

# Is OpenStack for Real and How Does It Impact the Software Landscape?

## Watch Service Providers First; Ripples Will Come to Enterprise

### ■ Industry Overview

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- **OpenStack Is "Too Big To Fail"** — In three short years, the open source OpenStack initiative has reached broad-based industry support towards an ambitious goal of providing a complete cloud-based infrastructure offering. At this point, while there still is risk of fragmentation (200+ contributing) that would delay enterprise adoption and even diminish the scope of OpenStack's eventual success. However, our takeaway is that support is too broad (nearly 200 tech companies) and there is simply too much momentum behind OpenStack development for the base case to not be at least moderate success.
- **Initial Traction in Service Providers** — The large, integrated tech companies (IBM, HP, etc.) are betting with OpenStack to deliver Infrastructure as a Service economics inline Amazon's AWS. There are also a number of Web / Internet companies using OpenStack to underlie their next-gen apps. Enterprise traction is scant, with most waiting for stability of technology, something that has happened with portions of OpenStack (compute, object storage) but not all. We expect enterprises that will look for hybrid cloud scenarios (private / public) will be early adopters.
- **OpenStack Is a Viable Alternative** — Amazon's AWS owns the public cloud and we expect that while OpenStack can offer some of these benefits, AWS is and will likely be more mature and have greater scale than OpenStack competition for some time. Innovation around OpenStack puts VMware's vCloud initiative in perspective and in our view, VMware is substantially behind. We expect this to keep a lid on VMware's multiple this year. Microsoft's Azure is more mature than OpenStack and is a viable competitor in hybrid scenarios, but doesn't have a comparable ecosystem and less mindshare around next-gen applications that demand cloud-based infrastructure.
- **Red Hat Shares Come with a "Leap"** — In three releases of OpenStack, Red Hat has become the largest contributor to OpenStack and also announced its OpenStack distribution with commercial support. Red Hat is a play on enterprise adoption of OpenStack and we don't believe we'll see 2013 or 2014 revenue from this initiative leaving us concerned about the impact of slowing incremental Linux demand. However we recognize the value of this long-term option (the "leap") and if sub 15% growth were embedded in the stock we'd look to be more constructive.
- **Further Impact on Software** — Citrix is pushing a competing initiative (CloudStack) and having success given more mature / easier to deploy product. We expect the management software market (CA / BMC) to be pressured by the new generation of tools coming in with new cloud platforms. We also expect software defined networking (as part of OpenStack) to favor software-based network security competitors, with CHKP the prime example.

See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

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## What Is OpenStack?

Launched in 2010, OpenStack is an open-source software project that aims to provide a cloud management platform (CMP) that can control pooled compute, storage, and network resources in the cloud. In short, it enables companies to deploy their own elastic Infrastructures-as-a-Service (IaaS) similar to Amazon's (AMZN.O; US\$267.40; 1) Amazon Web Services (AWS). OpenStack is one of several open-source CMPs. Others include Citrix's (CTXS.O; US\$69.07; 1) CloudStack (initially commercial but later open sourced), Eucalyptus, and OpenNebula. The best known commercial CMPs is VMware's (VMW.N; US\$76.54; 2) vCloud, although we expect others to enter the market as well.

Open Stack is governed by the OpenStack Foundation (OSF), which is made up of ~50 technology vendors and nearly 1,000 end user organizations with over 7,000 individual members. The OSF is governed by a 24-member board of directors, elected from its gold and platinum members as well as the broader membership. Technical direction is set by a 13-member technical committee had up of project technical leads and at large members.

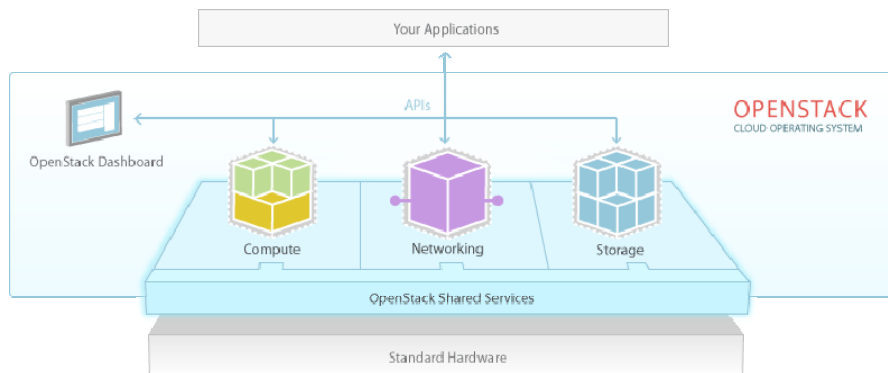
## A Brief History

The seeds for OpenStack were laid at NASA and Rackspace (RAX.N; US\$46.09; Not Rated). In 2008, NASA was attempting to consolidate its internal web resources, and NASA's IT division was attempting to build a Platform-as-a-Service to facilitate the project. Shortly afterward, NASA turned its attention first to IaaS – specifically elastic provisioning of compute resources – as a necessary foundation. Meanwhile, web hosting and cloud company Rackspace was working on a similar foundation for its storage product called Cloud Files. The two companies joined together in 2010 to launch OpenStack as an open source project under the Apache Foundation.

## A Look at OpenStack Components

At its core, OpenStack is a Cloud Management Platform (CMP) but it encompasses more than just a management layer. OpenStack includes a highly scalable, elastic components such as a computing fabric, image and object storage, and a software-defined networking framework. OpenStack ties these various elements of cloud computing together and enables these services on industry standard hardware. This reduces the complexity and cost of deployment. The hardware resources and its capabilities are presented to applications through a rich set of application program interfaces (APIs) that abstract the hardware to the application. The figure below outlines a rough overview of services.

Figure 1. Overview of key OpenStack components



Source: OpenStack.org

The key components include:

- **Compute** – Nova is a framework for managing and automating pools of compute resources that enables horizontal scaling that is hypervisor agnostic (KVM and Xen are most common).
- **Storage** – OpenStack features both object storage (code-named Swift) and block storage (code-named Cinder). Swift ensures that data across storage nodes are consistent and is ideal for inexpensive object storage. Cinder is block/volume-based storage that is optimized for high-volume input/output applications such as a database attached to Nova.
- **Networking** – Quantum is a framework to provide “network as a service” to various OpenStack services and was separated from networking in the Nova project. Quantum has a software-defined network architecture and includes plug-ins to enable OpenStack to work with multiple network vendors.
- **Dashboard** – Horizon is the OpenStack component that offers a graphical user interface to access, provision, and automate various OpenStack services. The dashboard can hook into third-party products as well as some of the newer OpenStack services like orchestration and metering/billing.
- **Shared services** – The OpenStack project is held together by a number of shared services in the areas of image management (Glance) and identity services (Keystone) that are used across the above services.

