

AN OVERVIEW OF THE CLOUD MARKET VENDOR LANDSCAPE

AUGUST 2011



In this paper, Taneja Group presents an evaluation of the cloud solution market. Our objective was to evaluate cloud infrastructure and management, application platform, and service provider solutions from leading vendors, to enable senior business and technology leaders to decide which vendors in the market offer the best cloud solutions.

We evaluated ten of the leading cloud solution vendors, and scored their offerings in two categories: cloud infrastructure-as-a-service (IaaS) and management capabilities, and cloud platform-as-a-service (PaaS) solutions from the five vendors with the most advanced offerings. All vendors were required to have solutions in one or both categories that were generally available as of June, 2011. To assess the offerings in each of these categories, we looked at six differentiating factors, one of which was specifically on the requirements of the hybrid cloud. In our minds, the hybrid cloud is the ultimate “end game” of cloud computing, since it can help users achieve the best of both worlds: agility and compelling economics. As a final step, we reviewed the vendors’ products, solutions, and overall cloud strategy, and – using the leading vendor as the baseline – explored how competitive solutions compare favorably and unfavorably against that vendor’s solutions.

The Cloud Market: Ranking the Solutions (4 = Highest Score)

Roll-Up Scores	VMW	MSFT	AMZN	IBM	HP	CA	RAX	BMC	RHT	ORCL
IaaS + Mgmt.	3.6	2.6	2.4	2.4	2.4	2.4	2.3	2.2	1.8	1.0
PaaS	3.7	3.1	2.4						2.2	1.7

To assess each vendor’s IaaS and Management solutions, we evaluated virtualization platform, service delivery and consumption, resource and performance management, security and compliance, hybrid cloud capabilities, and partner ecosystem. To rate each of the five PaaS offerings, we evaluated runtime language support, developer tools, application services, data management support, application performance management, and application portability for hybrid cloud deployments.

Taneja Group Opinion

Overall, VMware stands out as the cloud leader – and in particular, a leader in enterprise hybrid cloud solutions – due to the reach and maturity of its on-premise and off-premise offerings: IaaS solutions, its broad service provider ecosystem for IaaS, the industry-leading vFabric PaaS suite, Cloud Foundry for open standards-based PaaS, a broad portfolio of virtualization and cloud management solutions, and aggressive development of cross-cloud enabling tools and interfaces to bring them all together.

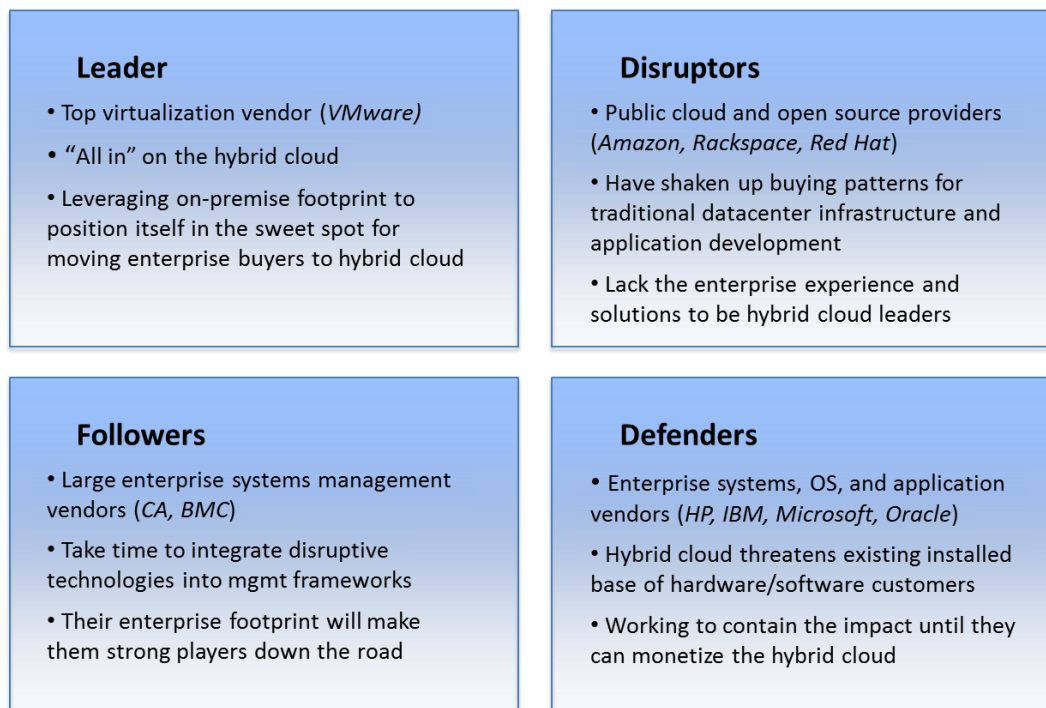
No other vendor reviewed in our assessment is yet executing as effectively and simultaneously along all of these hybrid cloud dimensions.

Despite significant “cloud-washing” of existing solutions, tangible cloud offerings do exist, though it can be difficult to tell them apart. All vendors in this study (except Oracle) have a cloud strategy; the differences emerge when it comes to execution. In our view, the competitive landscape is made up of four primary categories:

- **Leader:** The top virtualization vendor (VMware)
- **Disruptors:** Public cloud and open-source providers (Amazon, Rackspace, Red Hat)
- **Defenders:** Enterprise systems, OS and application vendors (HP, IBM, Microsoft, Oracle)
- **Followers:** Large enterprise systems management vendors (CA, BMC)

We have shown (in Figure 1) how these four categories of vendors are positioned to address hybrid cloud opportunities.

Figure 1: The Cloud Market Vendor Landscape



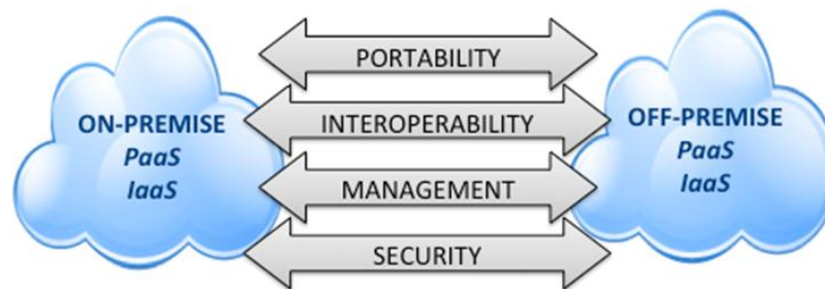
SOURCE: TANEJA GROUP

Key Takeaways for IT and Business Leaders

- **In evaluating cloud solutions, go beyond just “kicking the tires”.** The cloud market is still emerging, and hype is well out in front of reality. As a buyer, you must check out whether the various offerings perform as advertised. We recommend hands-on, proof-of-concept engagements that put the offerings through their paces, and test and exercise key capabilities.
- **Plan for the best of both worlds.** The most effective cloud solutions will marry the security, quality of service and control of an on-premise cloud, with the agility and compelling economics of an off-premise solution. As you evaluate solutions, focus on vendors that provide the enterprise-class security, cross-cloud management, standards-based workload portability and interoperability required to bridge on- and off-premise deployments.

- **Start with a private cloud.** We believe the fastest and surest route to a robust, highly capable hybrid cloud deployment is to build a private cloud first. The best cloud IaaS offerings will enable you to build a highly secure, enterprise-capable private cloud. From this deployment, you will have laid 70+% of the foundation required for a successful enterprise hybrid cloud.
- **Insist on virtual security.** Enterprise-grade security is one of the most critical requirements for an enterprise hybrid cloud. When evaluating hybrid cloud offerings, look for solutions that offer *virtual* security, versus approaches that graft existing physical infrastructure security solutions into a virtualized environment. Work with the vendor to understand the security framework, and validate that this framework addresses each layer of the cloud IaaS stack.
- **Look for management that's optimized for virtualization and cloud.** Dynamic cloud environments require a new approach to management – one that is as agile and flexible as the underlying virtual infrastructure. Platform vendors have an edge here as they are able to build in and tightly integrate management into their cloud platforms. Prioritize solutions that have high levels of automation and policy-based service assurance.
- **Demand the freedom to choose cloud service providers.** Your cloud vendor must provide you with the freedom of choice to move from one off-premise provider to another. To make this a reality, look for vendors that are building an ecosystem of *compatible* cloud providers.
- **Make sure your PaaS options are wide open.** Now promised by many vendors, the ability to abstract application runtime, middleware and data services from the underlying infrastructure is extremely compelling. But your PaaS solution should also support a broad range of languages, application services and data technologies to maximize flexibility, and provide a choice of deployment options to avoid lock-in. In particular, your choice of PaaS should allow you to switch providers and to run all or a portion of the platform behind your firewall.

Figure 2: Enterprise hybrid cloud marries IaaS & PaaS, both on- and off-premise, with bridging tools & technologies



SOURCE: TANEJA GROUP

Why VMware?

The most successful enterprise hybrid clouds will be built on the foundation of an enterprise-grade virtualization platform. Of the vendors we have evaluated, only VMware can offer the combination of industry-leading virtualization and the management solutions required for an on-premise, private cloud, *plus* the enterprise-class enablers needed to bridge the private cloud with one or more off-premise, public clouds (see Figure 2).

VMware's hybrid cloud offering provides the performance, availability, security and compliance demanded in large-scale deployments. And of critical importance, VMware also offers an ecosystem of compatible cloud providers to eliminate lock-in and allow you to move easily from one off-premise provider to another.

THE CLOUD MARKET: DEFINITION, DRIVERS, AND VENDOR LANDSCAPE

Cloud Definition

Cloud computing takes many forms and is rapidly evolving from a broad range of pre-existing and new vendor technologies. The essential characteristics of any cloud computing solution are generally agreed and most understand them to include: broad network access on demand, via a self-service interface, to a pool of shared IT resources which exhibit rapid elasticity and are consumed as a measured (pay-per-use) service. Above this baseline, however, delivery and deployment models vary widely.

The major delivery models are Infrastructure-as-a-Service (IaaS, for compute, memory, storage, and network resources), Platform-as-a-Service (PaaS, for application development tools and runtime services) and Software-as-a-Service (SaaS, for applications delivered as a service). The primary deployment models include on-premise (private cloud), off-premise (public cloud), or a mix of both (hybrid cloud).

Drivers for Cloud

Enterprises come to the cloud from multiple starting points and with varying objectives, but we feel there are two main competing drivers that summarize the current state of the market:

- **Increase business agility while maintaining IT security and control.** Today's business climate and the demands of an increasingly mobile and tech-savvy workforce make continuous innovation mandatory. In order for any enterprise to stay relevant, new applications must be built quickly—designed for anywhere-deployment and anytime-access—and must be deployed and maintained in a cost-effective way. But the agile business must also maintain strict security and controls to turn relevance into long-term success.
- **Achieve cloud economics while leveraging existing IT investments.** The rise of highly successful public clouds over the last decade puts pressure on enterprise IT teams to reduce infrastructure costs and increase operational efficiency in order to aim for the low-cost commodity-style pricing that is the hallmark of public clouds such as Amazon EC2. To do this, most companies turn to virtualization to consolidate workloads, ramp up utilization, and drive down labor costs.

As our discussions with end users confirm, these pressures are driving dramatically increased interest in cloud computing today. While we believe that most enterprises will begin their cloud computing journey with a private cloud, we are convinced that a majority will migrate to a hybrid cloud model within one to two years of their initial deployment.

