers the same technologies to enterprises for private use.

Four Deployment Models

- **Private Clouds** – For exclusive use by a single organization and typically controlled, managed and hosted by the organization's IT department. The hosting and operation of private clouds may also be outsourced to a third party service provider, but a private cloud remains for the exclusive use of one organization.
- **Public Clouds** – For use by multiple organizations (tenants) on a shared basis and hosted and managed by a third party service provider. Public clouds are a form of outsourcing. The degree of resource sharing varies – shared resources can include some or all of facilities, network, storage, computing servers, databases, middleware and applications.
- **Community Clouds** – For use by a group of related organizations who wish to make use of a common cloud computing environment. For example, a community might consist of the different branches of the military, all the universities in a given region, or all the suppliers to a large manufacturer.
- **Hybrid Clouds** – When a single organization adopts both private and public clouds for a single application in order to take advantage of the benefits of both. For example, in a

“cloudbursting” scenario, an organization might run the steady-state workload of an application on a private cloud, but when a spike in workload occurs, such as at the end of the financial quarter or during the holiday season, they can burst out to use computing capacity from a public cloud, then return those resources to the pool when they are no longer needed.

Comparing Public and Private Clouds

The two basic models of public and private clouds have a number of compelling business benefits, some of which are common to both public and private, while others are only for one or the other.

Benefits common to both public and private clouds include:

- **High efficiency** – Because both public and private clouds are based on clustering and virtualization, both offer high efficiency and high utilization due to the sharing of pooled resources, enabling better workload balancing across multiple applications.
- **High availability** – Another benefit of clustering is that applications can take advantage of a high availability architecture that minimizes or eliminates planned and unplanned downtime, improving user service levels and business continuity.
- **Elastic scalability** – Clustering also provides public and private clouds with elastic scalability, the ability to add and remove computing capacity on demand with no downtime. This is a significant advantage for applications with highly variable workload or unpredictable growth, or for temporary applications.
- **Fast deployment** – Because both public and private clouds can provide self-service access to computing resources, and because the software and hardware components are standard, re-usable and shared, application deployment is greatly accelerated.

Some benefits are unique to public cloud computing:

- **Low upfront costs** – Public clouds are faster and cheaper to get started, so they provide users with a low barrier to entry because there is no need to procure, install and configure hardware.
- **Economies of scale** – Large public clouds enjoy economies of scale in terms of equipment purchasing power and management efficiencies, and some may pass a portion of the savings onto customers.
- **Outsourced management** – Public clouds do not require IT personnel to manage and administer, update, patch, etc. Users rely on the service provider instead of the internal IT department.

- **Operating expense** – Public clouds are paid out of the operating expense budget, most often by the users' line of business, not the IT department. Capital expense is avoided, which can be an advantage in some organizations.

Other benefits are unique to private cloud computing:

- **Greater control of security, compliance and quality of service** – Private clouds enable IT to maintain control of security (data loss, privacy), compliance (data handling policies, data retention, audit, regulations governing data location), and quality of service (since private clouds can optimize networks in ways that public clouds do not allow).
- **Easier integration** – Applications running in private clouds are easier to integrate with other in-house applications, such as identity management systems.
- **Lower total costs** – Private clouds with sufficient scale may be cheaper over the long term compared to public clouds, since it is essentially about owning versus renting. According to several analyses, the breakeven period is most often between two and three years.
- **Capital expense and operating expense** – Private clouds are funded by a combination of capital expense and operating expense.

Cloud Benefits and Challenges

The two top benefits of cloud computing are speed and cost. Through self-service access to an available pool of computing resources, users can be up and running in minutes instead of weeks or months. Making adjustments to computing capacity is also fast, thanks to elastically scalable grid architecture and automated, policy-based scaling. And because cloud computing is pay-per-use, operates at high scale and is highly automated, the cost and efficiency of cloud computing is very compelling as well.

There are also a number of challenges and barriers to the adoption of public cloud computing. The top concern far and away is security. While one can debate the relative security of public clouds versus in-house data centers, the reality is that many organizations are not comfortable entrusting certain sensitive data to public clouds where they do not have full visibility and full control. So some particularly sensitive applications will remain in-house while others may take advantage of public clouds. Another concern is quality of service, since public clouds may not be able to fully guarantee service level agreement in terms of performance and availability. A third area of concern is fit, the ability to integrate with in-house systems and adapt SaaS applications to the organization's business processes, and a fourth concern is lock-in, since users may want to switch to another provider or to in-house at a later point in time.