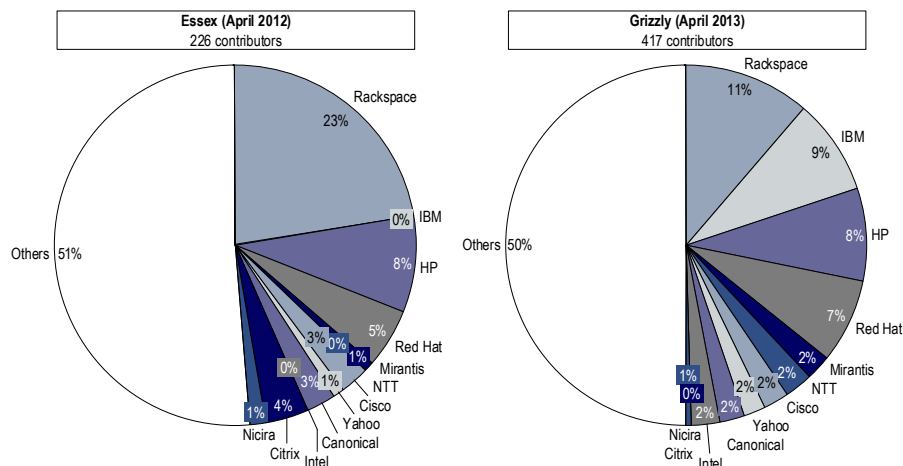
OpenStack is still a relatively immature project, as OpenStack has been in development for just 3 years and the scope of the project is ambitious. With the relative youth of the project, some technology firms have only recently committed to OpenStack. Other CMPs such as Eucalyptus and CloudStack have been around for longer and can boast more traction in production at service providers and enterprises.

## Who Is Behind OpenStack Today

While the project started at NASA and Rackspace, contributors have evolved to include most of the major technology vendors. In just one year, there has been a near doubling of code committers to the project, and also some substantive changes in the composition of contributors. For example, IBM (IBM.N; US\$209.67; 1) is now the second-largest contributor to OpenStack, up from zero presence one

year ago. Citrix had 4% of code committers a year ago, but no longer have any contributors due to their focus instead on CloudStack. Service providers such as NTT (9613.T; ¥307,000; 2) and HP (HPQ.N; US\$20.49; 3) (which is playing a dual role as tech contributor as well as service provider) are also contributing meaningful amounts of code.

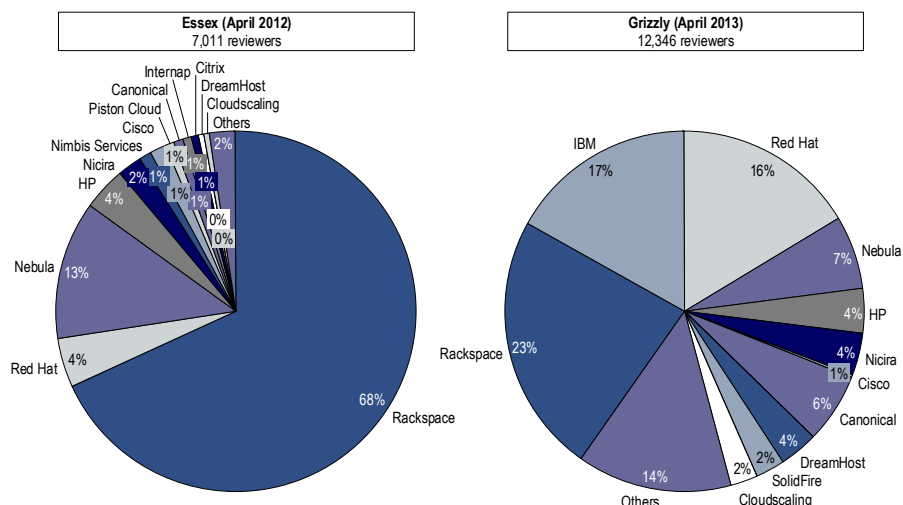
**Figure 2. Number of OpenStack code contributors reflect investment by tech firms**



Source: Mark McLaughlin via Github.com

While the number of contributors indicates the level of investment, the number of reviewers provides some indication on control of the overall project. What's striking in the figure below is the magnitude of the shift in reviewers. Whereas Rackspace used to dominate the code reviews, IBM and Red Hat (RHT.N; US\$50.27; 2) have swiftly (no pun intended) staked a prominent claim on the direction of OpenStack. Some of this reflects their level of investment and the openness of the OpenStack community to these firms' involvement, but another contributor to Rackspace's diminished control is the fact that Grizzly includes new modules such as identity, and companies like IBM have the resources to marshal the open source community to build these new components.

**Figure 3. Code reviews by employer reflect broad adoption by tech giants**



Source: Mark McLaughlin via Github.com

We believe this broadening of contribution within the technology community is a positive sign. Also, we note below, the number of contributors, code commits and lines of code in the OpenStack project stack up well versus other open source initiatives. We note there isn't any clear way to use these metrics to gauge traction, however the comparison here of OpenStack versus other well-known and mature open source projects suggests that OpenStack is moving into the league of support inline with projects such as KVM (Red Hat's virtualization technology), Linux and Webkit (see Figure 12).

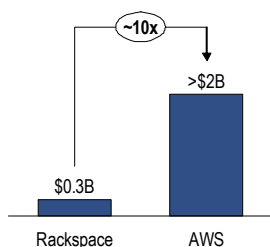
## Drivers of OpenStack Demand Are Powerful

The benefits of cloud-based architecture are clear and we believe will continue to catalyze change within IT. Whether public or private, the shared nature of cloud-based architecture enables better economics, at least until minimum efficient scale is reached. Automation inherent in cloud architecture enables the infrastructure to keep pace with the level of innovation that application developers and their new breed of applications demand. Finally, being able to abstract capabilities of underlying hardware and software infrastructure as APIs bring the benefit of infrastructure portability and developer efficiency.

We see three primary value propositions for OpenStack. Each of these drivers are a mainstay driver for one type of customer, although all customers benefit from all three value propositions.

### Enabling Service Providers to Compete with Amazon (as well as Microsoft and Google)

Figure 4. AWS is an order of magnitude larger than the field of IaaS competitors



Source: Company Reports and Citi Research

First, OpenStack brings an architecture that public cloud providers can use to stand up and operate IaaS. OpenStack hopes to be an open source alternative to Amazon Web Services as well as Google's (GOOG.O; US\$782.56; 1) Google Compute Engine (GCE) and Microsoft's (MSFT.O; US\$28.83; 1) Windows Azure. The most complete ecosystem today in IaaS is Amazon Web Services, which has a) scale, b) an ecosystem of developers, and c) technical maturity. Windows Azure appears to compete on compatibility with the .NET stack, and Google's GCE competes on price since it has similar if not greater scale than AWS. But the entire tech ecosystem – OpenStack included – is attacking AWS. Citi estimates AWS is roughly 90% of Amazon's "Other revenue," which will reach \$3.8 billion in revenue in total in 2013. This is an order of magnitude more cloud revenue than Amazon's nearest competitor, RackSpace. AWS has a significant lead in product adoption, with traction among independent software vendors (ISVs, e.g. SAP) as well as consumer services (e.g. Netflix).