Enterprise Hybrid Cloud Capabilities Model

Hybrid cloud is therefore an amalgam of on-premise and off-premise deployment, and could be interpreted to include elements of IaaS, PaaS, and/or SaaS. For this study, we focused only on IaaS and PaaS, because in our experience these are two tightly-linked aspects of many customers' overall hybrid strategy (see endnote). Increasingly, customers not only seek to move existing application workloads efficiently between on- and off-premise clouds (and ideally also between multiple compatible off-premise clouds), but require development platforms that accelerate the creation of new applications in either location (for maximum agility and developer efficiency).

In order to be considered a hybrid cloud solution, a vendor offering should include the platforms and technologies to enable both on- and off-premise clouds (ideally offering at least one example of both a private and a public option) *plus* a management suite and programmatic interfaces that simplify and accelerate the development and execution of existing and new applications across both.

Solution Vendor Landscape

Cloud solutions are offered from a wide range of vendors with prior experience across an equally wide range of IT disciplines: packaged application vendors, virtualization and operating system vendors, enterprise systems management vendors, hosting providers, and pure-play public cloud vendors, to name a few. Since each customer environment will include a unique mix of infrastructure, applications, and development needs, as well as varying location requirements, we selected vendors that are established providers in one or more of these dimensions. Few vendors excel in every dimension today, which is to be expected in such a young and vibrant solution segment. We chose players that have strong market recognition, run established businesses, and market themselves as cloud vendors.

Service Provider Landscape

The landscape of IaaS cloud service providers is broad and this report does not include an exhaustive list. There are three major infrastructure platform ecosystems emerging in the public cloud service provider space: Amazon AWS, OpenStack (also representative of other open source efforts, such as around Red Hat KVM), and VMware vCloud Datacenter. We evaluated one representative service provider offering solutions based on each (from Amazon, Rackspace, and CSC, respectively), in order to explore relative platform maturity and breadth.

CLOUD VENDORS AND SOLUTIONS EVALUATED

Vendor Comparative Categories

To organize our analysis and facilitate accurate comparisons with VMware's enterprise hybrid cloud offerings, we grouped competitive solutions into three main comparative categories in order to call out each vendor's preexisting areas of expertise as well as their current hybrid cloud strategies:

- **Cloud Infrastructure and Management (IaaS + Management) Category.** Solutions which offer some combination of: virtualization (hypervisor platform) or converged infrastructure, offered on-premise, off-premise and/or both; management tools and enabling technologies to support virtual or converged infrastructure (the vendor's own or third-party); and/or enterprise hybrid cloud-specific management tools and technologies.
- **Cloud Application Platform (PaaS) Category.** Solutions which offer application development tools, platforms, services and management components on-premise, off-premise and/or both, as well as hybrid cloud-specific features.
- **Cloud (IaaS) Service Provider Category.** Vendors in this category offer packaged cloud services off-premise, on-premise and/or both, based on their own or third-party virtualization, converged infrastructure, or application platforms.

Vendor Selection Criteria

Few vendors specifically brand solutions as "hybrid" yet (or have a well-integrated hybrid solution suite). This makes sense in a maturing marketplace, where customers are coming to the hybrid cloud from many directions: some start with an on-premise IaaS model based on virtualized workloads and are moving some of those workloads to an off-premise cloud, for example; others have experience with off-premise PaaS solutions and are looking to build an internal cloud application platform; still others have deployed a little of both.

Since our goal was to paint a broad picture of the vendor landscape, we selected vendors that have proven themselves in at least one type of private or public IaaS/PaaS segment, are generally considered to be industry leaders, and/or compete actively with VMware in the enterprise customer market for cloud solution mindshare. As a baseline, all vendors were required to have solutions in one or

more categories that were generally available as of June, 2011. Exceptions were made for solutions that are both close to general availability launch and viewed as significant in the industry but currently in limited or staged roll-out (VMware Cloud Foundry, Amazon Elastic Beanstalk, and Red Hat CloudForms & OpenShift).

Vendors and Solutions Evaluated

Cloud IaaS + Management Solutions:

Vendor	Solution(s) Evaluated
VMware (VMW)	vSphere, vCenter suite, vCloud suite
Microsoft (MSFT)	Hyper-V (part of Windows Server 2008), System Center suite
Red Hat (RHT)	RHEV (KVM), RHEV-M, CloudForms (beta)
Amazon (AMZN)	AWS EC2, S3, Virtual Private Cloud
Rackspace (RAX)	Rackspace Cloud, Private Cloud
Oracle (ORCL)	Oracle Optimized Solution for Enterprise Cloud Infrastructure
IBM	IBM SmartCloud, IBM CloudBurst
HP	CloudSystem Matrix, Cloud Services Automation
CA Technologies (CA)	3Tera AppLogic, Automation Suite, Oblicore Guarantee
BMC Software (BMC)	Cloud Lifecycle Management, BladeLogic components in CLM

Note: CA and BMC do not offer infrastructure technologies, so they were evaluated on the strength of their hybrid cloud management capabilities only. Citrix is not included because they only recently started executing on a credible cloud IaaS strategy, and they do not have a PaaS offering.

Cloud PaaS Solutions:

Vendor	Solution(s) Evaluated
VMware (VMW)	vFabric suite, Cloud Foundry (beta)
Microsoft (MSFT)	Windows Azure
Red Hat (RHT)	OpenShift (beta)
Amazon (AMZN)	AWS Elastic Beanstalk (beta)
Oracle (ORCL)	Exalogic Elastic Cloud

Note: IBM WebSphere and Oracle WebLogic traditional application servers were not evaluated as PaaS-enabling technologies because they do not have lightweight agile footprints and were not designed for modern, cloud-based deployments, nor do they offer usage-based licensing.

Cloud IaaS Service Providers:

The service providers selected for this report are a representative sample to illustrate the types of services being offered on the three major emerging public cloud infrastructure platforms: Amazon AWS, OpenStack (representative of Open Source ecosystems), and VMware vCloud.

Vendor	Solution(s) Evaluated
Amazon (AMZN)	AWS
Rackspace (RAX)	Rackspace Cloud (soon to be OpenStack-based), Private Cloud
CSC	CloudCompute and BizCloud (vCloud-based)

EVALUATION METHODOLOGY AND CRITERIA

Methodology

Taneja Group performed independent research in May/June 2011, augmenting our experience with and knowledge of vendor solutions with additional briefings and, where possible, demos and interviews. For each comparative solution category, we established a set of evaluation factors based on required cloud features and our opinion of the importance of each to the enterprise buyer interested in hybrid cloud. For each factor, we scored vendor solutions on a sliding scale: 0 = none or inadequate capabilities; 1-2 = basic, limited, or immature capabilities; 3-4 = feature-rich, broad or mature capabilities. Roll-up scores are based on a 5-point Harvey Ball scale and were calculated by averaging each factor score, then weighted by our analysis of each vendor's cloud focus, expertise, level of investment, and publicly-announced solution strategies and product directions.

Evaluation Factors

Cloud IaaS + Management Factors:

Factor	Solution Features Evaluated
Virtualization	Virtualization or converged infrastructure maturity, market penetration, number of application certifications. Advanced virtualization features (dynamic workload balancing, HA/DR, etc.).
Service Delivery and Consumption	Self-service portal capabilities. Resource lifecycle management. Request workflow automation. Chargeback/showback features. Common management across on- and off-premise.
Resource and Performance Management	Performance monitoring and management. Infrastructure monitoring (compute, storage, network, VM, host, guest, etc.). Change, capacity, configuration management tools and interfaces.
Security and Compliance	Security framework, transparency, auditability. Virtualization-aware security. Role-based access controls. Virtual layer-2 networking and stateful virtual firewall.
Hybrid Cloud Capabilities	Support for workload portability across on- and off-premise and choice of off-premise providers. Multi-tenancy and workload isolation. Cross-cloud management tools and interfaces. Support for emerging open cloud standards (e.g. OVF). Solution elements purpose-built for cloud.
Partner Ecosystem	Breadth and depth of partner / service provider ecosystem. Global consistency. Multi-tiered and enterprise-class SLAs. Virtual private (dedicated) infrastructure options. Service provider expertise (best practices, road maps, reference architectures).

Cloud PaaS Factors:

Factor	Solution Features Evaluated
Runtime Language Support	Breadth of languages and frameworks supported (Java, Ruby, Microsoft, others).
Developer Tools	Support for popular IDEs, dynamic languages (PHP, Python, etc.), code generation tools, drag-and-drop development, and command line interfaces.
Application Services	Web server. Application (code execution) server. Messaging services. Support for load balancing, high availability and dynamic scale-up and scale-down.
Data Management	Support for relational database, database as a service, in-memory data, New-SQL and No-SQL (key value store, document store, blob store).
Application Performance Management	Code execution monitoring, application services monitoring, performance issue alerting and resolution, and policy-based auto-remediation.
Application Portability (Hybrid)	Integration with hybrid cloud infrastructure and management to enable apps to be deployed across on-premise and off-premise (private/public) clouds.

Cloud IaaS Service Provider Factors:

Factor	Solution Features Evaluated
Security Framework and Auditability	Extent of documented security controls implemented in the cloud infrastructure. Ability to obtain logs for audit purposes.
Multi-tiered, Enterprise-Class SLAs	Tiers of service levels and performance available for different classes of workload. SLAs that are suitable for enterprise workloads, with quantified resource (memory, CPU, disk) and availability guarantees.
Pricing Transparency	Published rate card(s) for services (vs. a custom-priced contract).
Support for Dedicated (Virtual Private) Infrastructure	Ability to place applications on segregated (single-tenant) physical infrastructure for compliance or performance purposes.
Global Consistency and Reach	Ability to place workloads in multiple geographies to meet data privacy/locality requirements. Consistent service features in each geography such that workloads do not have to be modified to run in a different geography.
Hybrid Cloud Expertise	Documented reference architecture and best practices for hybrid cloud deployments.

CLOUD INFRASTRUCTURE COMPETITIVE LANDSCAPE

IaaS + Mgmt. Factors	VMW	MSFT	AMZN	IBM	HP	CA	RAX	BMC	RHT	ORCL
Virtualization Platform	●	◐	◐	N/A	N/A	N/A	N/A	N/A	◐	◐
Service Delivery & Consumption	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Resource & Performance Mgmt.	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Security & Compliance	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Hybrid Cloud Capabilities	●	◐	◐	◐	◐	◐	◐	◐	◐	○
Partner/SP Ecosystem	●	◐	●	◐	◐	◐	●	◐	◐	◐
OVERALL SCORES:	3.6	2.6	2.4	2.4	2.4	2.4	2.3	2.2	1.8	1.0

Note: we have not evaluated Rackspace on its vSphere-hosted offering in this report.

Taneja Group Opinion

- Virtualization is an essential foundation technology for cloud.** The top two virtualization platform vendors lead the IaaS+Management category for good reason: efficient on-premise IaaS is an essential baseline capability for successful enterprise hybrid cloud readiness. Business-critical workloads must be decoupled from the physical infrastructure, consolidated, and optimized before they are hybrid-cloud ready. VMware's market dominance in enterprise x86 virtualization and the unrivalled breadth of its vCenter management suite give the vendor a strong advantage here. Microsoft has increased market share in recent years and expanded its management capabilities, but vSphere still far outpaces Hyper-V in terms of deployed production workloads and application certifications.

