



**GIGAOM** RESEARCH

# Infrastructure-as-a-Service basics: a guide for IT pros

---

Janakiram MSV

a cloud report

# Infrastructure-as-a-Service basics: a guide for IT pros

12/17/2013

## **TABLE OF CONTENTS**

---

1. EXECUTIVE SUMMARY
2. WHO IS BEHIND THE IAAS MOMENTUM?
3. BUILDING BLOCKS OF IAAS
4. TOP 10 FACTORS TO CONSIDER WHEN CHOOSING AN IAAS PLATFORM
5. OVERVIEW OF THE KEY PLAYERS
6. CONCLUSION AND KEY TAKEAWAYS
7. ABOUT JANAKIRAM MSV
8. ABOUT GIGAOM RESEARCH
9. COPYRIGHT

Though it started as a phenomenon primarily driven by startups, public cloud is gaining traction among all customer segments including large enterprises. When compared to Platform as a Service (PaaS) and Software as a Service (SaaS), Infrastructure as a Service (IaaS) is growing at a significant rate. According to Gigaom Research, by 2014 the worldwide cloud market is estimated to grow 126.5 percent, driven by 119 percent growth in SaaS and 122 percent growth in IaaS.

Customers choosing public cloud IaaS need to consider a variety of parameters that include the choice of virtual machine types, operating systems, billing models, purchase options, and SLAs, among others. This information is crucial for decision makers. But this data is fragmented across various sources making it hard to make the right choice.

This report emphasizes the key factors that need to be considered when choosing an IaaS provider. It highlights the capabilities of each player in a concise form so that decision makers can easily compare and contrast the offerings.

Since the IaaS industry is experiencing a price war that's forcing the key players to drop prices almost on a quarterly basis, this report doesn't attempt to compare the cost structure of each provider. Instead, it captures all the crucial factors that go into choosing an IaaS provider.

This report doesn't attempt to benchmark the performance of the IaaS offerings. This is best left to customers since each workload and deployment is unique and demands a different level of technical benchmarking.

This report covers the following:

- Evolution of the IaaS market and the key contributors
- Building blocks that form the foundation of cloud infrastructure services
- Important factors that need to be considered when choosing IaaS
- Analysis of the key players of IaaS market
- Comparison of the services offered by the key players

*Thumbnail image courtesy of [Flickr user Max Klingensmith](#)*

## Who is behind the IaaS momentum?

---

No one ever predicted that a set of web services offered by an online bookstore would pave the way to a new IT business model. Back in 2006 Amazon exposed Storage as a Service (Amazon S3) followed by the queuing service (Amazon SQS) before opening up virtualized servers on subscription (Amazon EC2). Since then many vendors have entered the IaaS market to claim their stake.

Early adopters of IaaS moved web workloads that required scalability and elasticity. The next step in IaaS adoption was setting up development and test environments in the public cloud. As the public cloud providers matured, enterprises started to consider migrating line of business applications that did not necessarily demand elasticity but a reliable infrastructure. Today we come across a variety of workloads ranging from corporate directory services to business intelligence to collaboration software hosted on the public cloud. Many enterprise customers are actively evaluating the move to IaaS by comparing the returns on investment of traditional hardware and the operating expense (OPEX) model of cloud infrastructure services.

A year ago, the choice of public cloud providers was limited. Amazon Web Services was the first choice to host a variety of workloads. But today the scenario is very different. In 2013, we have seen two major players — Microsoft and Google — enter the IaaS market aiming to be an alternative to Amazon Web Services. HP went live with its public cloud in May 2012 and since then it has been regularly adding new features. Rackspace has converged its traditional IaaS platform with OpenStack and, with the momentum behind the OpenStack initiative, expects to drive adoption. With viable alternatives to AWS that compete both in features and cost, it is increasingly becoming complex to choose the right infrastructure to host applications in the cloud.

With the exception of Amazon, most of the IaaS players come from a traditional business model that logically positions them to play in the infrastructure services arena. These vendors are on an aggressive path to offering infrastructure services that compete with AWS. These providers that are transforming the market come from a variety of backgrounds. They have decades of experience in managing data centers and a few are well positioned to sell services in a subscription model.

Below is a classification of typical IaaS vendors.

### **Hosting providers**

It was inevitable that the traditional hosting providers would evolve into cloud providers. With a business model that is shifting from capital expense (capex) to opex, the hosting business is under threat. Hosting companies are transforming into IaaS providers, investing in data centers and the base infrastructure. Some of the well-known cloud providers like Rackspace and GoGrid started as hosting companies before making a mark on the IaaS market. These players continue to innovate using their decades of experience in dealing with developers and businesses.

## **Platform vendors**

Traditional platform vendors have no choice but to offer their platforms on the cloud. Microsoft built Windows Azure as a PaaS solution for .NET developers. Though Google didn't own a language runtime, it was one of the first players to offer a Python and Java-based PaaS solution called Google App Engine. Oracle also made attempts in bringing its Fusion platform to the cloud. Red Hat is doing the same with JBoss and OpenShift. Interestingly these players are the ones who started with a PaaS but realized the IaaS opportunity at a later point. Microsoft evolved Windows Azure to an IaaS offering through Windows Azure Infrastructure Services (WAIS) and Google launched Compute Engine. VMware also entered the public cloud with Cloud Foundry before announcing its vCloud Hybrid IaaS strategy. We can expect to see more PaaS players entering the IaaS space.