In the pure web-scale public cloud market, Amazon will prove difficult to compete with as its scale, supported workloads, richness of APIs for developers, and self-service interface / dashboard are all competitive advantages. We expect there be to a more vibrant level of competition for enterprise-grade public cloud services, where the customer set values enterprise class support.

We see two ways for OpenStack service providers to compete with Amazon:

1. **Take advantage of fuzzy cost allocations:** Some companies may believe operating an internal OpenStack instance gives them a cost advantage because there is excess real estate, excess server capacity, sunk fixed costs, failure to allocate associated labor costs, or some combination of the above. In such situations, OpenStack might have an opening to effectively compete on marginal cost (perceived or real).

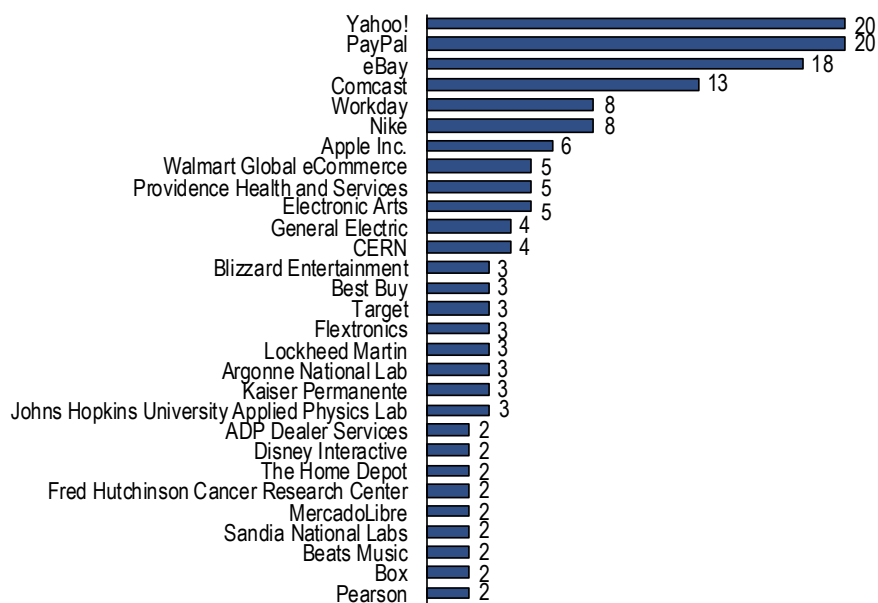
2. **Get prices “close enough”:** There is a minimum efficient scale (MES) in public cloud infrastructure, and that scale is lower for IaaS than it is for SaaS. Public cloud vendors such as AWS have driven down costs through sourcing (e.g. going direct to Taiwanese ODMs), engineering/support (e.g. supporting their own versions of Linux), and operating scale (large-scale data centers with favorable electricity agreements). These cost advantages are nearly impossible for a small-scale OpenStack service provider to match – not to mention an enterprise – but given that there is some MES for IaaS and that beyond MES the cost curve might not be that steep, OpenStack can get prices “close enough.”

Beyond these traditional service providers, we also saw a small niche of attendees at OpenStack Summit that have similar goals as service providers (scale of compute). These are the scientific and academic community that harnesses massive computing pools for research purposes.

## Enable the Infrastructure to Keep Pace with Continuous Innovations in Applications

The consumer Internet is seeing significant innovation, especially on the back of mobile applications where smartphones and now tablets have significantly expanded the interaction points with users. The result has been a massive wave of innovation and fierce competition among start-ups and with incumbents in various markets. The result is a pace of innovation in applications that is continuous with enhancements that are delivered continuously as well. This “continuous innovation / continuous delivery” is stretching the limits of infrastructure. As examples, think of mobile / social games that many times go virally very quickly, requiring back-end infrastructure that scales quickly. Similarly, “daily deal” shopping applications are updated very frequently and infrastructure must be constantly realigned to support this delivery.

Figure 5. Enterprise attendance at OpenStack Portland was noticeable



Source: Citi analysis of OpenStack attendee list as of April 15, 2013 (includes companies with >2 attendees)

Many start-ups leverage Amazon’s AWS. However it’s clear that many more established organizations would like to have AWS-like infrastructure in-house, in order to have control over their deployment. We note that beyond service provider customers, the group of fast-moving technology and consumer companies is

amongst the early adopters of OpenStack. At recent OpenStack Summit, attendance from a number of such companies was a clear growing trend (see figure on left). Over time, we expect mainstream application development will take on an increasing pace of release frequency as there is more pressure to innovate. This trend is likely to focus on new applications and will likely necessitate a more agile infrastructure, much akin to the specifications of OpenStack.

## Hybrid Corporate Workload Will Require Public / Private Symmetry

One of the promises of cloud computing, the utility model, can only be achieved with a degree of common architectural baseline. A benefit of this utility model is to have individual workloads and potentially whole applications run flexibly in EITHER private or public cloud.

Figure 6. Competition for the corporate workload is fierce

|                           |  |   |
|---------------------------|--|---|
| VMware<br>Windows/Hyper-V | OpenStack<br>CloudStack<br>Vmware vCloud<br>Eucalyptus<br>OpenNebula<br>Joyent<br>Abiquo<br>Flexiant | Amazon AWS<br>Windows Azure<br>Google GCE |
| Private                   | Hybrid   | Public                                    |

Source: Citi Research

Today, the majority of corporate workloads live in existing data centers and while may have been virtualized to drive hardware efficiencies. There are four scenarios for corporate workloads in the future, including two flavors of a hybrid cloud deployment: 1) deploy in current datacenter architecture, 2) deploy in an internal hybrid cloud data center, 3) deploy in an external hybrid cloud, or 4) deploy to the public cloud. Here, #2 and #3 are complementary, with the ability to leverage both if the hybrid cloud is built on common architecture. The Figure below highlights some of the tradeoffs in terms of economics and flexibility.

Figure 7. Workload deployment options

| Deployment options                    | Deployment cost |     | Ongoing cost | Migration flexibility | Conclusion   |
|---------------------------------------|-----------------|-----|--------------|-----------------------|--|
|                                       | Existing        | New |              |                       |  |
| Existing data center                  |                 |     |              |                       | Existing workloads have to overcome some friction                    |
| Rearchitect private IaaS (OpenStack?) |                 |     |              |                       | Private rearchitecture is expensive but companies will want symmetry |
| Migrate to public IaaS (OpenStack)    |                 |     |              |                       | Public OpenStack clouds might not match AWS economics                |
| Migrate to public IaaS (e.g. AWS)     |                 |     |              |                       | Strong incentive to begin workloads in the public cloud              |

Source: Citi Research

All three options will be viable options. However, OpenStack's key value proposition, symmetry, is both a strength and a weakness. That symmetry has drawn nearly all heavyweights in technology. The downside is that it might not deliver on the symmetry due to interoperability or because enterprises might never revamp their internal data centers to run OpenStack.