Microsoft Hyper-V still has some fundamental architectural weaknesses, such as reliance on a parent OS, which compromises security and can increase downtime for patching and maintenance activities. Red Hat KVM still has single-digit market share and is lacking some key features, such as an automated memory ballooning capability. Oracle VM has a very small market share (<2%), is very infrequently updated (at 18-24 month intervals), and is designed almost strictly to run Oracle applications. We have given the five vendors that do not have their own hypervisors an “N/A” in this category.

- **Service delivery and consumption capabilities are a work in progress.** Cloud IaaS self-service provisioning and service delivery management capabilities are in their early stages of development and tend to be focused either on on-premise OR off-premise clouds. VMware gets pretty high marks here, due to the strength of vCloud Director and VMware Service Manager cloud service catalog, self-service provisioning and service delivery management, vCenter chargeback, and hybrid cloud focus. VMware also is unique in providing users the ability to provision workloads between an on-premise cloud and multiple off-premise clouds through its vCloud Datacenter Service Providers program. Microsoft has no common on- and off-premise management today, nor a single portal to provision workloads between an on-premise cloud and multiple off-premise clouds. Though Microsoft is expected to address the former issue in a release later this year, they will still only offer a single public cloud – Azure – to their cloud users, raising the threat of lock-in. Red Hat Cloud Forms service delivery management and Cloud Engine self-service portal are really oriented to on-premise clouds today. On the flip side, Amazon and Rackspace self-provisioning and usage accounting capabilities are built for their public clouds. The “big 4” (IBM, HP, CA, BMC) tend to offer strong portals and automation, but weak cloud-tailored service delivery management, since most of their offerings rely on existing products that have been retrofitted for the cloud.
- **Be wary of management tool cloud-washing.** In our view, management tools designed for physical environments (from provisioning through lifecycle and performance management operations) are not easily optimized for virtual workload management—this was clear in our review of competitive management solutions. We found very loose integrations, inflated claims, and heavy requirements for customization when compared to vCloud Director/Connector. We have docked the big 4 vendors somewhat for not having virtual infrastructure management capabilities, but they still get reasonably high scores due to the breadth of what they can manage. VMware (with its vCenter suite) and Microsoft (with System Center) also get strong marks here. Red Hat’s underlying virtualization platform is not as strong on resource and performance management for the cloud. As you would expect, Amazon and Rackspace management capabilities are geared to public cloud requirements.
- **Virtual security is critical, and security concerns must be addressed on the path to hybrid cloud deployments.** Security and compliance concerns top nearly every list of enterprise cloud barriers. While VMware’s competitors bring preexisting security/compliance components to the hybrid cloud market, none have the virtualization-aware breadth and feature-richness of the VMware vShield and vCenter Configuration Management solutions. Microsoft Hyper-V, with its built-in parent OS, and lack of security at the logical boundaries between VMs and applications, cannot provide the level of virtualization-aware security that VMware does. Red Hat, with its KVM virtualization platform, does not offer the breadth and depth of virtualization-aware security that VMware does. Amazon and Rackspace provide the kind of security levels you would expect from public cloud providers. We have given CA, IBM and HP high scores for their compliance capabilities, but they get docked slightly for a lack of virtualization-aware security. Big 4 vendor security solutions are still largely linked to physical infrastructure, rather than to virtual machines and applications.

- Very few true hybrid cloud offerings exist today.** With the exception of VMware, vendors scored poorly in the area of hybrid cloud differentiators, primarily because their hybrid cloud offerings are not that far along. With its vCloud Director and vCloud Connector offerings and its vCloud ecosystem of compatible service providers, VMware is the only vendor offering a true hybrid cloud model, including cross-cloud security, management, interoperability, and workload portability. Microsoft offers one-way workload portability between its private cloud IaaS and Azure public cloud platforms, but there's no way to get your applications back out of Azure. Neither Microsoft nor Red Hat provides the enterprise-class functionality to enable cross-cloud management and interoperability. Amazon and Rackspace do not offer compatible, on-premise versions of their public cloud offerings. The big 4 vendors lack the public cloud presence needed to enable a hybrid cloud model.
- VMware offers the largest choice in hybrid cloud service provider partners.** VMware, through its vCloud Datacenter Services program, is building an ecosystem of certified, enterprise-savvy service provider partners that is ahead of rival offerings. For this reason, VMware scores well on the final cloud IaaS evaluation factor, Partner/Service Provider Ecosystem. Amazon scores well here for its well-developed ecosystem of other ISVs building compatibility to and/or supporting EC2, although they have to focus on helping other service providers offer EC2-based solutions. Rackspace has the potential to build a significant service provider partner program around OpenStack, but that effort is still in its early stages. The big 4 vendors are also earlier in building their cloud ecosystems and in recruiting service providers for public cloud IaaS.

CLOUD APPLICATION PLATFORM COMPETITIVE LANDSCAPE

PaaS Factors	VMW	MSFT	AMZN	RHT	ORCL
Runtime Language Support					
Developer Tools					
Application Services					
Data Management					
Application Performance Mgmt.					
Application Portability					
OVERALL SCORES:	3.7	3.1	2.4	2.2	1.7

Taneja Group Opinion

Developers are becoming a strategic battleground for cloud technology providers, just as they were in the early days of the x86 virtualization market. All of the systems and virtualization/OS platform vendors understand this very well, and have also recognized that the application development platform for the cloud will be delivered as a service.

VMware, Microsoft and Red Hat have all designed their PaaS offerings to appeal to the developers they consider most critical to their success. In the case of Microsoft (with Windows Azure), it's Windows/.NET developers, and for Red Hat (with OpenShift), it's the broader open-source developer community. VMware, with its PaaS strategy, is doing its best to give developers a choice: the on-premise vFabric is focused on Java, while developers who want to work in another standard open

source framework can use the off-premise Cloud Foundry. Cloud Foundry is not only open source, but built on a portable layer, so developers can run it on whatever cloud they like, using their choice of developer frameworks and application interface services.

We believe this innovative approach will enable VMware to appeal to a broader developer base, but more importantly, help accelerate the emergence of enterprise hybrid clouds driven by VMware. In particular, VMware's PaaS approach will facilitate both workload portability and cloud interoperability, two of the crucial elements underlying an enterprise hybrid cloud offering. Here's some of our rationale for the PaaS factor scores in the table above:

- **Runtime Language Support.** VMware, between its vFabric and Cloud Foundry PaaS offerings, supports a wide range of languages, including Java Spring, Java Scala, Ruby, Grails, and Node.js. Amazon is agnostic with respect to languages, and scores well with its broad language support. Microsoft Windows Azure scores less well here, since it supports only .Net and PHP. Similarly, Oracle PaaS supports only Java, and we have scored it accordingly.
- **Developer Tools.** We have given VMware a high score in this category due to the strength of its SpringSource Tool Suite, as well as support of Spring Roo, Grails framework, WaveMaker visual development, and various other developer offerings. Microsoft Windows Azure also scores well on the strength of its .NET developer franchise. Amazon (with its in-beta Elastic Beanstalk PaaS) and Red Hat (with its OpenShift PaaS) have more limited development tool portfolios.
- **Application Services.** VMware vFabric PaaS offers a strong set of application services, ranging from the vFabric Enterprise Ready Server for web serving and load balancing, to the lightweight tc Server for building and running Java applications, to the RabbitMQ messaging solution. Microsoft Windows Azure provides a broad set of .NET application services, while Red Hat OpenShift PaaS supports Apache Tomcat, JBoss, and a host of other open-source services. Amazon also provides a rich set of application services. Oracle focuses just on components for running its own applications, and we have scored it accordingly.
- **Data Management.** Based on offerings such as SQLFire and the GemFire in-memory data grid, VMware vFabric provides strong data management support. Microsoft Windows Azure also scores well here, based on offerings such as SQL Azure and MongoDB. Amazon, too, has some breadth here, with support for Amazon Relational Database Server and a host of third party database offerings, along with the in-beta, non-relational Amazon Simple DB. Oracle doesn't provide much breadth here, since its PaaS solution is based entirely on Oracle database and middleware components.
- **Application Performance Management.** Both vFabric and Windows Azure have strong, built-in application performance management offerings: vFabric with Spring Insight and Hyperic; and Windows Azure with the AppFabric Application Manager and in-beta Azure Application Monitoring Management Pack. Red Hat provides rudimentary performance management capabilities in OpenShift, while Amazon and Oracle do not have offerings here.
- **Application Portability.** The Spring framework underlying VMware vFabric provides the foundation for full application portability across VMware-based private and non-VMware based public clouds. What this means is that developers can build cloud-based applications with the assurance of knowing they can easily unplug that application from a private VMware cloud, and plug it back into their cloud service provider of choice – and vice versa – without having to refactor the code. Microsoft does not offer this level of workload portability between its private cloud IaaS and Azure public cloud platforms. Applications built using Amazon technology are not portable, and Oracle also provides no portability.

CLOUD INFRASTRUCTURE SERVICE PROVIDER COMPETITIVE LANDSCAPE

Service Provider Factors	vCloud (CSC)	OpenStack (RAX)	AWS (AMZN)
Security Framework	●	◐	◐
Enterprise-class SLAs	◐	◐	◐
Pricing Transparency	●	●	●
Dedicated Infrastructure	◐	◐	◐
Global Consistency & Reach	◐	◐	◐
Hybrid Cloud Expertise	◐	◐	◐
OVERALL SCORES:	3.3	2.5	2.2

Note: we have not evaluated Rackspace on its vSphere-hosted offering in this report.

Taneja Group Opinion: Comparing Service Providers in Three Major Ecosystems

The three leading cloud ecosystems today—driven by Amazon, Rackspace/OpenStack, and VMware—are each designed for a different audience and purpose. Amazon created the commodity cloud market, based on the proprietary AWS IaaS stack targeted at software developers, and has built a rich ecosystem. Rackspace is augmenting its highly-regarded Cloud Servers and Virtual Private Cloud services with its OpenStack ecosystem. VMware is creating an ecosystem of certified vCloud service providers, which can offer enterprise-grade, hybrid cloud services to medium to large end users.

In this study, we have evaluated a representative service provider in each of these three cloud ecosystems. In the case of Amazon and Rackspace, we assess the service capabilities of each of these public cloud providers, since neither company has built relationships with strong and independent third party providers. VMware, on the other hand, has developed the vCloud Datacenter services program, and has attracted and certified a number of leading service providers that are now delivering vCloud services.

CSC is an outstanding example of such a service provider, and is among the first to offer a true, VMware-based, enterprise hybrid cloud offering. The CSC offering consists of two components: CSC BizCloud, a dedicated private cloud developed by CSC delivered on-premise or off-premise; and CSC CloudCompute, an IaaS capability hosted in seven CSC Trusted Data Centers around the world. CloudCompute provides compute, storage and network resources as a service to support any application, including business-critical workloads. Both CloudCompute and BizCloud meet the VMware vCloud Datacenter services definition.

VMware/CSC sets the standard. The VMware-CSC service provider partnership highlights some of the differentiators of the vCloud Datacenter Services program that make it attractive to large end users, and set VMware's hybrid cloud service provider program apart from all others:

- **True enterprise hybrid cloud offering.** CloudCompute is based on a VCE Vblock infrastructure, composed of VMware virtualization; unified networking, compute and security from Cisco; and security and management from EMC. CSC claims that BizCloud offers the best of both worlds: the dedicated infrastructure and security of a private cloud, with the pay-as-you-go economics and convenience of a public cloud.