## **Telecom providers**

Leveraging their relationship with enterprise customers, telecom providers are logically positioned to offer IaaS. With bandwidth, MPLS, and CDN services, telcos have most of the crucial elements of IaaS already in place. Some of the telcos also have colocation and data center offerings, which makes it logical for them to play in this space. AT&T, Verizon, NTT, and Tata Communications are examples of IaaS players with a solid telecom background.

## **IT solution providers**

Most of the system integrators and solution providers manage end-to-end infrastructure for customers including the networking, servers, desktops, and applications. With many enterprises preferring to outsource their IT to a third party, this business is booming. Many system integrators are also managed service providers taking over internal IT by offering SLA-driven support. They also have a large infrastructure management services (IMS) and remote management services (RMS) practice, which includes managing IT back ends of global enterprises. These system integrators are now turning into IaaS businesses by extending their offerings. Examples of these IaaS players include CSC and SunGard.

## Hardware vendors

When IaaS entered the mainstream, it was expected that the hardware vendors would be negatively impacted since all the physical servers would be dumped in favor of virtual machines (VMs). Realizing the threat, traditional hardware vendors started entering the IaaS business by leveraging their strengths. Hardware vendors have a successful channel and sales ecosystem combined with a loyal enterprise customer base. They can tap into their reseller network to sell cloud services along with the physical servers. HP is a classic example of a hardware vendor turning into an IaaS provider with HP Cloud Services. IBM also has a public cloud offering in the form of IBM SmartCloud and its acquisition of SoftLayer.

## The IaaS ecosystem



*Source: Janakiram MSV/Gigaom Research*

Excluding Amazon Web Services, most of the cloud service providers can be classified into one of the categories listed above.

## Building blocks of IaaS

---

Cloud infrastructure services have evolved rapidly over the last two years. Initially most of the IaaS vendors offered virtual servers on a subscription model. This was the logical evolution of web hosting, colocation and the virtual private server (VPS) business models. This was followed by storage services as the majority of customers running their applications on virtual machines needed separate storage to serve static content. As the complexity of the applications hosted on VMs grew, there was a need to introduce firewalls, load balancers, and routing tables that closely emulated on-premise topologies. This forced the service providers to bring networking capabilities to the infrastructure. Since databases are a key component of applications, IaaS providers added managed databases to their portfolio. This freed the customers from performing regular DBA operations on their hosted databases. Thus, virtual servers, storage, networking, and databases became the core of cloud infrastructure services.

Let's take a closer look at each of these building blocks.

### **Compute**

Compute is the lowest common denominator of the IaaS stack. It translates to the virtual machines that can be launched in just a few minutes. Each provider offers a catalog of server templates known as images that are launched as VMs based on predefined configurations. Customers can choose from a variety of configurations that differ in the number of cores, CPUs, memory, disk space, and I/O capabilities. Each VM can be saved as a custom template that can be used to launch additional VMs on demand. This makes it possible to bring elasticity to cloud applications.

### **Storage**

With the explosion of media and user-generated content on the web, contemporary applications need a scalable and durable storage engine. By serving the media and content from a dedicated storage engine, developers can reduce the load on web servers. Traditionally, this dedicated storage was available in the form of a storage area network (SAN) or network-attached storage (NAS) that was a part of the physical infrastructure. With IaaS, storage is offered as an independent service that can be subscribed to separately. The flavor of storage service that serves static content is called object storage while the storage that is attached to VMs is called block storage. Mature providers extend their object storage service by linking it with a content delivery network (CDN) that decreases the latency to access static content. Block storage can be thought of as a USB disk that can be plugged into a VM that can be formatted like any other disk. To enhance the performance of Block Storage, some providers are moving the back-end storage to solid-state drive (SSD) devices.