## State of OpenStack Today

### Customer Traction

OpenStack is a 2.5-year old project, and given the ambitious reach of the project, remains early in terms of customer adoption. While there has been a significant amount of vendor and even service provider commitment to OpenStack, the number of notable production wins for OpenStack is still relatively few. This was our clear take-away from the recent Portland OpenStack Summit where we heard of an aggregate “several dozen” full production OpenStack deployments. There are likely 10x this in some sort of proof of concept. However deployments definitely lag the hype in this market at the present time. We note that the more limited, narrowly supported “CloudStack” initiative (curated by Citrix) has more deployment traction at the current time. The Figure below outlines examples of customer commitments to OpenStack:

Figure 8. OpenStack customer examples

| OpenStack user Sector    | New/Replacement                              | Rationale  | Current Scope              | Future direction                               | 1 <sup>st</sup> Version | Components            | Key partners    |
|--------------------------|--|--|----------------------------|--|-------------------------|-----------------------|-----------------|
| Paypal Payments          | Replacement of private cloud (VMware)        | As service provider, needs control over entire stack | 10,000 servers by summer   | Increasing use in 80,000 server footprint      | Essex                   | Nova, Swift           | Mirantis        |
| HP                       | New public cloud                             | Support turnkey business model                       | n/a                        | Key element to turnkey solution                | Essex                   | Nova, Swift, Keystone | HP              |
| Best Buy Retailer        | New private cloud                            | n/a  | Tens of internal customers | n/a  | Essex                   | n/a                   |                 |
| CERN Scientific          | New private cloud                            | Cheaper than public cloud when factoring bandwidth   | In beta – 15,000 VMs       | 100,000-300,000 VMs; hybrid cloud (for burst)? | Cactus                  | Nova, Swift, Glance   |                 |
| Mercado Libre E-tailer   | Replacement of private cloud (Red Hat / KVM) | Bias for open source, self support                   | 500 physical servers       | OpenStack private cloud                        | Diablo                  | Nova, Swift, Glance   | Canonical       |
| Cisco WebEx SaaS company | New private cloud                            | As service provider, needs control over entire stack | Tens of internal customers | OpenStack private cloud                        | Essex                   | Nova, Swift, Glance   | Mirantis, Cisco |

Source: OpenStack.org and Citi Research

We note several observations from the examples above:

- First, the vast majority of customers began deploying on the Essex release, which is just a year old.
- Second, most customers are live with just Nova (compute) and Swift (image-based storage), including HP. In our view, both of these observations point to OpenStack’s relative immaturity. Other projects such as Cinder (Block storage) and Quantum (networking) are much less mature.
- A third observation is that most of these customers have implemented OpenStack in a pure private cloud environment. We believe that demand for hybrid clouds – something we view as a key long-term of OpenStack – is not a driving force today in demand. We believe large IT companies such as HP and IBM have plans to come to market with turnkey hybrid offerings. However, technology and collective industry experience with OpenStack in such deployments is at an early stage.
- Fourth, most implementations (aside from PayPal) are not displacements but rather to facilitate new capacity in a more dynamic development environment. This is inline with how we expect OpenStack to be adopted before it is likely to be used for a deep re-architecting of traditional datacenters. The result of this is we don’t think private cloud deployments (such as those based on OpenStack) are directly cannibalizing workloads running in virtualized server environments. However, we do expect these to architectures to compete for growth in incremental workloads, a battle that favors cloud architecture.

## OpenStack Business Models

We see a number of business models developing around OpenStack, ranging from selling support for a basic software distribution to an OpenStack hardware appliance to a full range of OpenStack delivery (hardware, value-added CMP components, and integration). In the figure below, we map the key players in OpenStack against these business models.

Figure 9. The OpenStack ecosystem features a broad variety of vendors and business models

|                      | Established vendors |           | Start-ups    |              |
|----------------------|---------------------|-----------|--------------|--------------|
| Turnkey solution     | HP                  | IBM       |              |              |
| Integrators          | HP                  | IBM       | Mirantis     |              |
| Service provider     | Rackspace           | AT&T      | Metacloud    | Media Temple |
|                      | Orange              | KT        | Dreamhost    |              |
| OpenStack+           | Oracle (Nimbula)    |           | Cloudscaling | Piston Cloud |
| Distro               | RedHat              | Canonical | StackOps     |              |
| OpenStack appliances |                     |           | Nebula       | Morphlabs    |
| Heterogeneous mgmt   | BMC                 | HP        | Numerous     |              |

Source: Citi Research

- **Technology integrator** – This is the traditional role played by IBM that others are seeking to replicate. HP is the primary competitor here, although we expect other SIs will build significant infrastructure practices around OpenStack. Also, boutiques, such as Mirantis, have gained significant mindshare as OpenStack specialists. The business model here is one of traditional consulting and integration services (headcount-based), although over time, it is likely intellectual property developed in customers engagements will be productized (e.g. IBM's "Smarter Planet") or the customer relationship could turn into a service provider relationship.
- **Service provider** – Public service providers can leverage OpenStack to create a scalable IaaS. Rackspace has been a leader among service providers, but there are many other peer companies that plan to deploy OpenStack. Rackspace has the clear lead in this market, but over time, this market is likely to become more competitive as telcos seek ways to enter the IaaS space to take advantage of their datacenter capabilities and offer "Amazon-like" services.
- **OpenStack+** – We refer to the category of software companies building extensions to OpenStack (additional management capabilities, streamlined installs, etc) as OpenStack+, because they are not just bundling the open source distribution but are attempting to add value on top of it. With this business model, providers are able to differentiate via proprietary technology. However some customers may also want to avoid adopting non-standard technology, especially from smaller vendors.