- **Fast time to deployment:** CSC pledges to have a BizCloud linked to CSC-hosted IaaS and ready for workload deployment within 10 weeks of initially engaging with a customer.
- **Transparent and auditable security.** The solution is protected with VMware's vShield security framework, which is fully virtualization aware. CSC also wraps its defense-in-depth security and managed services into this offering. CSC is well regarded for its security and compliance capabilities, in serving both government and large enterprise accounts.
- **Dedicated infrastructure.** This is provided by the on-premise BizCloud deployment.
- **Multi-tiered enterprise SLAs.** BizCloud offers SLA's in four tiers, ranging from Bronze and Silver self-service tiers to Gold and Platinum managed-services tiers, with Platinum availability commitment at a minimum 99.95%. The BizCloud SLA is tougher than most cloud SLAs, in that it specifies full workload availability; e.g. in the case of a Platinum tier, if a customer's workloads are not available at least 99.95% of the time, then CSC will provide compensation.
- **Global consistency and reach.** CSC offers a consistent set of public CloudCompute services from seven CSC Trusted Data Centers on three continents today, and plans to continue to expand the service to a number of its other 28 data centers over the next couple of years.
- **Enterprise hybrid cloud expertise.** The vCloud Datacenter Services program provides a set of rigorous training and certification services, and requires participating service providers to meet enterprise-level standards for security, agility and application-level portability. Certified vCloud Datacenter Service Providers such as CSC provide customers with the benefit of their considerable expertise, in the form of best practices, reference architectures, and implementation services.

Amazon and Rackspace lack in security, SLAs and hybrid cloud capabilities. Let's briefly compare the Amazon and Rackspace cloud service provider offerings against this VMware/CSC standard:

- **Lack of enterprise-grade security.** Both Amazon and Rackspace provide security that is acceptable for public cloud developers, including basic identity management and role-based access controls, but nowhere near the robust offering provided by VMware/CSC. Amazon and Rackspace run on a Xen-based virtualization platform, which suffers from the inherent vulnerabilities of a Dom0 architecture and built-in parent OS. These public cloud providers also do not offer the virtualization-aware security that VMware vSphere provides at the logical boundaries between VMs and applications.
- **SLAs are single tier, not enterprise class.** Both public cloud providers offer single-tier SLAs, which were really designed originally for developers. Amazon's SLA is particularly weak, since its availability commitment is based merely on the ability to start new instances, a much weaker standard than CSC's hard Platinum-level commitment for 99.95% availability of all running workloads.
- **Lack of global consistency and reach.** Amazon AWS has set up five "availability zones", and has given itself significant wiggle room in its SLA to have several of these zones down and yet still be able to meet its SLA commitment. Rackspace to date has only open-sourced its Cloud Files offering; the Cloud Servers offering is still not based on OpenStack. This gap in consistency, if not closed soon, may begin to impact the company's growth. Rackspace is also still in the early stages of expanding its offering outside the US; its European cloud initiative was just launched in January 2011. While the company has a thriving hosted services business in Europe, it is based mostly on vSphere—and not OpenStack—today.

- **No dedicated (virtual private) infrastructure that is compatible with public cloud offering.** Amazon is still in the process of bringing its Virtual Private Cloud (VPC) service to market, so this is not available from them today. Rackspace does offer a VMware-based Rackspace Private Cloud, but since workloads cannot be freely moved today across Rackspace public Cloud Servers and Rackspace Private Clouds, this is not a true hybrid cloud solution.
- **No hybrid cloud capabilities today.** This brings us to the most important point: neither Amazon nor Rackspace can offer true hybrid cloud capabilities today. Amazon's VPC is still in a pre-release stage, and even when it's up and running, it won't provide customers with an on-premise alternative. And due in large part to Amazon's proprietary EC2 environment, customers cannot easily move applications between AWS and on-premise clouds today. In fact, most users must completely re-write applications to make them work on EC2, and if they later decide to take them off the site, must work hard to convert them to run again on premise. Rackspace has a VMware-driven Private Cloud solution, but it is not compatible with the company's public cloud, and given Rackspace's commitment to OpenStack, it will continue to be incompatible in the future. Rackspace also has the challenge of putting all of its own public cloud IaaS under the OpenStack umbrella, if it wants to build a thriving service provider ecosystem.

VENDOR EVALUATIONS

VMWARE

VMware is the leader in x86 virtualization and virtual infrastructure management, and is leveraging those strengths to take a leading position in the nascent cloud infrastructure market. VMware plays at every level of the cloud market, including IaaS and management (via vSphere, vCloud and vCenter suites), PaaS (based on vFabric and Cloud Foundry), and VMware-hosted SaaS (via VMware Horizon Application Manager).

vCloud Director, which runs on top of the vSphere virtualization platform, is at the core of VMware's cloud IaaS offering. vCloud Director enables IT to create a fully functional on-premise cloud IaaS, based on logical pools of compute, network, and storage resources, each with defined management policies, and with governing SLAs and pricing. Based on vSphere, the virtual infrastructure supporting an on-premise cloud can be consolidated across multiple clusters. The underlying VMware vShield security framework is fully integrated into the virtual infrastructure and application layers, and secures cloud IaaS at the host, network, and endpoint level, while also securing user applications and data. vShield's security capabilities are augmented by vCenter Configuration Manager, which ensures compliance with vSphere security hardening guidelines.

vCloud Director provides fully automated, self-service access to the cloud IaaS resources, as well as access to application services such as VMs and virtual appliances. vCloud ties into the vCenter suite and its full and integrated set of virtualization management capabilities, including vCenter Operations, an automated operations solution that brings together the disparate disciplines of capacity, performance, and configuration management.

VMware, with its PaaS strategy, is focused on giving developers a choice: the vFabric Cloud Application Platform is the leading PaaS offering for Java applications, and is widely used behind corporate firewalls and offered as a service by many large service providers. VMware is also aggressively developing an open source PaaS offering, Cloud Foundry, which is offered to developers free of charge at www.cloudfoundry.com. Cloud Foundry is also available for developers to download and run locally and the source code is accessible to anyone via a very lenient Apache 2 open source license. Though VMware intends to integrate all of vFabric's commercial offerings into the Cloud Foundry PaaS, some of these vFabric services will likely continue to be commercially licensed as add-ons to Cloud Foundry.

VMware's PaaS offerings include a comprehensive set of development and management features, including developer tools, multi-language runtimes, application services, and data management support. vFabric Hyperic provides in-depth visibility, monitoring and troubleshooting for custom web applications, whether they reside on physical or virtual infrastructure. While there are compelling reasons to run vFabric on a VMware-powered virtual infrastructure, such as increased automation, scale, application performance management, and security, the PaaS layer will run on most popular infrastructure including Amazon AWS, OpenStack and bare metal hardware.

Cloud Foundry is not only open source, but it is built on a portable layer, so developers can run it on whatever cloud they like, using their choice of developer frameworks and application interface services. Cloud Foundry supports multiple application frameworks and languages including Spring, Grails and Scala for the Java community, Rails and Sinatra for the Ruby world, and node.js.

Unlike competitive PaaS offerings such as Windows Azure, VMware's solutions are targeted specifically for hybrid cloud development. We believe this innovative approach will enable VMware to appeal to a broader developer base, but more importantly, help accelerate the emergence of enterprise hybrid clouds driven by VMware. Also differentiating Cloud Foundry from Azure is the ability to de-

ploy Cloud Foundry locally for development and testing, via the use of a micro cloud. In addition to the public PaaS service VMware hosts at cloudfoundry.com, a number of VMware hosting provider partners will be offering Cloud Foundry services of their own.

VMware's hybrid cloud advantages extend to a set of enterprise capabilities and services that help users to effectively bridge private and public clouds. The first of these is vCloud Connector, which allows administrators to deploy and manage VMs and vApps from a single-pane-of-glass across VMware public and private clouds as well as vSphere infrastructure. Unlike competitive offerings, vCloud Connector enables users to quickly move applications from internal datacenters to private or public clouds, and back again – users need not worry about potential lock-in.

The second is VMware's support of open standards like the Open Virtualization Format (OVF) and vCloud API (submitted to the DMTF), which together enable workload portability and interoperability across private and public clouds. The third hybrid cloud differentiator is VMware vCloud Datacenter Service program, which enables a growing number of VMware certified service providers to deliver enterprise-ready services based on VMware cloud technology. vCloud Datacenter Service Provider partners provide a globally consistent set of vCloud-driven services, along with multi-tiered, enterprise-class SLAs. We have profiled CSC, one of the leading partners, in a separate section of this Appendix.

Competitive Advantages

- VMware is the market leader in virtualization, with proven solutions being used by more than 250,000 customers today, as well as a leader in cloud infrastructure technologies.
- The company has the broadest cloud portfolio, including IaaS and management, PaaS, and VMware-hosted SaaS (via VMware Horizon Application Manager, not covered in this paper).
- VMware provides the most secure cloud IaaS, enabled by the vShield security solutions working in conjunction with partner solutions built for the vShield security framework. Unlike competitive offerings, vShield is fully integrated into the virtual infrastructure fabric, and delivers security at all layers of the cloud IaaS stack, including host, network, application, data and endpoint.
- VMware's enterprise hybrid cloud offering effectively bridges on-premise and off-premise clouds, with enterprise-class enablers such as workload portability and interoperability leveraging common platform, management, and security layers.
- The company has built and nurtured the industry's largest (and growing) ecosystem of leading cloud service providers, which offer services ranging from on-demand, pay-as-you-go IaaS to enterprise-grade hybrid cloud services.

Competitive Disadvantages

- VMware vFabric Cloud Application Platform does not support development of .NET applications today.

MICROSOFT

Microsoft provides IaaS and management capabilities for the private cloud, and PaaS for the public cloud. The company's IaaS offering is based today on Hyper-V (part of Windows Server 2008), and its management offering is based on a range of Microsoft System Center modules. Microsoft's biggest strength in private clouds is its lifecycle management portfolio, which includes configuration management and application performance monitoring capabilities.

But the company's Hyper-V + System Center VMM platform is lacking in private cloud capabilities, in areas such as security, networking, and storage. For example, Hyper-V does not provide virtualization-aware security (such as VMware does with vShield). From a networking standpoint, Hyper-V

lacks host resource management features such as network traffic shaping, per-VM resource shares, and the ability to set quality of service priorities for storage and network I/O. Hyper-V is also missing advanced storage management features such as an integrated, clustered file system and live storage migration. In contrast, VMware's virtualization platform provides all of these features and capabilities for private cloud IaaS to reduce downtime and maintain SLAs.

The company's platform-as-a-service offering is Windows Azure, which provides a strong, full-featured platform for developing new cloud applications and migrating existing enterprise applications to the cloud. Windows Azure is strictly a public PaaS offering today; Microsoft plans to offer a Windows Azure Platform Appliance for on-premise use through several system reseller partners later this year. Windows Azure compares favorably to VMware vFabric along dimensions such as developer tools and support, data management and application services, but the platform is clearly targeted at the core of the Microsoft developer community and requires quite a bit of manual configuration to run applications built using PHP. PHP developers typically use development tools (Zend framework) and runtime services (Apache, MySQL) that are not part of the Azure platform and require a different (non-Windows) local development environment for the typical PHP developer. Windows Azure has an edge in addressing .NET applications, but it is only offered from a single hosting vendor, Microsoft, and does not yet have an on-premise version. In contrast, VMware's Cloud Foundry supports multiple application frameworks and languages (see VMware profile above).