To recap, cloud computing is characterized by real, new capabilities such as self-service, auto-scaling and chargeback, but is also based on many established technologies such as clustering, virtualization, SOA shared services and large-scale, systems management automation. Cloud computing offers compelling benefits in terms of speed and cost, but also presents serious concerns around security, compliance, quality of service, fit and lock-in. Today some organizations have fully embraced cloud computing, while others have adopted cloud computing for a portion of their business. Most are at least evaluating the pros and cons of cloud. For many organizations, it makes sense to adopt both public and private cloud computing for portions of their business. These organizations are running some applications in public clouds, other applications in private clouds, and some applications remain as they are.

With this view of cloud computing in mind, we now turn to the role that Oracle and its products and services play in the cloud era.

Oracle Cloud Computing Strategy

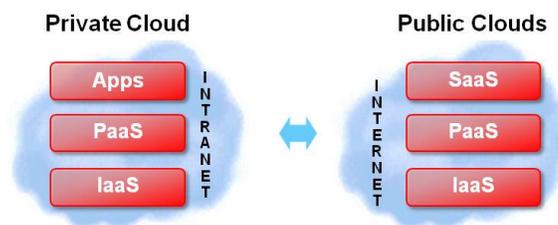
Oracle's cloud computing strategy is broad and comprehensive to provide customers choice and a pragmatic roadmap toward their adoption of cloud computing. We provide enterprise-grade software and hardware products and services for both private and public clouds, including:

Private Cloud Solutions

- Applications on a shared platform
- Database & middleware for PaaS
- Hardware & systems for IaaS

Public Cloud Solutions

- Oracle On Demand cloud services
- Oracle on 3rd party public clouds
- Powering 3rd party public clouds



Cloud Integration

- Security, business process integration and data integration spanning on-premise and public clouds

Private Clouds:

- An extensive portfolio of horizontal and industry-specific Oracle applications which run on a standards-based, shared, elastically scalable cloud platform
- Oracle middleware and database for private PaaS which allows customers to consolidate existing applications and more efficiently build new applications

- Oracle’s server, storage and networking hardware combined with virtualization and operating system software for private IaaS which allows customers to consolidate their applications on shared hardware

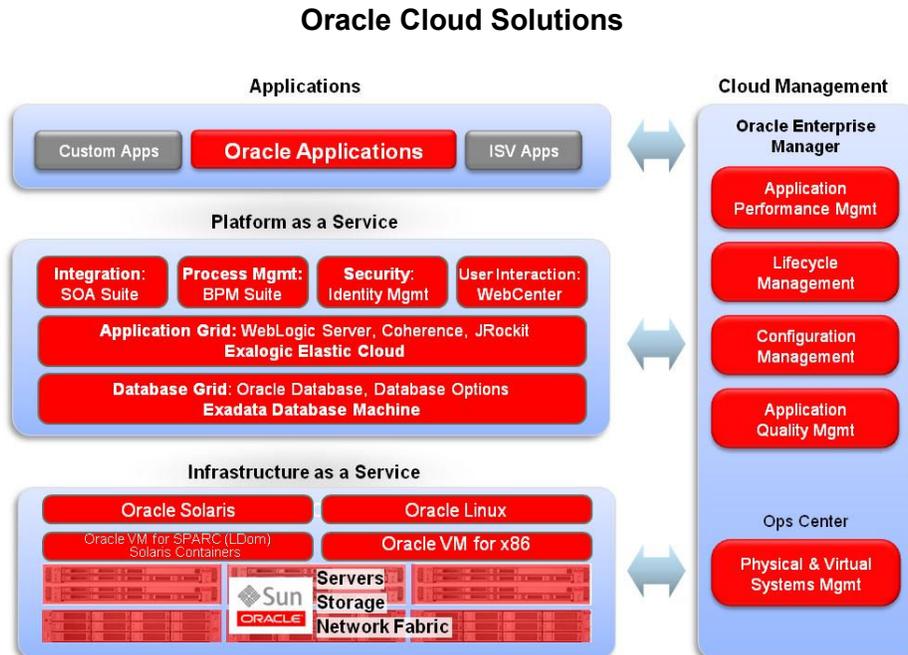
Public Clouds:

- Oracle On Demand which is a cloud service provider for Oracle applications, middleware and database
- Oracle products which customers can deploy in third party public clouds, including Oracle applications, middleware, database, operating systems and virtualization software
- Oracle middleware and database powering third party clouds including SaaS and PaaS providers

Integration Between Clouds:

- Oracle enables integration across public and private clouds with a set of products for identity and access management, SOA and process integration, and data integration.