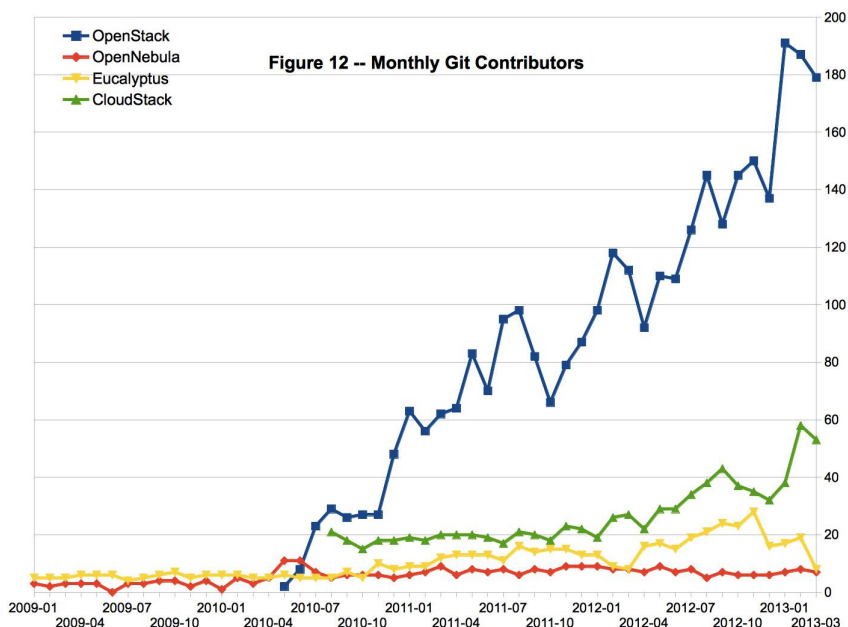
- **Distribution (“Distro”)** – These OpenStack participants are the usual suspects in Linux, and the business model is the same: charging end-customers for support. In addition, some technology stack vendors such as HP and Dell are packing their own distributions, although their business models are more aligned with turnkey integrators rather than distros. While in theory, maintaining a code base and supporting customers does not sound difficult, very few companies have been successful with this business model. Red Hat is the notable standout with a \$1B+ Linux business. For example, Oracle’s (ORCL.O; US\$32.49; 1) effort with its “Unbreakable Linux” distribution has seen only modest success. One counter-point to the distri approach is that an OpenStack distro is complex, with code across compute, storage and networking as well as management and shared services. This makes it more difficult for a customers to use a software load (versus appliances or pre-configured hardware) to set up complex infrastructure.
- **OpenStack appliances** – Nebula and MorphLabs are building OpenStack distributions and tying it to specific hardware architectures to help minimize the complexity in deploying OpenStack. We expect that Oracle might join Nebula in selling hardware for OpenStack, and we could see other makers of hardware adopt this model to help smooth customer adoption pain of OpenStack.

We discuss which business models have the potential to monetize OpenStack best in the section below entitled “Implications for Citi Software coverage.”

## OpenStack vs. the Field

This report focuses on OpenStack, although OpenStack is by no means the only CMP, the only open-source CMP, or the only open-source CMP with significant momentum. We do believe, however, that OpenStack is carving out a de facto leadership position due to the breadth and amount of resources that are going into the project from various technology companies. In the Figure below, we highlight the number of contributors to each of the open source CMPs. While the number of contributors is not necessarily the best indicator of health/maturity/traction, we believe directionally it tells an important tale about OpenStack’s momentum.

Figure 10. OpenStack is gaining significant momentum over other open source CMP projects



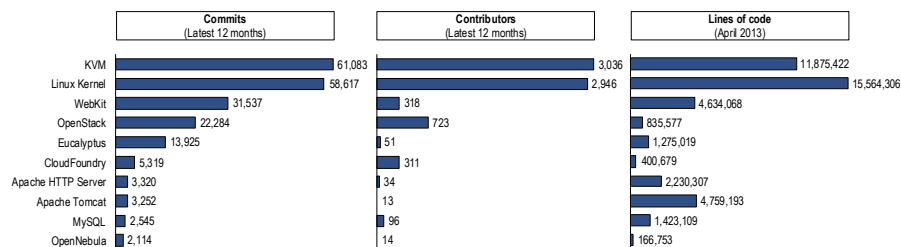
Source: Qingye Jiang

## What to Watch for to Gauge Success

OpenStack is still relatively early in its product maturity, yet it has the benefit of significant investment above any other open source CMP. Customers who commit to OpenStack are making significant architectural decisions, and so far we have seen relatively few customers commit fully to unproven software. Ultimately we expect to judge OpenStack's progress against both technical and business milestones. Specifically, we highlight several areas to watch:

- **Community health** – We look for continued growth in the number of contributors as development begins to mirror the truly widespread Linux community. We are also looking for new contributors, similar to the way IBM began committing meaningful resources between the Essex and Grizzly releases.

Figure 11. Participation statistics of popular Open Source communities



Source: Ohloh.net, retrieved on April 16, 2013

- **Product maturity** – Swift (object storage) has been in production at Rackspace for many years, while Nova (computing) has been one of the earliest components with some large live customers such as HP (see figure below). Both modules are

mature, as they have been through multiple revisions and customer tests. Other important modules such as Quantum (networking) and Cinder (block storage) are relatively new and immature, and projections such as Cielometer (metering) are critical for service provider environments. Consensus among industry analysts is that OpenStack still needs some time to mature for large-scale enterprise deployments. However, turnkey service providers such as IBM will be able to build around any OpenStack components that are incomplete.

Figure 12. OpenStack modules and key technical improvements by release version

| Area                          | Release             |                     |                           |                       |                          |                        |                           |
|-------------------------------|---------------------|---------------------|---------------------------|-----------------------|--------------------------|------------------------|---------------------------|
|                               | Austin<br>Oct 2010  | Bexar<br>Feb 2011   | Cactus<br>April 2011      | Diablo<br>Sep 2011    | Essex<br>Apr 2012        | Folsom<br>Sep 2012     | Grizzly<br>Apr 2013       |
| Imaging<br>(Glance)           |                     | REST-ful<br>API     | Checksum                  |                       |                          | New API                |                           |
| Compute<br>(Nova)             | Xen, KVM<br>support | Hyper V<br>support  | Supports 8<br>hypervisors |                       | Better live<br>migration |                        | Hypervisor<br>agnostic    |
| Object Storage<br>(Swift)     |                     | S3<br>compatibility |                           | Multi-cluster<br>sync | Svc provider<br>features |                        | True cluster<br>support   |
| Block Storage<br>(Cinder)     |                     |                     |                           |                       |                          | Volume<br>storage also |                           |
| Networking<br>(Quantum)       |                     |                     |                           |                       |                          | Open<br>vSwitch        | SDN                       |
| Dashboard<br>(Horizon)        |                     |                     |                           |                       | Self service<br>portal   |                        | Cielometer<br>integration |
| Identity<br>(Keystone)        |                     |                     |                           |                       | Multiple<br>factor auth. | LDAP, PKI<br>support   |                           |
| Metering<br>(Cielometer)      |                     |                     |                           |                       |                          |                        |                           |
| Orchestration<br>(Cielometer) |                     |                     |                           |                       |                          |                        |                           |

Source: Citi Research

- **Enterprise deployments and OpenStack symmetry** – We are also looking for signs that enterprises will invest in OpenStack. We noted two reasons for this, namely the change happening in application development, which drives a faster pace of iterations and continuous deployment. This requires infrastructure to keep pace. Thus if this fast pace of development continues to gain traction within enterprise customers, then this is a leading driver of OpenStack. The other is around demands for symmetry of deployment between private and public cloud. Paypal is one example of a bleeding edge deployment (a displacement of VMware) where the aim is rapid app development as well as symmetry.
- **OpenStack service provider pricing** – We are watching pricing for public OpenStack options to understand whether these service providers can achieve a minimum efficient scale that is price competitive with the likes of other public cloud providers. We note that currently OpenStack public cloud options appear to be priced at a premium to the other public cloud providers (see Figure below).