Though Microsoft is also claiming to provide hybrid cloud capabilities, the story is well out in front of reality, since a Microsoft-enabled, enterprise hybrid cloud just isn't possible today. In particular, there is currently a significant disconnect between Microsoft's private cloud IaaS and public cloud PaaS. While it is possible though quite complicated to move an application from Hyper-V to Windows Azure, it is impossible to ever move that application out of Windows Azure. In effect, that application becomes locked in to Microsoft's PaaS. In addition, the company does not yet offer an equivalent to VMware vCloud Director and vCloud Connector, nor does it offer the breadth and depth of virtual infrastructure management functionality that enterprise users would expect.

Microsoft's cloud market traction to date has largely revolved around small to medium (SMB) customers, which are attracted to SaaS offerings such as Office 365. But with the release of various MS System Center 2012 modules (most notably SC VMM 2012) expected later this year, Microsoft will strengthen its enterprise-level capabilities for *private* clouds, including a whole host of new management features. Follow-on releases will likely introduce some new hybrid cloud capabilities, but we believe the lack of two-way workload mobility between Hyper-V cloud IaaS and Windows Azure PaaS will remain a major stumbling block for some time to come.

Competitive Advantages

- Microsoft is now playing at nearly every level of the cloud market, including IaaS, PaaS, and SaaS offerings, and is investing considerable money and effort to brand itself as a cloud leader to business customers. The company has announced its intention to become a leading hybrid cloud supplier.
- Microsoft is investing heavily in training, equipping, and motivating its vast array of channel partners to win in cloud opportunities. The company is providing specific partner incentives to accelerate adoption of MS cloud technologies.
- Microsoft is focused on a cross-hypervisor strategy that may appeal to some customers.

Competitive Disadvantages

- Microsoft is relatively late to the enterprise hybrid cloud, and is playing catch-up to VMware and other providers. The Hyper-V + System Center VMM platform is lacking in private cloud capabilities, in areas such as security, networking and storage (see details above).

- Microsoft's Hyper-V platform is a distant second in the virtualization market, and though it has gained some market traction over the past year, it still trails vSphere by a significant amount. Despite the strength of MS System Center in traditional Windows environments, Microsoft also lags VMware in building virtualization and cloud management capabilities.
- Microsoft's ability to bring new and enhanced virtualization and cloud offerings to market is still architecturally tied to its multi-year Windows Server and System Center release cycles, which will make it quite difficult for Microsoft to become an innovator in this space.
- Though Microsoft is currently investing in channel development, many partners are quite worried about the likelihood of channel conflict, which could very well result in Microsoft taking business and the customer relationship away from them.
- Microsoft has very limited uptake of Hyper-V and System Center among service providers, given the company's lack of IaaS capabilities and their reluctance to partner with a company that is directly competing with service providers with its PaaS.
- Existing and would-be Microsoft customers are concerned about the potential for lock-in to the proprietary elements of Microsoft's cloud offerings.

RED HAT

Red Hat provides CloudForms IaaS and OpenShift PaaS as its two primary cloud offerings. Both of these were announced in May 2011 and will be available in production by the end of the year. Red Hat's IaaS stack is built on the foundation of Red Hat Enterprise Virtualization (RHEV), a hypervisor platform based on KVM technology. RHEV-M, the management component of RHEV, provides capabilities such as high availability, live migration, storage management, and system scheduling for virtual server workloads.

Red Hat Network (RHN) Satellite provides on-premise systems management, including provisioning, monitoring, configuration management, and software updates across physical and virtual Red Hat Enterprise Linux (RHEL) servers. Like Microsoft, Red Hat also provides operating system (RHEL) and middleware (JBoss Enterprise Middleware) layers as part of its IaaS offering.

As one of the key tenets of its cloud strategy, Red Hat aims to allow workloads to run in a consistent environment between an enterprise data center (usually in a private cloud) and one or more Red Hat certified public clouds. For example, if a user runs out of capacity in the data center, Red Hat software (specifically, RHEV-M or MRG Grid) will automatically schedule an equivalent workload on a virtual machine in the Amazon public cloud. Given that Red Hat virtualization is based on KVM and Amazon EC2 is based on Xen, we wonder whether and how Red Hat will technically be able to pull this off. Red Hat intends to leverage this application portability between public and private clouds to build a true hybrid cloud offering.

To facilitate management across private and public clouds, Red Hat provides Deltacloud. Each vendor's IaaS cloud today tends to present a unique API that developers must write to in order to consume a cloud service. The idea behind Deltacloud is to create a common REST-based API, which will enable developers to write once and manage anywhere. The plan is to include drivers in Deltacloud that map the API to any public or private cloud. If the Deltacloud project goes as planned, administrators will be able to manage workloads across multiple private and public clouds from a single API.

Deltacloud will succeed or fail based on adoption of the API by developers. The challenge is that there are no deployments of Deltacloud today, and it is entering a crowded field of entrenched APIs, such as the AWS API and VMware's vCloud API. In addition, we believe Red Hat might find it challenging to develop and maintain an API that fully maps to any public or private cloud, and yet provides capabilities that go above and beyond a lowest common denominator.

Based on technology acquired from Makara, Red Hat's OpenShift PaaS provides developers with a range of open source languages, tools, application frameworks, and data management support for building, testing, running and managing their applications. Red Hat claims that OpenShift is the first PaaS to run CDI (Contexts and Dependency Injection) applications, with plans for Java EE 6 support in the near future. Based on Red Hat's Deltacloud API, OpenShift PaaS will enable developers to write applications that can run on any Red Hat Certified Public Cloud, including Rackspace and Amazon.

OpenShift PaaS comes in three flavors: Express, Flex, and Power. The first two levels can only deploy applications written to web languages (e.g. Java, PHP, Python), whereas Power will also deploy to the cloud applications that are written to Linux, even those without a web front-end. Current Red Hat Certified Cloud Provider Partners include Amazon, Fujitsu, IBM and Savvis.

Competitive Advantages

- Red Hat has done an impressive job of acquiring a diverse set of open source offerings, which it has rolled up into a solid CloudForms IaaS and management offering.
- CloudForms IaaS is designed to work across multiple hypervisor platforms and multiple clouds, though it is still in a pre-production state today.
- OpenShift PaaS will enable developers to write applications that can run on any Red Hat Certified Public Cloud and across major virtualization platforms.
- As a master packager and aggregator of many open source software initiatives, Red Hat benefits greatly from the rapid innovation and leveraging effect of its partner ecosystem, making it a highly agile and nimble player among cloud technology providers.
- Red Hat's cloud offerings are based fully on open standards and are priced very competitively, which gives many IT buyers greater confidence that they can avoid lock-in and higher costs down the road.

Competitive Disadvantages

- Red Hat's cloud technologies are based on hundreds of different open source projects, which will make it challenging and time-consuming for Red Hat to integrate them and bring its cloud IaaS and PaaS platforms up to the standard of enterprise readiness and robustness that large end users expect.
- Red Hat has done a good job of articulating an enterprise hybrid cloud roadmap, but the "enterprise" element in this roadmap remains largely unproven. Red Hat's IaaS and PaaS cloud entries were just launched in May 2011 and won't be available in production until later this year, so its cloud story and value propositions have yet to be validated.
- Despite Red Hat's well-deserved reputation as an open standards supplier, enterprise customers buying into Red Hat's cloud offerings will largely be tied to Red Hat IaaS and PaaS for their cloud development and management efforts, since Red Hat is really the only source for the commercial versions of these packaged open source software efforts, and the technical support and product roadmap that goes along with them. Red Hat will also seek to provide the OS (RHEL) and middleware (e.g. JBoss) used in a customer's cloud deployment. That said, customers will still have a broad choice of public cloud deployment options. Whether IT buyers really understand all of this – including the potential for lock-in – is a different question.
- Red Hat's stated IaaS and PaaS strategy is to span and be compatible with all of the other major cloud ecosystems. While this is a laudable goal, we have doubts about whether this can be technically accomplished without ending up with a watered-down, "lowest common denominator" solution. To pull this off in what is still an extremely dynamic and emerging market, Red Hat will somehow need to respond rapidly each time something significant changes in the market or in one of the ecosystems it is trying to support. Given the likely frequency of such changes, we are concerned that Red Hat may be trying to bite off more than it can chew.

AMAZON

Amazon provides cloud IaaS and PaaS offerings, based on its Amazon Web Services (AWS) platform. The company was a pioneer in commodity cloud computing and has the largest market share among public cloud providers, with five years' experience in delivering cloud compute services. AWS EC2 compute, Elastic Block Store (EBS) and Simple Storage Service (S3) are primarily focused on developers, who value the ease of use, simple credit-card billing and overall productivity of the AWS environment.

EC2 instances can take advantage of AWS functionality such as auto-scaling, load balancing, and cloud monitoring services. AWS CloudFormation eases provisioning by allowing users to create a collection of related AWS resources, describe them in a template, and then provision them without having to worry about underlying dependencies. Amazon CloudWatch provides visibility into the operational health, resource utilization, and application performance of each EC2 instance. Amazon also offers a series of security services, including AWS Identity and Access Management (IAM). Though AWS security and management capabilities are not enterprise class, they are more than sufficient for a majority of Amazon's developer-oriented user base.

Amazon recently introduced a Virtual Private Cloud (VPC) offering, which enables users to provision AWS virtual servers in a user-defined virtual IP network. This allows companies to do things like create a public-facing subnet for web servers but keep their database or application servers in a private-facing subnet with no Internet access. Enterprises can also connect on-premise infrastructure to private and isolated AWS compute resources via a VPN connection, and extend existing security (firewalls, IDS) and management to those resources. Though many companies will find this capability useful, the VPC still runs on AWS infrastructure, which does not give it the level of high availability, security and layer 2 isolation that most enterprise users would expect from an enterprise-class private cloud.

The company's new platform-as-a-service offering is AWS Elastic Beanstalk, which will debut as a production offering later in 2011. Users upload their applications, and Elastic Beanstalk handles all the deployment details. Elastic Beanstalk will support a broad array of developer tools, runtime languages, application services, and databases. While these PaaS capabilities compare favorably to those in VMware Cloud Foundry, Elastic Beanstalk will not enable portability of applications to private clouds, aside from Amazon VPC.

Amazon has a large following of developers, and though the company is working to expand its offering beyond that base, AWS remains primarily a developer cloud. One area it has succeeded in addressing is in providing on-demand, hyper scale out of homogeneous virtual server resources. AWS provides the largest pool of public cloud computing capacity in the industry, which makes it a good fit for "spiky" modeling and simulation workloads and some HPC applications.

Competitive Advantages

- The company provides a large portfolio of Amazon-developed IaaS products and services, which simplify software development.
- A rich ecosystem of third party software has developed around AWS, including a large stable of popular software tools and applications (including selected Oracle and SAP software) that have been licensed, packaged, and certified to run (mostly as SaaS) on EC2.
- The EC2 cloud has strong appeal for developers, due to its vast array of tools and APIs, exceptional ease of use, low pricing, and quick time-to-deployment.