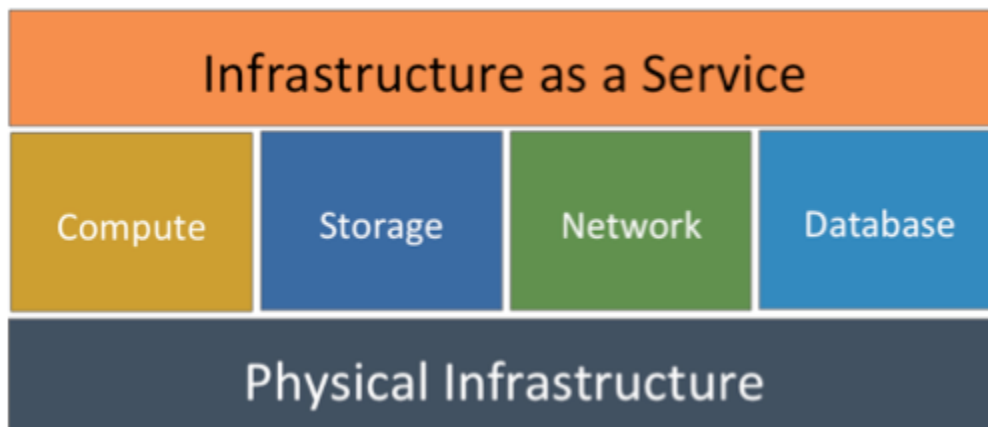
## Network

Both physical and virtual infrastructures have networking at their core. With compute and storage offered as services, the providers had to surface the networking capabilities on the cloud. The basic networking capabilities include a firewall service and load balancers. Since VMs launched on the public cloud are exposed to the public, it is important to have a firewall associated with each virtual server. Similarly, a load balancer is essential to route the traffic across a fleet of virtual servers that are dynamically launched. Almost every IaaS provider offers these basic networking features. Enterprises, however, need more than the basic abilities since their deployments have complex needs and topologies. Some providers go beyond the basics to offer virtual subnets, dedicated MPLS connectivity and VPN integration. These features form the core of hybrid cloud where mission critical applications continue to run on-premise while the front-end applications are hosted on the public cloud. The emergence of software-defined networking (SDN) will take the network services of IaaS to the next level.

## Database

There is a debate on whether Database as a Service (DBaaS) should be considered part of IaaS or PaaS. Though databases are part of almost all PaaS offerings, they are quickly becoming the key building blocks of IaaS. While customers can always launch VMs and set up a database of their choice, the DB service is different because it is set up, configured, managed, and monitored by the infrastructure service provider. Popular databases, including MySQL, Oracle, Microsoft SQL Server, and PostgreSQL are offered as services. Apart from the relational databases, some vendors also expose NoSQL databases as a service. Subscribing to these DB services enables customers to stay focused on their core application instead of managing and administering a database.

## The building blocks of IaaS



*Source: Janakiram MSV/Gigaom Research*



## Top 10 factors to consider when choosing an IaaS platform

---

Given the disparity and variation in IaaS services, comparing these providers is not straightforward. But there is a set of parameters that can be considered by potential customers to assess the strengths of each service provider.

Cost is not a major differentiating factor among the providers, as almost all the vendors are dropping prices to stay competitive. Customers are considering performance and maturity as key factors when choosing the right platform.

This section explains some of the key factors that should be considered when choosing an IaaS offering.

### **10. Platform completeness**

While there are dozens of IaaS providers, very few go beyond the basics. Platform completeness includes additional application and management services that the service provider offers beyond the core services mentioned in the last section. These additional services extend the building block services and deliver more value to their customers. For example, extending a storage service to a CDN, offering high-performance computing (HPC) and parallel processing built on top of compute, and extending the database service to business analytics and data warehousing will deliver more value and an integrated experience for customers.

### **9. Choice**

IaaS offers flexibility to customers but lack of choice can be a deterrent to the adoption. Customers want choice at every level from the operating systems to the virtual machine specifications to the language bindings of the API. An IaaS provider offering the latest Linux distributions from Red Hat, CentOS, Canonical, and SUSE, along with the availability of Windows Server 2012 and Windows Server 2008 R2, gives confidence to customers that the platform will be updated regularly. Similarly, if the database is offered as a service, customers want MySQL, Oracle, Microsoft SQL, and PostgreSQL. The SDKs that wrap the API should also be made available in popular languages including Java, PHP, Ruby, C#, Python, and Node.js.

### **8. Geographical footprint**

Many IaaS customers start small with their user base concentrated around a specific geography. But as they grow and target global users, their infrastructure must expand to

support that global customer. Cloud brings the benefit of targeting global customers with low investment. It is important to understand the number of data centers and locations that an IaaS provider is present in. They should have at least a data center in each of the continents. Having presence in additional geographies through edge locations is a bonus. This would make it manageable for customers to run multiple workloads targeting multiple geographic locations across the globe.

## **7. Mature API**

One of the biggest benefits of the cloud is automation. Automation reduces the error rate and makes it productive for customers to perform repetitive tasks. It also makes it easier to integrate with existing workflows and processes. Though many IaaS providers offer rich web interfaces to manage deployments, they completely ignore the API to perform the same tasks programmatically. This may not look like an important factor to be considered but as customers start investing more, they realize the limitations. For example, a developer might want to integrate IaaS with the workflow of an on-premise system that sends a newsletter to a million customers and then launches additional servers that can withstand the load. Lack of an API or an immature API will make this task very complex.

## **6. Partner ecosystem**

It is important to assess the quality of the partners that support the IaaS platform. A rich partner ecosystem is a sign that the industry has confidence in the vendor and wants to make them successful. Since IaaS is becoming an extended data center for many organizations, support from OS vendors, database vendors, security providers, ISVs, and developers is critical. For example, if the database powering your on-premise application is not certified to run on your IaaS provider, you cannot migrate the application. Similarly, your VPN device should be supported by the IaaS to enable hybrid cloud capabilities. Finally, a thriving marketplace or a store listing all the certified and supported software is an indication of the maturity of the provider.

## **5. Support**

Though most of the IaaS providers offer excellent self-service portals and dashboards, customers need support in resolving issues related to their deployments. Support services offered by vendors have multiple tiers that include basic, developer, corporate, and enterprise plans. Customers should carefully evaluate the response time and the cost of each tier when considering an IaaS platform.

## **4. Rapid innovation**

Unlike traditional software, the innovation cycle involving cloud services is short. Customers realize the additional features and enhancements introduced to the platform almost instantly. Rapid innovation indicates commitment and an active investment by the service provider. Customers should consider the key features and enhancements added during the last two quarters to assess the pace of innovation.