Figure 13. Public OpenStack clouds appear to be priced at a premium to the pure public clouds

|  | AWS              |   | Google GCE      |  | HP Cloud (OpenStack) |  | RackSpace (OpenStack) |   |
|--|------------------|---|-----------------|--|----------------------|--|-----------------------|---|
|  | Price            | Capabilities  | Price           | Capabilities                                     | Price                | Capabilities                                     | Price                 | Capabilities  |
| Compute<br>Micro/Extra Small instance        | \$0.02/hr        | • 613MB RAM<br>• Up to 2 EC2 units<br>• Pay for EBS       | n/a             | • n/a  | \$0.035/hr           | • 1GB RAM<br>• 1 compute unit<br>• 30GB disk     | \$0.022/hr            | • 512MB RAM<br>• 1 compute unit<br>• 20GB disk            |
| Compute<br>Standard/Medium instance          | \$0.12/hr        | • 3.75GB RAM<br>• 2 compute units<br>• 410GB disk         | \$0.132/hr      | • 3.75GB RAM<br>• 1 virtual core<br>• 420GB disk | \$0.14/hr            | • 4GB RAM<br>• 4 compute units<br>• 120GB disk   | \$0.24/hr             | • 4GB RAM<br>• 2 virtual cores<br>• 160GB disk            |
| Object Storage<br>Micro/Extra Small instance | \$0.095/GB/month | • As low as \$0.055<br>/GB/month based<br>on volume tiers | \$0.10/GB/month | • No volume<br>discounts                         | \$0.09/GB/month      | • Discounts for<br>volume tiers not<br>published | \$0.10/GB/month       | • As low as \$0.075<br>/GB/month based<br>on volume tiers |

Source: Citi Research

- **OpenStack service provider success and revenue growth** – Another read on the scale of OpenStack cloud providers – in addition to pricing – is revenue growth. While Rackspace and other web hosters will likely transition their customers to OpenStack, we are keener to judge HP Cloud and IBM's progress in rolling out OpenStack clouds that are currently in development. Given their roles as turnkey vendors who can help companies migrate to the hybrid/public cloud, their endorsement in the market and traction of their offerings is important.
- **OpenStack monetization** – We are also looking for signs that the OpenStack ecosystem can be successfully monetized as a gauge of health and customer value. If OpenStack business models are not building profitable growth, we would question the sustainability of these businesses.
- **Interoperability** – Key to OpenStack's value proposition is interoperability, and early OpenStack clouds such as Rackspace and HP do not deliver interoperability according some OpenStack observers. Without interoperability, the project could lose value as customers will not be willing to standardize on stacks that are not interoperable for fear of vendor lock in. We believe this is an area of significant risk for OpenStack, as continued fragmentation of different distributions would leave customers unable to make a serious commitment to the OpenStack platform.

We've noted what to watch to gauge success of Open Stack in the market. We note from spending two days this week at the Open Stack Summit in Portland meeting with companies in the ecosystem and interacting with some of the early customers looking to deploy Open Stack, we have a balanced view of the pace of adoption.

The service providers are out ahead of the web 2.0 / specialty entities, which similarly are out ahead of mainstay enterprise customers. We expect adoption to continue to proceed in this fashion as the drivers for the service providers around evolving from managed hosting / infrastructure outsourcing to AWS-like cloud services are most powerful. Cloud stack stands as a competing architecture today and we expect the near-term headlines to be a battle between Open Stack and Cloud Stack, where Cloud Stack is currently ahead in terms of deployments. Ultimately, there appears to be more innovation behind Open Stack and if early adoption challenges can be smoothed, Open Stack is likely to win long-term.

For Web 2.0 / specialty companies, the driver of continuous innovation, continuous deployment of their applications continues to mount. However these entities have other options including using AWS and also leveraging their engineering expertise to pick and choose infrastructure components or self-engineer (as Google, Facebook, etc do). Ultimately, this segment will adopt Open Stack, however the number of entities is relatively small (compared to enterprise) and this is likely to be a smaller market than enterprise.

In the enterprise segment, this is obviously the largest, most important market for monetization of Open Stack technology. However, the drivers are least urgent as the evolution of application development towards continuous innovation, continuous deployment (1st value prop of Open Stack) will happen slowly and adoption of hybrid cloud architectures (2nd value of Open Stack) is at odds with the inertia of traditional enterprise IT and also some of the security and governance requirements many customers have. As a result, we see Open Stack adoption as a revenue driver for software companies focused on enterprise to not be significant in 2013 and 2014. Instead we believe the proof points will come first in the two markets discussed above.

## Implications for Citi Coverage: OpenStack Winners and Losers

We believe it is very early to assess definitively the prospects for success of these various business models. However, we have several observations about how the above business models will impact the market.

**OpenStack deployments are likely to be large, standardization decisions** – As a result, we expect that the typical “viral”, “land and expand” or “try to buy” model will have some challenges in terms of selling core technology. OpenStack is largely an architectural decision for an IaaS running at scale. Linux distributions were successful because they reduced the friction for departments (the early adopters of Linux), but OpenStack will first need to succeed at the Service Provider level to enable the “land and expand” strategy. We therefore believe that most companies will initially turn to either a turnkey provider for their private cloud or a Service Provider for their public cloud. In either case, the distribution is less important than the value added services from turnkey provider. And in the case of public cloud options, it is highly likely that the service provider will self support, further marginalizing the value of the distribution. While initially the market may go to turnkey solutions because of ease of deployment and minimized complexity, over time, we expect standard distro’s may become the dominant means of deployment as certification across all hardware and applications will enable a wide variety of use cases.

**Service Providers have the advantage of Amazon scale** – Amazon has achieved scale largely through two factors: 1) massive buying power which it has passed on to customers and 2) easy technical onramps to AWS. With so many CMPs offering compatibility with AWS (including OpenStack), all CMPs are competing against AWS to some extent, including price competition. We believe Service Providers will have difficulty monetizing OpenStack without adding some differentiation against the field of OpenStack competitors. We believe the winners here could include Service Providers who also do extensive private cloud work, including HP and IBM, as well as Service Providers who can achieve Amazon-like scale such as RAX.

**Management model shifting to be smarter, tolerant, and higher level** – Management software historically focused on monitoring traditional components including individual physical servers. OpenStack builds on top of commodity hardware and assumes hardware faults instead of a focus on fault prevention and detection. The adaptability of CMPs requires smarter management software that is written for this environment. With OpenStack, the management software focuses on virtual workloads instead of physical hardware, a more complex orchestration that is hypervisor agnostic over standardized hypervisor management, and on complex software defined networking over traditional networking. With this flexibility comes a higher degree of complexity. This is another cycle in what we term [The Not-So-Amazing Race](#), where management software companies toil on a treadmill to keep pace with these paradigm shifts. We see the IaaS paradigm driving a change in the management model and there are a flurry of start-ups including RightScale, ServiceMesh, Puppet Labs, Cloudsoft, Hotlink, and OpsCode while posing a challenge to incumbents such as CA and BMC.