Competitive Disadvantages

- Amazon's offering is developer centric, rather than enterprise focused. The company does not have a field sales and solutions engineering function to interact with corporate clients. Though technical support is available for an add-on fee, it is really geared towards providing expert help to developers.
- AWS has a weak cloud compute SLA, even among public cloud providers. AWS does not provide an SLA for the uptime of virtual servers, or guaranteed resources for compute, storage and networking.
- Though Amazon does provide a Virtual Private Cloud (VPC), the VPC still runs on AWS infrastructure, and therefore does not offer true enterprise hybrid cloud capabilities. AWS does not provide the option for an on-premise private cloud, and the company has militantly insisted there is no reason for private clouds to exist.

ORACLE

The Oracle cloud IaaS offering, Oracle Optimized Solution for Enterprise Cloud Infrastructure, was announced in June 2011. This IaaS stack consists of all-Oracle hardware and software, including Oracle Sun Blade 6000 Modular Systems, the Oracle VM Server for x86 virtualization platform, a choice of Oracle Linux or Solaris operating systems, and Oracle Sun ZFS storage appliances. Oracle VM provides server pooling, live migration, load balancing and automated failover capabilities, while Oracle Enterprise Manager delivers management capabilities.

Service consumption and delivery is driven by a combination of Oracle VM Manager and Oracle Enterprise Manager. Oracle Enterprise Manager provides provisioning, resource monitoring, configuration management, and application quality and performance management solutions. It comes with connectors and plug-ins for third-party tools and systems, and this pre-integrated Oracle IaaS stack is designed to run Oracle enterprise applications, middleware and databases.

Oracle's PaaS is based primarily on its database-as-a-service (including Oracle DBMS and Oracle Exadata database machine) and middleware-as-a-service offerings (including elements of Oracle Weblogic and Oracle Exalogic Elastic Cloud). Exalogic is optimized for Java execution in the middleware and application tiers. Oracle states that Oracle PaaS is built on a combination of Oracle VM and Oracle Virtual Assembly Builder (OVAB), designed for IT administrators rather than developers. The Oracle PaaS is designed for on-premise use only; there is no hosted component. In fact, the Oracle PaaS does not seem to be a real product offering at all – Oracle states on the PaaS FAQ page of its website that “Oracle does not have a PaaS product offering; rather, PaaS is a *technique* that can be employed with available Oracle technology”.

Oracle's stated cloud strategy is to ensure that cloud computing is fully enterprise grade (which it is doing well, but exclusively using Oracle components), and to give customers a choice between public and private computing. Oracle does not appear to be executing as well on the second part of its strategy, as its entire cloud offering appears to be geared to private clouds, with the exception of Oracle SaaS offerings running on Amazon. The company encourages customers to take a “phased path” to the cloud, and is making very deliberate moves to ensure that Oracle customers' cloud journey is squarely focused on Oracle platforms. Oracle wants to provide customers with an eventual path to the hybrid cloud, but it will need to open up its APIs and strengthen its cloud-oriented partnering efforts if it really wants to pull that off.

Overall, we believe that Oracle's cloud IaaS and PaaS solutions will appeal to existing Oracle customers and developers who are looking to move to the cloud on an Oracle platform. The offering has the potential to provide customers with greater flexibility in how they deploy and use Oracle middleware and application products. Whether it also increases customer ROI is an open question.

Competitive Advantages

- Oracle's cloud IaaS solution stack is pre-integrated, pre-tested and optimized to run Oracle applications, and to accelerate cloud IaaS deployment specifically for existing Oracle customers.
- Oracle has a large installed base of customers that will find Oracle's cloud offerings of interest, not only because they offer an evolutionary step toward the cloud, but also because they have the potential to extend and enrich the value these customers are already deriving from existing Oracle products.
- As one of the leading independent software vendors, with the #1 share in database management, Oracle's cloud offerings will be considered a "safe choice" by many IT buyers.

Competitive Disadvantages

- Oracle's IaaS and PaaS offerings are based almost entirely on Oracle hardware and software solutions, which will likely create additional customer lock-in to proprietary Oracle stacks.
- Oracle VM, the underlying virtualization platform for the Oracle cloud IaaS stack, lacks the market maturity, proven functionality, and range of application certification offered by VMware vSphere, and is thus a much weaker foundation for private cloud IaaS. In addition, because Oracle VM is heavily oriented towards running Oracle applications, it has a limited breadth of customer adoption (with usage confined exclusively to Oracle customers).
- Oracle has been quite slow to bring Oracle VM enhancements to market. As an example, Oracle just released Oracle VM Server for x86 2.2.2 in June 2011, which was the first major enhancement since version 2.2 started shipping in October 2009.
- The Oracle PaaS offering is designed solely for on-premise, private clouds – there is no public, hosted platform (though it is rumored that Savvis will soon provide a "hosted Oracle PaaS").
- Oracle seems to be engaging in a bit of "cloud washing" of its current infrastructure and middleware products.

RACKSPACE

Rackspace is the second largest provider of public cloud computing services, behind Amazon, and the largest provider of managed hosting services. Rackspace provides IaaS in a public, hosted cloud (Cloud Servers), with or without managed services. The company also provides cloud-hosted storage (Cloud Files), Cloud Load Balancers, and a PaaS offering (Cloud Sites). Rackspace recently began to merge its cloud IaaS with managed hosting services, with the result that customers can now select a managed service level for Cloud Servers, which is over and above the SLA terms provided in the baseline offering.

Rackspace public Cloud Servers offers Xen-based virtual server migration capabilities, as well as load balancing via Cloud Load Balancers (for a small additional charge). Rackspace acquired Cloudkick in late 2010, which provides REST-ful APIs and plug-ins to enable server monitoring and management across multiple providers from a single dashboard. Cloudkick continues to be sold as a standalone service. Aside from Cloudkick, Rackspace is now offering managed services that provide monitoring of servers and cloud instances, with rapid response and resolution of issues. Rackspace currently lags behind Amazon and VMware in terms of IaaS and management capabilities.

To help close this gap, Rackspace is open sourcing its cloud development under the OpenStack initiative. Rackspace will offer an Amazon-compatible API, in addition to its own set of APIs. Rackspace is counting on creating an ecosystem that will accelerate the development of more advanced IaaS and management capabilities, to help bring its public cloud closer to feature parity with Amazon.

In addition to its public IaaS offering, the company provides a Rackspace Private Cloud, running on dedicated servers with VMware vSphere virtualization. Workloads cannot be freely moved today across Rackspace public Cloud Servers and Rackspace Private Clouds, so this is not a true hybrid cloud solution.

Rackspace also provides Cloud Sites, a PaaS offering designed for deploying and scaling static and dynamic web applications built on PHP or ASP/.NET. Cloud Sites spreads traffic across an entire cluster of servers, and provides auto-scaling, load balancing and redundant storage. Cloud Sites does not support Java development and has a much more limited set of developer tools and application services than other major PaaS offerings, including Windows Azure and VMware Cloud Foundry.

From what we've observed, Rackspace tends to appeal to small and mid-sized businesses as well as larger companies hosting less critical, web-centric applications. Rackspace competes on the basis of its strong support and managed hosting capabilities, and on the strength of the rapidly growing, open standards-based, OpenStack ecosystem.

Competitive Advantages

- Rackspace is a leading provider of managed hosting services, and is beginning to incorporate these into its cloud offerings to increase its competitive differentiation.
- Rackspace is highly regarded in the industry for its personalized, high-quality customer support and service, which is branded as "Fanatical Support".
- Rackspace's participation in the OpenStack initiative will help build a robust ecosystem for its cloud offerings, and will likely help strengthen its cloud IaaS and management capabilities.

Competitive Disadvantages

- Rackspace does not provide enterprise-class IaaS functionality today, and its self-management capabilities are particularly weak.
- OpenStack will be competing for mindshare in the open-source community with Red Hat's open source offerings.
- The company's PaaS offering lacks Java development support, and lags behind PaaS offerings from VMware, Microsoft, and Red Hat.
- Rackspace tends to be most proficient at handling Web-centric application environments, versus traditional enterprise applications like ERM and SCM suites.
- The company does not provide a true hybrid cloud solution. While Rackspace has a reasonably strong public IaaS cloud, and a separate private cloud based on VMware, workloads cannot be easily moved across these environments.

IBM

IBM CloudBurst, a private cloud IaaS solution, is offered either as a hardware appliance or as a software-only stack that can be run on IBM and (allegedly, with some effort) on non-IBM systems. IBM CloudBurst has been offered for several years as a pre-installed, pre-integrated hardware appliance running on IBM System x BladeCenter platforms. The hardware-based solution includes Linux xSeries as Operating system and a VMware ESXi embedded hypervisor on each blade inside a standard 42 U rack. The hardware-based version is highly scalable – offering the ability to scale up to 2000 virtual machines. The platform has built-in resiliency and availability, with no single point of failure. IBM claims that this "cloud in a box" style solution can greatly accelerate new cloud deployments.

IBM has recently begun selling a software-based version of CloudBurst called IBM Service Delivery Manager. Both hardware and software based versions include a self-service portal interface, automated provisioning (including pre-packaged automation templates and workflows), high availability, real-time physical and virtual resource monitoring, and chargeback capabilities.

In addition to the CloudBurst private cloud IaaS solution, IBM also provides the SmartCloud Enterprise public cloud IaaS offering, which is designed to accelerate large end users' journey to a private or public cloud. The current incarnation of SmartCloud Enterprise, announced in April 2011, is an updated version of the public SmartBusiness Development and Test cloud, which IBM has offered as a service to partners and customers since March 2010.

IBM SmartCloud Enterprise public cloud IaaS is a multi-tenant solution based on IBM x86-based server hardware, software and services. In the current version, customers can choose from nine different virtual machine configurations, and the option of Windows Server or Red Hat/Novell SUSE operating system images. The web-based 2.0 self-service portal automates the provisioning process. The IaaS offering incorporates the IBM Security Framework, including role-based access, authentication, and security management services.

IBM also optionally offers WebSphere, DB2, Rational, and Tivoli software stacks, with an option for customers to bring their own licenses or pay per use. This enables customers, for example, to extend the built-in SmartCloud Enterprise management capabilities to include management services such as Tivoli Monitoring and Tivoli Usage and Accounting Manager.

While the current IBM SmartCloud Enterprise offering is fairly restrictive and primarily oriented to the development and deployment of new cloud-architected applications, IBM intends to expand supported infrastructure and facilitate production-oriented use cases in the future. For example, IBM plans to support SmartCloud Enterprise on multiple virtualization platforms and across public, private and hybrid clouds.

The already announced IBM SmartCloud Enterprise Plus offering, which is targeted for availability by the end of 2011, will be focused on migrating customers' traditional and higher availability applications to the cloud, and will be offered with a full complement of managed services. This production-oriented public cloud will also provide multiple levels of security isolation, and will come with an SLA guarantee of 99.9%.

IBM is also still offering several specific cloud IaaS stacks for particular use cases. The public IBM SmartBusiness Development and Test Cloud caters to developers, while the private IBM HPC Management Suite for Cloud (formerly IBM Computing on Demand) is designed for high-performance computing applications.