### **3. Compliance**

One of the key criteria for choosing a cloud platform is the compliance and adherence to industry standards and certifications. As enterprises representing key verticals including government, finance, health care, and retail consider their move to the cloud, compliance becomes an important factor. Depending on the industry and vertical, it is important to check for compliance support. Certifications and attestations including SOC 1 (formerly SAS 70), PCI DSS Level 1, ISO 27001, FISMA, ITAR, and HIPAA give some confidence to migrate and run sensitive workloads on public cloud infrastructure.

### **2. Service-level agreements (SLAs)**

SLAs are there to ensure a minimum uptime of compute and storage resources. It is important to understand the terminology chosen by the provider to depict the data center (availability zone) and a group of data centers (region) that are typically covered under the SLA. Most of the IaaS providers commit an uptime at the region level over the course of the year practically making the SLA useless. Customers should read the fine print to carefully assess the granularity of the SLA involving the resource, uptime percentage, financial credit, and exclusions. Though downtime and service disruption are faced by almost every provider, how they handle it matters the most. Customers should look at the track record of the service provider for both the uptime and the graceful handling of a service disruption.

### **1. Security**

Security is the top concern among enterprise customers. Cloud service providers offer a variety of security-related services to increase customer confidence. Though cloud security is a shared responsibility, customers should check for multi-factor authentication, secure endpoints for APIs, firewalls, server-side encryption of data, VPN tunneling, and secure management of keys. Mature cloud service providers constantly strengthen security and provide guidance to customers.

## Overview of the key players

---

The key players within the IaaS landscape are Amazon, Google, HP, Microsoft, and Rackspace. They are shortlisted based on features, maturity, adoption, and their partner ecosystem.

### Amazon Web Services

Launched in 2006, Amazon Web Services (AWS) has evolved into a full-blown cloud services platform. As an early entrant, AWS set a standard for APIs, SLAs, and the self-service capabilities that are followed even by its competitors.

AWS is present in nine different locations — or Regions — across the world. Each Region has at least two independent, isolated, and symmetrical data center facilities called Availability Zones (AZ). Amazon recommends that customers deploy their applications across multiple AZs to get high availability and redundancy.

[Amazon EC2](#) is the flagship service of AWS that is widely used by customers. One of the first compute services to be offered on the cloud, Amazon EC2 has matured since its general availability in 2008. It scores high when it comes to the choice of geographic locations, VM types, OS support, purchasing options, and ecosystem support. Amazon constantly adds features based on customer feedback. Enterprises migrating I/O-intensive workloads running Oracle and SAP demanded better I/O throughput, and AWS responded with the announcement of a high storage instance type powered by SSD. Microsoft, Oracle, Red Hat, SAP, and IBM are among the software vendors to certify Amazon EC2 to run their enterprise software. Customers can choose an on-demand purchase option where they are billed for each hour of consumption. Reserved instance pricing offers discounts on the hourly price to customers willing to pay upfront for either one-year or three-year terms. Customers can also bid for spot instances whose pricing is typically lower than on-demand pricing. With the right planning, customers can align VMs with an appropriate purchasing option to take advantage of flexible pricing.

[Amazon S3](#) is the AWS storage service, which is widely used by both web companies and enterprises. While web companies use it to store static content accessed by their customers across the globe, enterprises started to treat Amazon S3 as an alternative to tape backups. According to a [report](#) published in April 2013, there are over two trillion objects stored on Amazon S3 with the API peaking at 1.1 million calls per second. This service is the storage backbone of many popular AWS services including [Elastic Block Store \(EBS\)](#), [Amazon Relational Database Service \(RDS\)](#), [Amazon Elastic MapReduce \(EMR\)](#), [Amazon CloudFront](#), and [Amazon Storage Gateway](#).

[Amazon Glacier](#), the low-cost archival service, heavily relies on Amazon S3 for storing and retrieving backups. Amazon Storage Gateway is a virtual appliance that enterprises can deploy to automatically backup rarely accessed data to the cloud. Amazon's CDN service, Amazon CloudFront is tightly integrated with S3 to deliver content through edge locations spread across the globe.

[Amazon Virtual Private Cloud](#) (VPC) is the preferred way of using AWS by enterprise customers. It lets customers create an isolated section within the public cloud to deploy sensitive workloads. This is done by creating virtual networks that are highly customized and controlled. Public-facing servers are typically deployed in a public subnet and back-end systems like application servers and database servers are deployed within the private subnet, which is not accessible on the public domain. When combined with [AWS Direct Connect](#), which offers dedicated connectivity between a corporate data center and AWS Region, Amazon VPC offers the most secure way of extending the infrastructure to the cloud. Customers from the financial and public sectors and healthcare verticals leverage this service when migrating workloads to the public cloud.