Unlike other product and service providers with narrow views of cloud computing, Oracle’s approach is comprehensive and integrated, providing customers with solutions for private and public clouds, for all levels of the cloud stack (SaaS, PaaS, IaaS), and across related solutions for cloud development, cloud management, cloud security and cloud integration.



Oracle Cloud Applications

Oracle pioneered the concept of accessing applications on demand as cloud services more than a decade ago. Today, Oracle is recognized as one of the world's leading providers of cloud applications services, with over 5.5 million users worldwide accessing our applications in the cloud. Oracle offers the choice of deployment models from subscription-based services and customer-owned applications hosted at Oracle, to managed, on-premise, private cloud deployments.

Oracle's portfolio of horizontal and industry-specific applications is extensive, and all modules can be hosted through Oracle On Demand or through service provider partners. Oracle also offers a rich set of subscription-based services, such as Customer Relationship Management (CRM), Human Capital Management (HCM) and Procurement.

Oracle Fusion Applications are a complete and modular set of enterprise applications, engineered from the ground up to be cloud-ready and coexist seamlessly with other Oracle applications. Oracle Fusion Applications offer better productivity and empowerment for the user, with a personalized role-based experience. Oracle Fusion Applications are built on Oracle Fusion Middleware, a standards-based platform with common components, offering developers unparalleled ease of application extension. And Oracle Fusion Applications deliver more value for the business as an integrated suite that can be adopted in an incremental, modular fashion, enabling rapid business innovation without the fragmentation challenges of niche solutions.

The combination of Oracle applications and Oracle On Demand cloud services can help you achieve business results quickly and cost-effectively, while giving you freedom of choice in terms of deployment location, upgrade path, and selection of application modules.

Oracle PaaS

The Oracle PaaS is a shared and elastically scalable platform for applications, delivered as a public or private cloud service. The Oracle PaaS is based on Oracle's industry leading database and middleware products and can run all workloads ranging from mission-critical to departmental applications, either Oracle applications, applications from other ISVs or custom applications. The Oracle PaaS enables organizations to consolidate existing applications on a shared, common architecture, as well as build new applications that leverage the shared services provided by the platform. The Oracle PaaS platform delivers cost savings through standardization and higher utilization of the shared platform across multiple applications. The Oracle PaaS also delivers greater agility through faster application development leveraging standards-based shared services, and elastic scalability on demand.

The Oracle PaaS includes Database-as-a-Service based on Oracle Database and Oracle Exadata Database Machine, as well as Middleware-as-a-Service based on Oracle WebLogic and Oracle Exalogic

Elastic Cloud. Engineered systems such as Exadata and Exalogic are pre-integrated and optimized combinations of hardware and software that deliver extreme performance, efficiency, security and manageability at lower TCO. Oracle Exadata is a database machine, and Oracle Exalogic is a machine optimized for Java execution in the middleware/application tier. Both offer breakthrough performance which also makes them very efficient for database and middle tier consolidation of hundreds of applications. Both machines are elastically scalable both vertically and horizontally, and fully fault tolerant. They offer simplified deployment since they are pre-integrated and pre-configured by Oracle, not by the customer in their datacenter. And they offer lower TCO because they can reduce the total hardware and complexity of your environment.

While customers can of course use Oracle Database and Oracle Fusion Middleware software running on other hardware, Exadata and Exalogic are complete engineered systems and the ideal foundation for private and public PaaS.

In addition to the runtime foundation for applications, the Oracle PaaS also includes capabilities for developing and configuring cloud applications, managing the cloud, securing the cloud, integrating across clouds, and collaborating using clouds.