**Leadership in server virtualization doesn’t assure leadership in move to hybrid and public cloud** – VMware is the clear leader in server virtualization with near 70% market share. Anecdotal evidence from customers suggests that application workloads that have been virtualized will continue to operate in the datacenter and benefit from the inherent benefits. However, applications that are



being built for the cloud era as being designed differently, for example they depend on API-level integration with infrastructure and also are built for an era where hardware scales horizontally and individual elements fail. As a result, this cloud architecture is not a simple evolution from the hypervisor and server virtualization. As a result, we believe VMware is actually the underdog in the race to build out hybrid and public clouds.








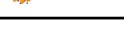


**Hardware budget eaten by software budget** – Server virtualization has already helped to significantly commoditize hardware, as the x86 standard was further embraced and hardware utilization increased significantly in the computing area. OpenStack or general CMP adoption is likely to further this commoditization. This may spread outside of compute and into storage and network as robust hardware is replaced with a software-rich platform like OpenStack. This will further boost the opportunity of the companies that capture value in the OpenStack market.

**Will continue to be a solution provider role** – Just like in today's IT landscape, there are systems integrators, outsourcers, etc. and we expect this to continue with OpenStack deployments. However we expect those that are on the OpenStack bandwagon early are likely to see share gains. At this point in time, it appears to be HP, IBM and some of the specialists, such as Mirantis.

## Implications for Software Universe

We've noted above the higher-level implications of the adoption of OpenStack on the market and how we expect OpenStack may be adopted. Below, we have described the impact of OpenStack adoption on a number of directly-exposed companies in our universe.

Figure 14. Summary of Software Impact from OpenStack Success

| Company     | OpenStack exposure  | Potential impact of OpenStack Success   |
|-------------|---|---|
| BMC         | • OpenStack management stack complementary/ competitive with BladeLogic, Cloud Lifecycle Manager assets                 |  |
| CA          | • OpenStack management stack complementary/ competitive with orchestration assets                                       |  |
| Citrix      | • Competitive with Citrix CloudStack<br>• OpenStack is Xen compatible   |  |
| Microsoft   | • Competitive with Windows Azure IaaS service<br>• OpenStack is Hyper-V compatible                                      |  |
| Oracle      | • Acquired OpenStack+ vendor Nimble<br>• Could sell OpenStack appliances  |  |
| Red Hat     | • Likely a principal distributor of OpenStack<br>• Success of OpenStack could preserve RHEL position in public clouds   |  |
| ServiceNow  | • Customers look to do more automation as they cloud-enable<br>• Early presence in automation                           |  |
| VMware      | • Incremental workloads likely to be managed by other software<br>• Driving networking project (Quantum) through Nicira |  |
| CHKP / FIRE | • OpenStack changes the security model<br>• Software only / commodity hardware will likely rule                         |  |
| FTNT / PANW | • OpenStack changes the security model<br>• Network security will be abstracted from proprietary hardware               |  |

Source: Citi Research



## Red Hat

Red Hat's position in the OpenStack ecosystem is strong as now a top code contributor (Figure 3) and a strong background in open source software (OSS) in general. We look at Red Hat as having a "call option" on Open Stack adoption in the enterprise. As we noted already, we expect enterprise adoption to lag service provider and web 2.0 adoption and thus, the option that Red Hat has is more of a "leap" as adoption is likely to happen beyond this year and potentially beyond 2014. In the mean-time as service provider up-take is the epicenter of Open Stack adoption, competitive Open Stack distributor Canonical (Ubuntu) appears dominant so far with service providers. There is some debate as to whether or not a pure distro model (see Figure 10) will be the route enterprise customers take in adopting Open Stack. The alternative is likely to be the appliance model, which is more packaged and may be simpler to deploy (although ultimately less flexible). We believe given Red Hat's history of making OSS more consumable by enterprise through robust certification of hardware and applications, Red Hat will bring some of the same simplicity in a distro that others have in an appliance.

We believe from a stock perspective, there continues to be risk that Linux slows before other products (including Open Stack) reach the point in growth ramp where they can bring meaningful revenue. This was the basis of our downgrade of shares from buy to neutral [link report]. Trading at 19x EV/FCF, we still think the company needs to show top-line growth (short-term billings) at 15%+ to maintain this current multiple. We'd like to have confidence in the ramp of new products given our view on the maturation of Linux.

## VMware

Server virtualization was successful at driving efficiency (to 50%+ utilization) in infrastructure that was previously inefficient (~5-10% utilization was common prior to VMware). We expect these existing mature workloads will remain on VMware. This maintenance of existing franchise alone would come with a stable maintenance revenue stream, but as license revenue is primarily driven by incremental

We believe VMware is competing for workloads long-term with Open Stack, AWS and other compute architectures. We expect that VMware will continue to dominate the corporate, legacy workload. However as enterprise application development velocity increases towards continuous iteration, continuous deployment, there will likely be demand for Open Stack in the enterprise. The early adopters of Open Stack in the Web 2.0 market, it is likely that enterprises go with Open Stack unless VMware can catch up in the meantime.

Our inputs suggest VMware will not release Open Stack equivalent APIs until sometime in 2014. By this time, Open Stack will be more mature with more deployment traction. We believe the result will be, over time, the balance of new workloads will tip away from VMware.

VMware, with its Nicira acquisition, is cemented into the reference architecture for Open Stack networking, as Nicira technical leaders servers as the project technical lead for Quantum. Networking is the least defined of the core Open Stack infrastructure elements and many of the early adopters are architecting their networks outside of Quantum due to this immaturity. However, as the network piece matures, VMware is in a good position to capitalize on this with Nicira sales (likely 2014+).

Our stock view remains that VMware is in the middle (year 2) of a multi-year growth transition. On the other side of this transition, drivers such as desktop, management tools and the software defined data center as potential drivers. However the

software defined data center is challenged by Open Stack while management tools are immature and the company lacks a complete product in desktop. We look to gain more confidence that growth can re-accelerate, something that guidance and street numbers assume in 2H13.

### **Citrix**

Citrix acquired Cloud.com in 2011 and with it provider commercial support for the CloudStack framework. CloudStack is a parallel project to OpenStack that has gained significant traction amongst services providers. This traction has been based on CloudStack having a lead in terms of maturity and simplicity. We heard from service providers that it is easier to deploy and manage and as a result, there are dozens of service providers deployed on CloudStack. The development community, however, is more narrow (see Figures 3 and 4) and technology vendor support is also narrow.

We don't believe CloudStack contributes significant revenue to Citrix (likely less than \$20M / annually). We also don't know if CloudStack is a long-term winner, as there is significantly more investment by the technology ecosystem behind OpenStack. However in the short and medium term, OpenStack is generating a lot of interest in IaaS built by service providers and some of this is showing up as deployments of the more mature and simple CloudStack.