[Amazon Relational Database Service](#) (RDS) is the Database as a Service offering from Amazon. It was initially started with MySQL. AWS then added support for Oracle and Microsoft SQL Server. By supporting high-availability features like Multi-AZ deployments and read replicas, customers find it convenient to run the data tier in Amazon RDS. By launching the Amazon RDS database instance within Amazon VPC, the data tier can gain additional security. Amazon has yet to bring supported features of Oracle and MS SQL at par with MySQL. To support high throughput and performance, Amazon recently launched a high-memory RDS instance type with 244 GB and 88 compute units, making it ideal for running enterprise, social media, and gaming workloads. [Amazon Redshift](#) is optimized for fast query and I/O performance when analyzing large datasets. Though not related to Amazon RDS, Amazon Redshift plays a key role in Amazon's enterprise strategy as it is gaining popularity among customers considering moving their data warehouse to the cloud.

Amazon is leading the IaaS revolution by catering to the needs of a diverse customer base. While it enjoys popularity among startups, services like Amazon Redshift, Amazon Storage Gateway, and AWS Direct Connect are designed to appeal to the enterprise. [AWS Marketplace](#) makes it easy to evaluate software on the cloud with one-click access to a variety of software stacks. It has hundreds of pre-configured Amazon EC2 images to choose from in software infrastructure, developer tools, and business software categories.

Amazon is expected to enter the private cloud market to effectively compete with Microsoft and VMware in the enterprise segment. Services like Amazon Storage Gateway and [Amazon DynamoDB](#) have local versions giving enough hints that other popular services may become available for on-premise usage. Eucalyptus, the open-source private cloud software, supported compatibility with the AWS API for a long time.

Last year it [announced](#) a partnership with AWS to officially work on the APIs. The recent [deal](#) between AWS and the CIA to build a private cloud also indicates the interest Amazon has in the private cloud space. Going by this, it would not be surprising to see a private cloud version of AWS in the future.

Despite fast-paced innovation, AWS customers want [certain features](#) to be fixed, which Amazon should address in the short term. To reach enterprise customers, it has to strengthen the reseller channel and enterprise sales team. This investment also helps AWS to compete with Microsoft and HP. Amazon's customers complain about the quality of support in terms of cost, guidance, and turnaround time. It should augment customer support to make it affordable and accessible.

## Rackspace

Originally started as a web hosting company, Rackspace transformed into a cloud infrastructure company in 2008 by acquiring virtual private server (VPS) provider, SliceHost. Rackspace is one of the few infrastructure providers to offer classic web hosting, colocation, private cloud, public cloud, and hybrid cloud. Apart from these, Rackspace also offers hosted email powered by Microsoft Exchange.

In 2010, Rackspace and NASA jointly announced an open-source cloud controller software called OpenStack. Rackspace's public cloud is now powered by OpenStack, which is also offered to customers as private cloud software.

Rackspace Cloud is available across five regions covering U.S., Europe, and Asia. As of September 2013, it is available in Dallas, Chicago, Northern Virginia, London, and Sydney with Hong Kong to be launched soon.

The compute service of Rackspace called [Cloud Servers](#) is an incarnation of the OpenStack compute project. Cloud Servers supports the latest versions of Microsoft Windows along with the popular flavors of Linux.

Originally launched as Mosso CloudFS in May 2008, [Rackspace Cloud Files](#) is the storage service that is powered by the OpenStack storage project. Rackspace has partnered with Akamai for the CDN service. This partnership enabled both players to compete with Amazon and Microsoft who also offer cloud storage combined with a CDN service.

[RackConnect](#) is the networking service from Rackspace for customers considering an hybrid cloud architecture. By connecting a corporate data center with Rackspace Cloud Server VMs through a VPN connection, customers can extend their IT infrastructure to

the cloud. When compared to Amazon VPC, RackConnect offers additional capabilities to load balance both physical and VMs together offering additional flexibility. Customers can leverage RackConnect to integrate servers within the colocation environment and the cloud.

[Rackspace Cloud Database](#) is a managed database offering that exposes MySQL as a service. It claims to be faster than Amazon's offering, and uses high-performance SAN on a dedicated network to achieve higher input/output operations per second (IOPS). According a report [published](#) by Rackspace, Cloud Database delivers 51 percent more transactions than Amazon RDS.

Rackspace has made the distribution of the OpenStack software that powers its public cloud [available](#) for customers, marking the official entry of Rackspace into the private cloud market. Though the software is free, Rackspace hopes to generate revenue through training and certification, professional services, managed services, and support.

Rackspace is not as fast-paced as AWS in launching new features and services, but it is the preferred choice by many users for its customer support — a key differentiating factor. Rackspace officially calls it [Fanatical Support](#), emphasizing a high level of commitment to its customers. With an army of Red Hat and Microsoft certified engineers, Rackspace goes beyond infrastructure support to fix the issues with workloads.

The company is still transitioning from the first-generation infrastructure based on the Mosso platform to OpenStack. Despite being the founding member of the OpenStack initiative, it is finding it hard to compete with other players. Rackspace's ability to advance its platform is directly tied with OpenStack's progress. Given the fact that OpenStack is still evolving, Rackspace is severely impacted by it. Being a reputed hosting provider, it is trying to leverage its investments across private, public, managed, and hybrid clouds. The fanatical support promise seems to be working for Rackspace as customers sing the praises of its responsive and dedicated support teams.