Competitive Advantages

- IBM CloudBurst private cloud IaaS running on IBM BladeCenter systems provides customers with a pre-integrated, feature-rich "cloud in a box", which IBM promises will accelerate and simplify enterprises' path to cloud computing.
- Given its strong reputation as an enterprise IT supplier and recently announced IBM SmartCloud Enterprise offerings, IBM is in a strong position to facilitate the development and deployment of enterprise-capable public IaaS clouds.
- Customers can take advantage of IBM's broader technology portfolio – including Tivoli management and Rational development tools – as cloud IaaS extensions.
- IBM claims that its future SmartCloud offerings will run across all the major virtualization platforms.
- IBM's pre-integrated cloud IaaS stacks – oriented today towards dev/test and high-performance computing – are designed to provide customers with a reliable and fully functional set of infrastructure services, and the additional advantage of faster time-to-deployment.
- IBM has a strong array of cloud-enabling professional and managed services that are designed to provide hand-holding to large customers as they transition to an enterprise private cloud.

Competitive Disadvantages

- IBM cannot offer an *enterprise hybrid* cloud solution today; its IaaS cloud stacks only enable robust private or public clouds oriented around specific use cases. Once IBM SmartCloud Enterprise Plus becomes available, IBM will have an IaaS solution that comes closer to enabling an enterprise-capable, public IaaS cloud.
- IBM's CloudBurst IaaS offering is complex because the company tries to bring in so many components. IBM's strategy is to sell a highly customizable offering, which requires customers to make a significant investment in professional services to actually implement. The result? A fairly complex and expensive solution.
- IBM has taken a very deliberate and measured approach to the overall cloud market, and has only very recently articulated a cloud IaaS strategy tailored to the needs of enterprise customers. As a result, the company has likely lost ground to some of its cloud IaaS competitors.
- Customers buying the hardware-based IBM CloudBurst IaaS offering (running on IBM BladeCenter) risk lock-in to IBM proprietary systems. IBM's cloud IaaS and associated management services tend to be higher priced than comparable offerings from most competitors.
- IBM's current SmartCloud Enterprise offering is focused solely on development and test, with an SLA guarantee of 99.5%.

HP

HP's cloud portfolio is based on two major offerings: HP CloudSystem and Cloud Service Automation (CSA). HP CloudSystem is an integrated hardware/software offering built on HP Converged Infrastructure, which enables users to build and manage cloud IaaS. CloudSystem comes in three flavors: CloudSystem Matrix, CloudSystem Enterprise (which will add unified, cross-cloud management), and CloudSystem Service Provider (designed specifically for cloud service providers). The CloudSystem architecture consists of a supply layer (infrastructure services), delivery layer (service delivery), and demand layer (service consumption).

The infrastructure services in the supply layer are based on HP BladeSystem technology with the Matrix Operating Environment (Matrix OE). Matrix OE provides all the tools needed to provision physical and virtual resources, monitor server health (via HP Insight Control), monitor and manage resource utilization, and ensure high availability of the infrastructure. Similar to offerings from the other "big 4" management vendors (as well as Microsoft and OpenStack), CloudSystem supports a heterogeneous virtualization platform, today including vSphere and Hyper-V.

HP's primary offering in the service and delivery layers is Cloud Service Automation (CSA) 2.0. CSA provides a set of secure, role-based portals, intelligent placement and monitoring of workloads, orchestration of provisioning (drawing on a library of thousands of pre-defined provisioning workflows), and configuration management, via integration of the HP Universal CMDB. As with the other "big 4" management vendors, HP offers a series of HP products that can extend the HP CloudSystem and CSA environment, such as ArcSight security/compliance, SiteScope application monitoring, and TippingPoint IPS and virtual firewalls. HP will also sell the Cloud Service Automation suite to run on non-HP hardware; CSA is rumored to be running today on other x86-based servers. Not surprisingly, HP does not encourage its customers or ecosystem partners to deploy and run CSA on non-HP gear.

HP also delivers "Cloud Maps" functionality as part of CloudSystem. Based on acquired Stratavia technology, HP Cloud Maps are designed to automate and optimize the deployment and delivery of major applications in the cloud. HP already has more than 20 cloud maps, for applications such as Oracle, MS Exchange and SAP.

One of the future CloudSystem capabilities HP touts is "dual bursting," which will enable workloads to burst to local private and/or external public clouds. This feature will likely debut later this year, with

Savvis as external bursting partner. Though all cloud infrastructure vendors are striving to offer such a capability, dual bursting will be an important foundational element in HP's future hybrid cloud offerings. HP is investing heavily to build a service provider ecosystem around HP clouds, through the Cloud Agile program. The program is targeting not just conventional service providers, but managed service providers (MSPs) and VARs as well, and has already attracted a number of medium to large service providers.

Competitive Advantages

- As one of the industry leaders in computing and systems management, HP is well positioned to compete as a provider of enterprise-level cloud IaaS technology and associated services.
- HP provides a portfolio of CloudSystem IaaS offerings, designed to meet the needs of a range of customers, from mid-sized businesses to large enterprises. To encourage adoption, HP is offering existing BladeSystem Matrix customers an easy upgrade path to CloudSystem.
- CloudSystem offerings are based on HP Converged Infrastructure, and as such, are quite well integrated up and down the stack.
- HP is aggressively recruiting new service providers through its Cloud Agile Program, offering an attractive mix of training, tools, financing and incentives to bring new service providers on board and make them productive.

Competitive Disadvantages

- HP does not yet offer an enterprise hybrid cloud solution – there are no public HP clouds available today, although the company has hinted that these will be coming in the near future.
- As with many of the cloud IaaS stacks offered by server hardware companies, users that employ one of the vertically-integrated CloudSystem offerings may risk future lock-in to HP as their IaaS provider.
- Recent turnover of high-level management in HP's cloud development and marketing organizations might cause further shifts in HP's cloud messaging and product roadmaps.

CA TECHNOLOGIES

CA Technologies (CA) launched its cloud computing management strategy at its CA World User Conference in May 2010, along with its Cloud-Connected Management Suite. CA's strategy is to establish itself as an industry leader in IT management and security for virtualization and cloud environments, while helping its legacy base of mainframe customers to take advantage of these new technologies. CA remains the world's largest independent provider of mainframe software, which provides a stable revenue stream but has hampered the company's efforts to become a leading innovator in new technologies, including the cloud.

The company provides a broad array of IT security and management suites, many of which are being extended and/or adapted to address virtualization and cloud opportunities. CA's first set of cloud management solutions, some of which are still being developed, includes CA 3Tera AppLogic, a "turn-key" cloud computing platform that combines infrastructure resources, security, availability and policy management into one system, all managed from a single interface, and enables users to rapidly compose, deploy and manage complex applications. CA's other cloud management solutions are CA Automation Suite for Hybrid Clouds, which automates provisioning, performance and financial management; and CA Oblicore Guarantee, which provides cloud service quality assurance. CA is also adapting and re-branding many of its security offerings, including its CA Identity and Access Management (IAM), CA Federation Manager, and CA Arcot Authentication solutions, for the cloud.

Though CA has articulated a compelling cloud strategy, it has been slow to execute on its vision so far. Many of the offerings in the CA Cloud-Connected Management Suite have yet to see the light of day,

and are no longer being emphasized in the company's cloud messaging. The company appears to be engaging in a bit of "cloud-washing", applying a cloud moniker to current products that aren't yet fully cloud-enabled.

Though a growing number of CA sales engagements are focused on cloud opportunities, its support for hybrid cloud capabilities is limited and directional at this stage. For example, CA enables users to provision workloads to Amazon EC2 and VPC (Virtual Private Cloud), as well as Fujitsu's public cloud, but offers very limited management capabilities for these public cloud images.

Competitive Advantages

- As one of the largest (and "big 4") providers of IT management software and services, CA's brand and reputation can carry considerable clout among CIOs in Fortune/Global 500 accounts.
- CA's cloud offering is largely platform agnostic, enabling it to address the needs of heterogeneous environments in large enterprises, and particularly those running multiple hypervisors.
- As a member of the Cloud Security Alliance, CA is building a strong set of cloud-based security and security assurance offerings, and often leads with these capabilities to help differentiate itself in selling cloud services to large enterprises and service providers.
- CA has a strong ecosystem of managed service providers, which it is working to educate and orient towards cloud opportunities.

Competitive Disadvantages

- CA is still struggling to shed its image as a mainframe tools supplier to legacy customers, which can put it in a defensive position in sales situations.
- CA offers a bewildering array of IT management tool suites, which can make it difficult for prospective users to evaluate and understand which solution works best.
- CA cannot bring a full portfolio of IaaS offerings to the table, which often forces it to partner with large platform providers in selling to service providers and end users.
- The company's approach to hybrid cloud management is largely services-oriented today, with tools designed for this purpose still in their early stages.
- CA is working with leading converged infrastructure platforms (e.g. Cisco UCS, VCE Vblock) to offer private cloud management tools, but the hybrid cloud capabilities of these management frameworks are not there yet.

BMC SOFTWARE

BMC announced its cloud strategy and initial offerings in May 2010, and has made some good progress in developing its cloud portfolio and business in the year since then. The company's strategy is to foster and support major cloud initiatives and best practices in large enterprises and service providers across a broad set of disciplines, including planning, lifecycle management, operations and optimization, and governance. To differentiate itself, BMC intends to leverage its core strengths in service desk, change and configuration management, service monitoring and management, and overall automation, and deliver a consistent set of capabilities across physical, private cloud, and hybrid cloud environments.

The company is pinning its private and hybrid cloud aspirations on the umbrella BMC Cloud Lifecycle Management (CLM) product suite, which it bills as a complete business solution for building and operating a private or hybrid cloud. Released in April 2011, CLM 2.0 includes capabilities such as user and administrator self-service portals, intelligent placement of cloud services, secure multi-tenancy, policy-based service governance, and integrated performance and capacity management. Though BladeLogic was not purpose-built for the cloud, the inclusion of BladeLogic automation capabilities in

CLM provides a solid service consumption and delivery capability, along with the ability to integrate with existing management tool sets. BMC also stresses platform heterogeneity as a key product differentiator, including support for physical and virtual infrastructure, multiple hypervisors, and integrations with a variety of public clouds.

BMC has built significant market momentum around its cloud offerings, with more than 40 major customer wins to date and nearly 300 additional prospects in the pipeline. Though a majority of BMC's current engagements are focused on private and hybrid clouds, its support for hybrid cloud capabilities is limited and directional at this stage. For example, while customers can provision services to a BMC private or Amazon EC2 public cloud, BMC's ability to manage those public cloud images is limited at best.

Competitive Advantages

- BMC can draw on its considerable experience and expertise in business service management, giving it strong credibility as a supplier of cloud management technology and services.
- BMC's cloud offering is largely platform agnostic, enabling it to address the needs of heterogeneous environments in large enterprises, particularly those running multiple hypervisors.
- BMC has announced cloud partnerships with some major technology players, such as Accenture, Cisco, Dell, Fujitsu, NetApp, and Red Hat.

Competitive Disadvantages

- BMC is management focused, and thus cannot bring a full infrastructure-as-a-service offering to enterprise and service provider customers.
- Though BMC's hybrid cloud product messaging is based on a single product/services suite (CLM), it is really just a collection of existing BMC products such as Remyd and Bladelogic.
- The company's approach to hybrid cloud management is still services-oriented today, with tools designed for this purpose still in their early stages.
- BMC is working with leading converged infrastructure platforms (e.g. Cisco UCS, VCE Vblock) to offer private cloud management tools, but the hybrid cloud capabilities of these management frameworks are not there yet.
- Despite signing some large strategic partners, the range and depth of BMC's cloud-oriented service provider ecosystem is still relatively limited.
- BMC is working to adapt many of its other management tools to the cloud, as they were not originally built for this purpose.