Similar to OpenStack for Red Hat, we view CloudStack as a call option for Citrix, although a less valuable one, due to questions about CloudStack's long-term viability. However, we've noted significant questions around OpenStack's ability to harness the power of its broad ecosystem, instead of that resulting in fragmentation and stagnation of development. If this negative scenario plays out for OpenStack, this would play to the hand of CloudStack and Citrix. For Citrix, in our view, the stock performance is likely to be driven primarily by the company's traction in desktop virtualization and secondarily in its datacenter and cloud business. Netscaler is the largest piece of that business with commercial CloudStack support a small part. Thus performance in desktop is still likely to drive shares and we have a favorable view of the set-up this year in desktop.

### **Microsoft**

Microsoft is one of the few relevant companies in our universe that is absent from OpenStack membership. Microsoft's Azure stacks up as a head-to-head competitor against Open Stack and to a lesser degree Amazon's AWS. Azure is more mature than Open Stack, but is also less flexible, as it is not really extensible beyond the Windows ecosystem.

We expect Microsoft will continue to occupy a strong position in mid-market and departmental deployments, where customers demand simplicity. Azure brings some incremental flexibility as applications evolve towards continuous iteration, continuous delivery. Also can deliver on symmetry between internal private cloud deployments, based on Windows Server and the public cloud Azure service.

Our conclusion on Microsoft is that its markets will become more competitive if Open Stack is successful, as it gives customers another alternative. However, we believe Microsoft is better positioned with intellectual property (versus providing hardware or services) among the large cap technology companies, as cloud frameworks are adopted. For the time being though, Microsoft shares seemed governed by the trajectory of PCs and this market remains challenged in 1H13. We expect that in 2H13 stabilization of PCs on the back of new form factors will be a positive catalyst for the shares.

## Oracle

The majority of Oracle's revenue comes from core, legacy enterprise applications that don't change quickly. Oracle database (70% of profits) and applications (20% of profits) can be deployed on whatever infrastructure a customer prefers (scale up Unix, scale out x86) and that could include Open Stack. However we assume that customers will keep legacy workloads on traditional infrastructure. Thus Open Stack is largely orthogonal to Oracle.

The company did acquire Nimbula, a private company in the crowded cloud management space. Nimbula specialized in bringing Amazon-AWS like API integration to applications and had recently pivoted to focusing on Open Stack. We assume Oracle will use this technology in its recently announced public cloud service as well as potentially developing hardware appliances optimized for Open Stack. Given Oracle's revenue stale (\$50B) we don't expect that Open Stack is a meaningful driver for Oracle.

## CA / BMC

We believe a re-platforming in the industry from client server to web to cloud is causing customers to revisit the tools they use to run their data center and IT operations. As leaders in the last generation of IT management tools, we believe CA (CA.O; US\$24.45; 2) and BMC (BMC.O; US\$44.03; 2) have a lot more to lose than to gain as this shift happens.

BMC acquired automation and orchestration technology right before virtualization took hold in the datacenter for production apps and these technologies are no longer market leading (BladeLogic, etc.), although the installed bases are large and valuable. This installed base gives BMC the opportunity to be a leader in the next generation if its technology innovation keeps pace. Thus far, its Cloud Lifecycle Manager products has had significant fanfare and marketing focus, but we understand its real traction in the market has been underwhelming. We believe the company recently lost one of its largest reference customers (also a strategic systems integrator) and we now believe BMC lacks the ability to acquire and invest to keep pace. As a result, we expect the evolution towards cloud-centric management tools will slowly erode BMC's ESM business, something that is already underway. Our fundamental view of the business remains negative and the stock outcome likely governed by interest from a financial buyer.

CA has more flexibility to invest, as its mainframe business is larger and the company has more room to cut costs in its ES business in order to fund new investments. The company has made some interesting acquisitions in the cloud area, notably ITKO and 3Tera, which brings cloud deployment and simulation technologies that are pieces of the solution. We expect the company to focus more on investing in internally developed technology (versus acquisition) and this could bolster its position in cloud. However, many of the company's traditional tools in management of distributed systems are likely to be made more vulnerable by the re-platforming happening in the data center. While our fundamental view is more positive than with BMC, we believe on the stock side, new CEO Mike Gregoire needs to invest as noted above, putting a cap on margins. Also, the aggressive dividend of \$1/share isn't likely to go higher. Our stock view is Neutral as we see support in the mid-20s from the dividend, but we don't see a catalyst for upside towards \$30.

### ServiceNow

ServiceNow (NOW.N; US\$35.63; 1) has come into many customers as they move toward the era of delivering IT as a service and thus the company is well positioned for this new era, of which “cloud” is a part. We believe this general re-platforming is benefiting the company, however as we expect enterprise adoption of Open Stack to lag, we believe other demand drivers for Service Now, most notably backlash against on-premise software upgrades, lack of innovation by peers in IT management (BMC, CA, HP and IBM) as well as the company’s continually expanding value proposition are more important drivers than Open Stack and cloud.

### Network security

As we noted earlier, the networking part of Open Stack is very early, with just the second iteration of the Quantum project in the recent Grizzly release. Security is a key service on the network. A significant change in the network could have an impact on security architecture, particularly how security policy is enforced. IN a world where the network is defined in software, security enforcement must be done in software as well, as opposed to specialized hardware. We note in our coverage universe, there are different approaches product design and this has different implications for how products would work in a software-defined networking world, such as what is designed into Open Stack Quantum.

Of the four core network security companies we cover, Check Point (CHKP.O; US\$45.50; 1) and Sourcefire (FIRE.O; US\$52.58; 2H) run their technologies on commodity hardware while Fortinet (FTNT.O; US\$18.07; 2H) and Palo Alto Networks (PANW.N; US\$51.94; 2H) use proprietary hardware in their appliances. We understand that Palo Alto has on its near-term roadmap a hardware independent version of its gateway, while we don’t believe Fortinet has that in the works. Given that network is the least mature part of Open Stack, we believe the impact of anything from Open Stack is not the most significant driver of business for any of these companies noted in network security.

### Symantec

Symantec (SYMC.O; US\$23.78; 1) has significant IP in the storage area, which could be leveraged in Open Stack. For example, data protection and file system / volume management that could have applications in cloud-based environments. We believe the company is very early in building product here and also we believe there are more significant drivers of the business in the next 2-3 years other than Open Stack. As evidence of this, the company has not yet joined the OpenStack foundation. For the stock, we believe revenue is a tertiary consideration right now, with margins and capital structure the first and second most important drivers.

### SaaS companies

We see Open Stack as technology that our SaaS companies (CRM (CRM.N; US\$167.35; 1), JIVE (JIVE.O; US\$14.22; 2H), WDAY (WDAY.N; US\$58.99; 2), NOW) could leverage to driver more efficiency in their infrastructures. While there is no top-line impact, this could help margins. We noted Workday had a significant representation at the Open Stack Summit in Portland this week.

## Appendix A-1

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