- **Cloud Development:** Programmers may use familiar development environments like JDeveloper, NetBeans and Eclipse to build new cloud applications, and business analysts may use Web-based tools such as WebCenter Page Composer, BI Composer and BPM Composer to configure and extend existing applications.
- **Cloud Management:** Oracle Enterprise Manager provides management of all technology layers from the applications through the platform to the infrastructure, and across the full cloud lifecycle, including setting up the cloud, deploying applications on the cloud, scaling the cloud based on policies, and metering cloud usage for public cloud billing or private cloud chargeback. Enterprise Manager also delivers general purpose capabilities for testing cloud applications, monitoring the cloud, patching the cloud, and all the other tasks administrators have to do in order to fully manage cloud services.
- **Cloud Security:** Oracle provides best-in-class products to manage all aspects of cloud security, including Oracle Identity Management to manage users' identity and Oracle Database security options for information protection.
- **Cloud Integration:** Since applications in the cloud are not always standalone, there is often a need to integrate across public clouds, private clouds and traditional non-cloud architectures. For this, Oracle offers Oracle SOA Suite and Oracle BPM Suite for process integration, Oracle Data Integration and GoldenGate for data integration, and Oracle Identity and Access Management for federated user provisioning and single-sign-on.
- **Cloud Collaboration:** Oracle WebCenter provides a portal for user interaction and collaboration with other users, including social networking.

Oracle IaaS

Only Oracle offers a complete selection of computing servers, storage, networking fabric, virtualization software, operating systems, and management software required for Infrastructure as a Service (IaaS). Unlike other vendors with partial solutions, Oracle provides all the infrastructure hardware and software components needed to support diverse application requirements.

Oracle's offerings for IaaS include a range of SPARC and x86 servers mounted in cabinets, racks and blades; storage including flash, disk and tape; converged network fabric; virtualization options including Oracle VM for x86, Oracle VM for SPARC and Oracle Solaris Containers; operating systems Oracle Solaris and Oracle Linux, and Oracle Enterprise Manager.

Oracle's robust, flexible cloud infrastructure supports resource pooling, elastic scalability, rapid application deployment, and high availability. The unique ability to deliver application aware virtualization and management integrated with compute, storage, and network technologies enables the rapid deployment and efficient management of public and private IaaS.

PaaS vs. IaaS

For many organizations deciding between building a PaaS or IaaS offering, the key issue is how much of a standardized, re-usable and shared platform do they want to provide their users. An IaaS provides the basic compute, storage and networking capacity, so it is the most flexible, but it requires users to provide the rest, including the application, middleware and database, resulting in greater development cost, time and heterogeneity. For many organizations, a private PaaS is a natural strategy that benefits users as well as the IT service provider. A PaaS gives users a standardized, re-usable and shared starting point for application development, providing faster and simpler development with sufficient flexibility. From IT's standpoint, a PaaS offering means greater manageability, security, consistency, efficiency and control.

Enterprise Evolution to Cloud Computing

Most organizations are evolving their current IT infrastructure to adopt more cloud characteristics over time, rather than moving everything to cloud computing immediately. The technology is rapidly evolving and advancing, but organizations will also need to change their policies and processes. In many cases, the technical building blocks for cloud computing are available in advance of organizational readiness.

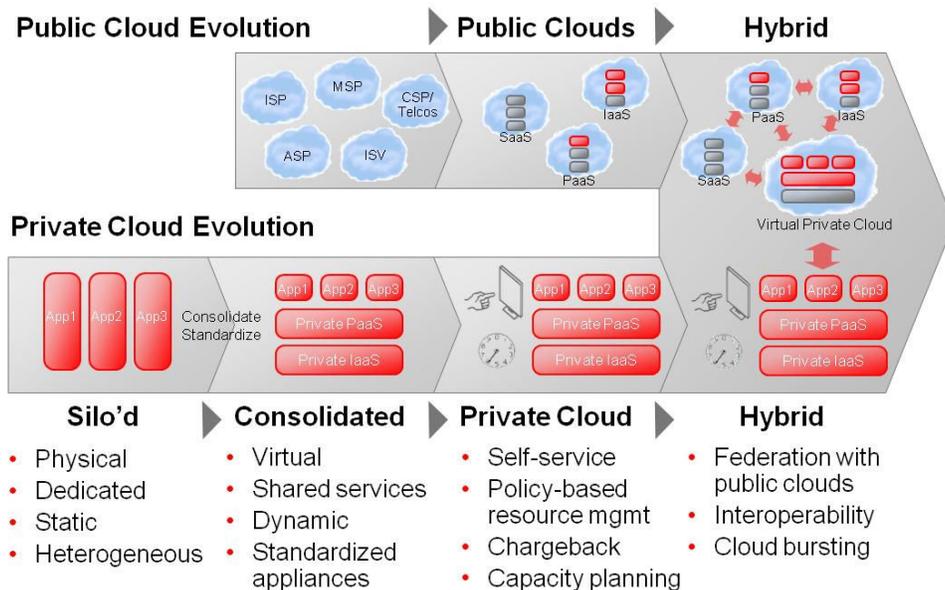
For many datacenters moving toward a private cloud, the first step in the evolution to cloud is consolidation, moving from dedicated, silo environments to shared and elastically scalable platforms and infrastructure. Silo applications running on dedicated middleware, database, servers and storage are sized for peak load, so there is inherently excess capacity built in. Each silo may involve

heterogeneous components from multiple vendors, leading to complexity and high management costs. By moving to a consolidated architecture with standardized, shared services, significant cost savings may be realized.