OpenStack is gaining attention from the ecosystem and like most open-source software, it is influenced by the companies with large numbers of developers dedicated to it. Red Hat is leading the contribution to OpenStack and it has already announced a distribution that is optimized to run on its Red Hat Enterprise Linux platform. Though one of the founding members of the OpenStack foundation, Rackspace is finding it tough to match the contribution of a platform company like Red Hat. On the other hand, HP, AT&T, and others have also gone live with OpenStack-powered public clouds. It will be interesting to watch how Rackspace maintains its position in the crowded OpenStack ecosystem.

## Microsoft Windows Azure

Windows Azure went live in 2010, originally launching as a PaaS offering. Microsoft continued to add new features with an aim of making it a rich .NET PaaS. Since then, Windows Azure has evolved into an IaaS platform and richer set of PaaS services beyond .NET.

Windows Azure data centers are available in eight locations across North America, Europe, and Asia, with two new data centers announced in Australia.

[Windows Azure Cloud Services](#) expose the PaaS capabilities of the platform by enabling developers to deploy code and run it on scalable infrastructure. Though preferred by .NET developers, Windows Azure PaaS can host Java, PHP, Ruby, and Node.js applications. In June 2012 Microsoft announced the availability of VMs on Windows Azure, bringing the infrastructure services to the cloud platform. This also reduced the gap between AWS and Windows Azure. [Windows Azure Infrastructure Services](#) support running popular distributions of Linux except Red Hat Enterprise Linux. Oracle has certified Oracle Linux and WebLogic servers to run on Windows Azure.

[Windows Azure Storage](#) is one of the original building-block services launched as a part of PaaS. The Windows Azure storage service consists of three components: blobs, tables, and queues. It offers durable and highly available storage in the form of blobs. This service is utilized by Windows Azure Cloud Services and Infrastructure Services to maintain the disks that contain the OS and data. According to an official Microsoft [blog post](#), Windows Azure blob storage hosts more than 8.5 trillion unique objects making it one of the most used cloud storage services. Microsoft acquired a startup, [StorSimple](#), which provides a virtual appliance for the enterprises to seamlessly archive data to Windows Azure Storage. Windows Azure CDN service is integrated with storage to enable the delivery of content through the network of edge locations.

[Windows Azure Virtual Network](#) enables creation of a logically isolated section in Windows Azure to securely connect to an on-premises data center or a single-client machine using an IPSec connection. Virtual Network makes it easy to extend a corporate data center using Windows Azure much in the same way that a remote branch office is set up and connected. Once created, all virtual machines and services can be pointed to a DNS server on-premises or a DNS server running in a virtual network. Customers can use their own domain controllers in Windows Azure. Customers running deployments across PaaS and IaaS use virtual networking as a bridge. Microsoft recently [announced](#) a partnership with AT&T to provide peering to its data centers in the U.S. This is similar to Amazon's Direct Connect feature that enables connecting corporate data centers to one of the regions of the cloud provider.

[Windows Azure SQL Database](#) is a fully managed relational database service that incorporates proven SQL Server technology. SQL Database server is logical group of



databases. Within each logical SQL Database server, customers can create multiple databases that have tables, views, stored procedures, indices, and other familiar database objects. Windows Azure SQL Database is available in three flavors: web, business, and premium. Web and business editions run on shared resources with the data replicated within a data center. Premium, which is currently in preview, offers a dedicated, fixed amount of capacity that is not shared with other databases. Customers running non-Microsoft SQL Server workloads on Windows Azure consider deploying the database in VMs.

One of the limitations of Windows Azure platform comes in the form of IOPS. According to the [official documentation](#), each disk can support only 500 IOPS. This severely impacts the performance of enterprise workloads like ERP and OLTP databases. Amazon's provisioned IOPS-based EBS volume supports up to 4000 IOPS, making it ideal for running complex enterprise applications. Though it is possible to overcome the IOPS limitation on Windows Azure, it is complex and expensive to configure disks to achieve higher throughput.

On the lines of AWS Marketplace, Microsoft has launched a library of preconfigured VM images called [VM Depot](#). Still in preview, it showcases the partner support and the availability of third-party software on Windows Azure.

Microsoft Windows Azure is inching closer to AWS in terms of completeness. With the addition of IaaS to its platform, Microsoft hopes to get traction in the market. But performance seems to be the biggest hindrance to Windows Azure adoption. Microsoft should invest in high-performance, SSD-based storage to immediately address the IOPS issue of Windows Azure Infrastructure Services. Lack of support for Red Hat Enterprise Linux is also hurting the chances of migrating enterprise workloads running on Linux.

## Google Cloud Platform

Google entered the cloud services world through [Google App Engine](#), which was launched in 2008. Since then, it's continued to add key building-block services to create Google Cloud Platform. With its investments in platform, infrastructure, storage, big data, and analytics, Google Cloud Platform is one of the most comprehensive cloud platforms in the market.

A recent addition to the Google Cloud Platform, [Google Compute Engine](#) (GCE), brought the IaaS capability. Google has focused on performance as a key differentiator of the platform. Currently GCE is still in preview mode and only available in the U.S. and Europe. Each of these regions has independent and isolated facilities in the form of zones. GCE only supports Debian and CentOS based VMs and doesn't support Microsoft Windows Server. Google's strategy is to acquire enterprise customers by making the

platform faster and high performance. It is one of only a few compute services that can be considered as a potential alternative to Amazon EC2.