COMPARISON OF CLOUD SERVICE PROVIDER ECOSYSTEMS

VMWARE VCLLOUD ECOSYSTEM

VMware is developing an enterprise hybrid cloud, offering the guaranteed security, availability and performance of a private cloud together with the flexibility and pay-as-you-go benefits of a public cloud. VMware vCloud is designed primarily to enable enterprises to develop and run their production-level IT environments (both infrastructure and applications) with a greater level of scalability, flexibility and efficiency.

The VMware cloud ecosystem consists of more than 5,200 service providers that help mid-sized and enterprise customers ease their transition to the cloud and realize all its potential benefits. In this hybrid cloud model, VMware's open-standard vCloud API and Open Virtual File format (OVF) for workloads give customers a choice of public cloud providers without having to re-factor applications when moving between them.

VMware enables service providers, including some of the world's largest telcos, outsourcers, and MSPs, to offer enterprise-grade, hybrid cloud services to large end users. vCloud Datacenter Services offers global coverage and a consistent computing service definition across carefully selected major service providers. This program provides a set of rigorous training and certification services, and requires participating service providers to meet enterprise-level standards for security, agility and application-level portability. Certified vCloud Datacenter Service Providers offer multi-tiered, enterprise-class SLAs, and provide customers with the benefit of their considerable expertise, in the form of best practices, reference architectures, and implementation services.

To better understand the caliber of hybrid cloud services offered under this program, let's take the example of one certified vCloud Datacenter Service Provider, CSC. This large IT integrator and outsourcer delivers a VMware-enabled enterprise hybrid cloud solution that consists of two components: CSC BizCloud, a dedicated private cloud developed by CSC delivered on-premise or off-premise; and CSC CloudCompute, an IaaS capability hosted in seven CSC Trusted Data Centers around the world. CloudCompute provides compute, storage and network resources as a service to support any application, including business-critical workloads. Both CloudCompute and BizCloud meet the VMware vCloud Datacenter services definition.

This offering is unique among traditional outsourcing providers, in that it extends CSC's enterprise-class managed services from its own cloud-enabled data centers to on-premise customer deployments. We believe this hybrid offering will initially appeal to customers who want to develop and test workloads on a pay-as-you-go basis in CSC's hosted data centers and then deploy them in a dedicated, private BizCloud environment, or vice versa. Another popular use case might be on-demand cloud-bursting for both dev/test and production applications.

The VMware-CSC service provider partnership highlights some of the differentiators of the vCloud Datacenter Services program that make it attractive to large end users:

- **True enterprise hybrid cloud offering.** CloudCompute is based on a VCE Vblock infrastructure, composed of VMware virtualization; unified networking, compute and security from Cisco; and security and management from EMC. CSC claims that BizCloud offers the best of both worlds: the dedicated infrastructure and security of a private cloud, with the pay-as-you-go economics and convenience of a public cloud.
- **Fast time to deployment.** CSC pledges to have a BizCloud linked to CSC-hosted IaaS and ready for workload deployment within 10 weeks of initially engaging with a customer.

- **Transparent and auditable security.** The solution is protected with VMware's leading vShield security framework. CSC also wraps its defense-in-depth security and managed services into this offering. CSC is well regarded for its security and compliance capabilities, in serving both government and large enterprise accounts.
- **Multi-tiered enterprise SLAs.** BizCloud offers SLA's in four tiers, ranging from Bronze and Silver self-service tiers to Gold and Platinum managed-services tiers, with Platinum availability commitment at a minimum 99.95%. The BizCloud SLA is tougher than most cloud SLAs, in that it specifies full workload availability; e.g. in the case of a Platinum tier, if a customer's workloads are not available at least 99.95% of the time, then CSC will provide compensation.

AMAZON AWS ECOSYSTEM

Amazon has built a public, commodity cloud targeted primarily at developers. The Amazon Web Services (AWS) cloud is the most popular place for developers to go to build and run new cloud-architected applications. AWS has by far the largest number of public cloud users, and has built an ecosystem that caters primarily to making development and test functions more cost-effective and productive. The focus is on building new applications that will run on the Amazon public cloud and adding new developer services to reduce the amount of effort required to deploy applications, while also increasing "stickiness" of the platform.

Unfortunately, this ease of use and productivity does not extend today to the deployment of production applications on EC2. While Netflix and Zynga are running production apps on EC2 today, both had to re-architect their applications to compensate for the EC2 issues they encountered.

The AWS partner ecosystem consists of a community of Independent Software Vendors (ISVs) and Systems Integrators (SIs) that build and offer services and solutions on the Amazon public cloud. The ecosystem is strong – many software tools and application vendors (including some of the world's largest) have licensed and packaged their software to run on EC2, easing overall deployment for customers. Amazon provides developers with full API access to the AWS infrastructure.

AWS has a weak cloud compute SLA, even among public cloud providers. AWS offers a 99.95% availability commitment, evaluated over a 1-year term, with maximum service credits at 10% of a customer's bill in the event of service disruption. It is important to note that Amazon's definition of "service availability" is not a typical enterprise uptime SLA definition: it is defined as the ability to launch new EC2 virtual server instances in a specific availability zone. Amazon expressly does not guarantee the continued uptime of any virtual server once it is running, nor any specific performance metrics.

As a result, AWS' highly publicized multi-day outage did not violate Amazon's definition of "availability", even though tens of thousands of customers were down for several days. Furthermore, it is the user's responsibility to re-start any VM that is halted due to planned or unplanned outages. While these SLA terms might be acceptable to most developers, the recent multi-day AWS outages, which took several prominent websites offline, underscore the risk of running applications on Amazon.

Though AWS now offers a Virtual Private Cloud (VPC) service, the VPC still runs on AWS infrastructure, and does not offer true hybrid cloud capabilities. Amazon differentiates itself based on price, ease-of-use, and time-to-market, but not enterprise-level reliability and service.

RACKSPACE CLOUD ECOSYSTEM

Rackspace offers a virtual private cloud based on dedicated VMware vSphere servers and a public IaaS cloud (Cloud Servers) based on the Xen hypervisor and proprietary IaaS stack (from its SliceHost acquisition). With NASA, Rackspace launched an open source project for a new cloud infrastructure

platform, OpenStack, in July 2010. Rackspace contributed the source code for its Cloud Files storage-as-a-service offering to the OpenStack project, but not the SliceHost code. Workloads cannot be freely moved today across Rackspace public Cloud Servers and Rackspace Virtual Private Clouds, so this is not a true hybrid cloud solution.

Today, the OpenStack community includes more than 80 corporate members, including companies and service providers looking to deploy large-scale cloud deployments for private or public clouds by leveraging an open-source ecosystem. At the time of writing, the OpenStack project is still under development and there are no cloud computing services available based on OpenStack.

Rackspace also provides Cloud Load Balancers, and a PaaS offering (Cloud Sites). Rackspace recently began to merge its cloud IaaS with managed hosting services, with the result that customers can now select a managed service level for Cloud Servers, which is over and above the SLA terms provided in the baseline offering.

The baseline SLA includes 100% uptime guarantees for the network and data center (excluding scheduled maintenance), a maximum of 1 hour of downtime on unplanned server outages, and twice daily snapshots of virtual server images for backup, along with 24x7 chat/phone support. The premium managed service level adds in server OS and apps patching/updating, 24x7 monitoring response and resolution, and more personalized technical support. Rackspace is well regarded in the industry for its proactive, high-touch service and support (which it brands as “Fanatical Support”).

While Rackspace has worked hard over the past few years to strengthen its cloud infrastructure and services, the cloud IaaS is still not enterprise class. Rackspace lacks the broad feature set of Amazon AWS, and the enterprise capabilities of VMware vCloud, and the OpenStack project has yet to deliver production-ready code. As such, Rackspace appeals to small and mid-sized businesses as well as larger companies hosting less critical, web-centric applications. Rackspace competes on the basis of its strong support and managed hosting capabilities.

DEFINITION AND PURPOSE OF ENTERPRISE HYBRID CLOUDS

WHAT IS AN ENTERPRISE HYBRID CLOUD?

Cloud computing definitions vary widely, and there is still significant industry debate around the relatively stable definitions of public and private clouds. For this study, we established a baseline definition for enterprise hybrid cloud that we feel captures the primary objectives of this emerging solution category:

- **Enterprise:** built to address large-scale clouds with enterprise-class workload portability, performance, availability and security.
- **Hybrid:** enabling both on-premise and off-premise cloud deployment models, with supporting cross-cloud management, migration, and interoperability tools.
- **Cloud:** based on a shared and metered resource model with elastic capacity delivered via self-service interfaces.

Note that we refer to on-premise and off-premise to avoid confusion between the terms public and private cloud. Several vendors market hosted dedicated resources (with or without some elasticity) as virtual private clouds. For simplicity, we have attempted to identify the location of cloud solutions when evaluating them, regardless of the marketing terms used to describe them.

WHY DEPLOY AN ENTERPRISE HYBRID CLOUD?

We believe that mid-sized and large organizations will move steadily toward an enterprise hybrid cloud computing model, and for good reason. When properly implemented, hybrid clouds can offer users the best of both worlds: the security, quality of service, and control of an on-premise (private) cloud, combined with the agility and pay-per-use economics of off-premise (public) clouds. To make a hybrid cloud *enterprise-capable*, it must be built to address large-scale deployments with enterprise-class performance, availability and security; *and* it must provide the workload portability, management, security and interoperability features required to make its on- and off-premise components work effectively together.

ENDNOTE

We excluded SaaS from this study in order to focus our efforts on the infrastructure and application platform aspects of hybrid cloud. There is a mature SaaS marketplace, with most solutions delivered via off-premise commodity (public) clouds. In addition, many enterprises provide users with shared access to applications via terminal services or desktop virtualization—a delivery model that can be construed as a form of private SaaS—but the drivers for a hybrid SaaS model are less clear at this point. Also, there are few if any SaaS solutions marketed as “hybrid.”

THIS REPORT WAS SPONSORED BY VMWARE

ABOUT TANEJA GROUP

Taneja Group’s mission is to deliver best-in-class technology analysis and consulting for the storage, server, virtualization and cloud markets to enable our clients to convert technology into business. We are a boutique firm of operational experts with both broad and deep expertise in storage systems and technologies, server and desktop hardware and software, virtualization platforms and appliances, cloud software and services, and physical and virtual infrastructure management solutions.

For more information, please visit www.tanejagroup.com.

NOTICE: THE INFORMATION CONTAINED HEREIN HAS BEEN OBTAINED FROM SOURCES BELIEVED TO BE ACCURATE AND RELIABLE, AND INCLUDES PERSONAL OPINIONS THAT ARE SUBJECT TO CHANGE WITHOUT NOTICE. TANEJA GROUP DISCLAIMS ALL WARRANTIES AS TO THE ACCURACY OF SUCH INFORMATION AND ASSUMES NO RESPONSIBILITY OR LIABILITY FOR ERRORS OR FOR YOUR USE OF, OR RELIANCE UPON, SUCH INFORMATION. COMPANY, BRAND AND PRODUCT NAMES REFERENCED HEREIN MAY BE TRADEMARKS OF THEIR RESPECTIVE OWNERS.