Consolidation may be done at either the IaaS level, typically leveraging server virtualization technology, or it can be done at the PaaS level, by standardizing and consolidating on a uniform database and/or middleware architecture. Consolidation at the PaaS level delivers more value because it reduces the heterogeneity of the software stack, which is the real driver of complexity and cost, in addition to increasing the utilization of IT resources. Consolidation at the IaaS level can also deliver higher efficiency by sharing hardware, but it does nothing to reduce the complexity of the software stack on top of the hardware. In a recent survey of Oracle customers, consolidation at the middleware and database level was more popular than consolidation at the computing server and storage level. Some customers are doing both.

While virtualization is an important technology for cloud computing, it is also important to realize another technology called clustering is complementary and also critically important. Virtualization is a great way to share hardware and enable easy deployment of applications. Clustering is critical to enable scaling beyond a single physical machine and fault tolerance. Oracle offers a choice of virtualization technologies, including Oracle VM for x86, Oracle VM for SPARC and Oracle Solaris Containers. Oracle also offers a comprehensive set of clustered products, including Oracle Database Real Application Clusters, Oracle TimesTen In-Memory Database, Oracle WebLogic application server and Oracle Coherence in-memory data grid.

Evolution of Public and Private Clouds



The next step in the evolution is to add self-service, automated scaling (called policy-based resource management on the chart) and chargeback. A user goes to the employee portal, signs in, makes a request for a virtual machine with a certain amount of CPU, memory and disk; picks a VM image for database or middleware; and then clicks “submit.” If that employee’s role and entitlements allow her to have that amount of IT resource, then it is automatically provisioned without an IT administrator being involved. If not, the request may be routed to a manager and/or IT for approval. In just a few minutes, they are up and running with an instance of the PaaS platform. After the application is deployed, the system has policy-based resource management to automatically make capacity adjustments, and the employee’s business unit gets an internal charge every month based on how much IT resource they consumed. To make all that happen, the enterprise must have policies and processes defined, and the technology must be able to support it.

Not every application benefits from self-service and elastic scalability, but many do, so enterprises are figuring that out and moving those first. Some organizations are not ready to implement full self-service, since that requires new policies and processes to be defined, and they may prefer allocation to pay-per-use chargeback models. There may be other challenges including gaining cross-organizational support, creating the business case and funding model, and various cultural issues.

Meanwhile, public clouds are also evolving. There are already many different public cloud offerings at all the layers of the cloud: SaaS, PaaS and IaaS. Many began as ISVs or hosting service providers. These offerings are typically highly specialized and isolated, as it is difficult to move workloads from one to another.

Ultimately, the evolution will move to a hybrid cloud model where a single application can span both private and public clouds and is managed in a federated manner through a single “pane of glass.” For this to happen, there need to be standards for interoperability and portability, and there needs to be technology to support such interoperability.

The notion of “cloud bursting” is very compelling to CIOs. This is when an application’s steady-state workload runs on the in-house private cloud, on hardware and data centers owned by the enterprise. But when there is a peak in the workload, it can dynamically burst out to a public cloud and take advantage of that capacity. When the peak is over, it can return that capacity back to the pool and shed that cost.

Organizations will evolve through these basic stages at different rates of speed, and organizations will occupy several stages all at once. In other words, organizations will leave some stable legacy applications in a silo mode. They will consolidate other applications to a standardized PaaS or IaaS. And for some types of applications, they will move to a full self-service private cloud and ultimately to a hybrid cloud model. All of this will take time, as we are still in the early days of cloud computing.

Summary

Oracle offers a broad portfolio of software and hardware products and services to enable public, private and hybrid clouds, enabling customers to choose the right approach for them. Unlike competitors with narrow views of the cloud, Oracle provides the broadest, most complete and integrated cloud offerings in the industry. Oracle powers the cloud and is the foundation for many of the world's public and private clouds today.

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