Compatible with Amazon S3 APIs and tools, [Google Cloud Storage](#) service is a potential competitor to Amazon S3 and Windows Azure Storage. Though Google doesn't officially mention the integration of CDN, some performance tests [demonstrate](#) that Google actually caches the static content across the servers in its global network. Google doesn't explicitly expose a virtual network like Microsoft and Amazon but has a mature networking stack integrated with GCE. It is possible to create subnets that isolate private and public workloads securely.

[Google Cloud SQL](#) is the database building-block service that offers managed MySQL in the cloud. Launched in 2011, the database engine supports MySQL version 5.1.59 with the maximum supported database size of 100 GB. Customers requiring additional database support can install them on the VMs running within GCE.

Google is adding more capabilities to the cloud platform that appeal to enterprises. It recently added a load balancer to the stack to enable customers to scale out their workloads. Initial [reports](#) indicate that GCE is faring better than Amazon EC2 on multiple performance fronts.

Since it was previously criticized for not being serious about its cloud platform, Google entered the IaaS market with a feature set that looked compelling. With support for a wide range of VM types and focus on performance, GCE is well received by customers. However, lack of OS choice and hybrid cloud capabilities will hurt Google's chances in the market. It should also gain the support of the ecosystem by roping in ISVs and platform vendors.

## HP Cloud Services

HP Cloud Services launched in the middle of 2012. It is one of the first commercial IaaS offerings powered by OpenStack. HP aims to be a complete, full-service public cloud by offering the core building-block services, application services, and management services. It is leveraging its partner ecosystem and relationships with enterprise customers to become a viable "enterprise" cloud platform.

[HP Cloud Compute](#) offers VMs based on KVM virtualization powered by OpenStack running across its data centers in the U.S. East and West. Though based on OpenStack, it doesn't support import/export of VMs from other OpenStack-based private clouds. While most of the features are common to the IaaS players, HP claims that the SLA is the differentiating factor. HP's SLA covers failure even for single VMs running in a single

availability zone. According to a [report](#) published by Cloud Spectator, a IaaS performance-metrics company, HP Cloud Compute scored better than the competition.

[HP Cloud Object Storage](#) is based on OpenStack storage service. Since both Rackspace and HP Cloud are based on OpenStack, they offer similar capabilities. Both Rackspace and HP partnered with Akamai for the CDN capabilities.

Instead of exposing the network stack as a self-service, pay-by-use, and configurable option, HP chose to bundle it with its enterprise cloud services offering. Enterprise Services-Virtual Private Cloud is the service that an enterprise must pay for upfront. HP doesn't disclose the cost of setting up and managing the virtual private cloud as it may charge customers based on their deployment. It is not clear if HP will expose the advancements in the OpenStack networking stack based on SDN. Lack of a self-service virtual networking service is a drawback for HP to compete with AWS, which has a powerful component in the form of Amazon VPC.

[HP Cloud Relational Database](#) service is the Database as a Service exposing managed MySQL capabilities. It offers the standard set of features like DB import/export, backups, and resizing of the DB servers, but there is no uniqueness to this service. Customers hosting web and application servers within HP Cloud Compute services may use this service.

HP has [partnered](#) with a diverse set of players to bring features like mobile back end, application platform services, and Hadoop. It became generally available in December 2012, though HP hasn't published customer case studies. There was [mention](#) of Workday, a popular SaaS provider of payroll systems, migrating from AWS to HP Cloud during the HP Discover event. This was followed by a [clarification](#) from HP that Workday continues to run on both AWS and HP.

HP's [Public Cloud](#), [Cloud OS](#), and [Converged Cloud](#) initiatives revolve around OpenStack. However, it has yet to take advantage of these investments. With the executive transitions that took place in the recent past, HP is hoping to consolidate and strengthen its cloud strategy. Like Microsoft, HP is planning to leverage its enterprise connections, reseller channel, and sales force to drive customers to its public cloud.

## How do they stack up?

These platforms are competing to become the choice of enterprise customers by offering a variety of services. The following table examines the various capabilities and services side by side.

Service	Feature	AWS	Windows Azure	Google Cloud	Rackspace	HP Cloud
Geographical Presence	Number of Regions	9	8	2	2	5
	North America	Yes	Yes	Yes	Yes	Yes
	South America	Yes	No	No	No	No
	Europe	Yes	Yes	Yes	No	No
	Asia Pacific	Yes	Yes	No	No	No
Compute	VM	Elastic Compute Cloud	VMs/Roles	Compute Engine	Cloud Servers	Cloud Compute
	Parallel Processing	Elastic Map Reduce	HDInsight	BigQuery		
	HPC	Cluster Compute	HPC Scheduler			
	Dynamic Scaling	Auto Scale	Auto Scale		Auto Scale	
Storage	Object Storage	Simple Storage Service	Blobs	Cloud Storage	Cloud Files	Cloud Storage
	Block Storage	Elastic Block Store	Disks	Disks	Cloud Block Storage	Cloud Block Storage
	Hybrid Storage	Storage Gateway	StorSimple			
Database	Relational DB	Relational Database Service	SQL DB	Cloud SQL	Cloud Databases	Cloud Relational DB
	NoSQL DB	DynamoDB	Tables	DataStore		
	Data Warehouse	Redshift		BigQuery		
	Reporting		SQL Reporting			

Caching	CDN	CloudFront	CDN		3rd Party (Akamai)	Cloud CDN
	In-Memory	ElastiCache	Cache	Memcache		
Networking	Load Balancer	Elastic Load Balancer	Load Balancer	Load Balancer	Cloud Load Balancer	Cloud Load Balancer
	Hybrid Connectivity	Virtual Private Cloud	Virtual Networking	Virtual Networking	RackConnect	Enterprise Services-Virtual Private Cloud
Messaging	Peering	Direct Connect	3rd Party			
	DNS	Route 53			Cloud DNS	Cloud DNS
	Async Messaging	Simple Queuing Service	Service Bus	Task Queues		Cloud Messaging
Monitoring	Push Notifications	Simple Notification Service	Notification Hubs	Cloud Messaging		
	Bulk Email	Simple Email Service				
		CloudWatch	System Center		Cloud Monitoring	Cloud Monitoring
	Security	Identity Management	Identity and Access Management	Active Directory		Cloud Identity
Deployment	Key Management	Cloud Hardware Security Module				
	Multifactor Authentication	Yes	Yes	No	No	No
	Resource Creation	CloudFormation				

	Web container	Elastic Beanstalk	Web Sites	App Engine	Cloud Sites	Cloud APaaS
	Devops	OpsWorks				
App Services	Mobile		Mobile Services	Mobile Back End Starter Kit		
	Media	Elastic Transcoder	Media Services			
	Workflow	Simple Workflow Service	BizTalk			
Compliance	HIPAA	Yes	Yes	No	Yes	No
	SOC 1	Yes	Yes	Yes	Yes	Yes
	SOC 2	Yes	Yes	Yes	Yes	No
	SOC 3	Yes	Yes	No	Yes	No
	PCI DSS Level 1	Yes	Yes	Yes	Yes	Yes
	ISO 27001	Yes	Yes	Yes	Yes	Yes
	FedRAMP	Yes	Yes	No	No	No
	DIACAP and FISMA	Yes	Yes	No	No	No
	ITAR	Yes	No	No	No	No
	FIPS 140-2	Yes	No	No	No	No
	CSA	Yes	Yes	Yes	Yes	Yes
	MPAA	Yes	No	No	No	No
Marketplace		Yes	Yes	No	No	Yes

## Conclusion and key takeaways

---

IaaS is one of the fastest growing segments of the cloud services market. Sensing the opportunity, traditional hosting providers, platform vendors, telecom providers, system integrators, and hardware vendors are entering the market. It is increasingly difficult for customers to choose from the available options. With price not being a major differentiating factor, customers should consider the platform completeness, maturity, compliance, ecosystem support, and security when choosing an IaaS offering.

- Compute, storage, network, and databases are the building blocks of IaaS.
- Amazon, Microsoft, Rackspace, Google, and HP are the key players dominating the IaaS landscape today.
- AWS is leading the pack with its fast-paced innovation and improvements to its platform.
- Microsoft aims to compete with AWS by turning Windows Azure into a complete cloud services platform.
- Rackspace is trying to align its public cloud offering with OpenStack by enhancing the core platform.
- Google Compute Engine is promising with its feature parity with Amazon EC2 and higher performance.
- HP Cloud doesn't have a differentiating factor from the other players but continued focus and investment will help it get traction with its existing customers.

## About Janakiram MSV

---

Janakiram MSV heads cloud infrastructure services at Aditi Technologies. He was the founder and CTO of Get Cloud Ready Consulting, a niche cloud migration and cloud operations firm that was recently acquired by Aditi Technologies. He is the principal analyst at Janakiram & Associates where he focuses on research and analysis related to cloud services.

Through his speaking, writing, and analysis, he helps businesses take advantage of emerging technologies. Janakiram is one of the first few Microsoft Certified Professionals on Windows Azure in India. He is also an AWS Certified Solutions Architect. Janakiram studies the cloud services landscape for the Gigaom Research analyst network. He is the chief editor of a popular portal called CloudStory.in where he analyzes the latest trends from the world of cloud computing. Janakiram is a guest faculty member at the International Institute of Information Technology, Hyderabad (IIIT-H) where he teaches big data, devops and cloud computing to the students enrolled for the master's course.

Janakiram has worked at world-class product companies including Microsoft, Amazon Web Services, and Alcatel-Lucent. His last role was with Amazon Web Services as the technology evangelist where he joined them as the first employee in India. Prior to that, Janakiram spent 10 years at Microsoft where he was involved in selling, marketing, and evangelizing the Microsoft application platform and tools. When he left Microsoft, he was a cloud architect focused on Windows Azure.



## About Gigaom Research

---

Gigaom Research gives you insider access to expert industry insights on emerging markets. Focused on delivering highly relevant and timely research to the people who need it most, our analysis, reports, and original research come from the most respected voices in the industry. Whether you're beginning to learn about a new market or are an industry insider, Gigaom Research addresses the need for relevant, illuminating insights into the industry's most dynamic markets.

Visit us at: [research.gigaom.com](http://research.gigaom.com).

© Giga Omni Media 2013. *"Infrastructure-as-a-Service basics: a guide for IT pros"* is a trademark of Giga Omni Media. For permission to reproduce this report, please contact [pro-sales@gigaom.com](mailto:pro-sales@gigaom.com).