



Comparison of several cloud computing providers

Khyati Kothari

Department of Information Technology, Sinhgad College of Engineering, Pune, India.

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ABSTRACT

An important transition in IT service delivery today is buzzword Cloud Computing. The tools, building blocks and best practices are evolving for cloud computing which in turn increases challenges to deploy the best suited cloud solutions. Initially the big players like Google, Microsoft, Amazon set the stage for how to deploy web applications & pay for their use on the web. Thus with number of platforms and services available to for a cloud it is hard to make a reasonable choice for at least a novice who has just entered into cloud. The paper is intended to provide an insight into few cloud providers' services with respect to their features and scenarios. This comparison may help in the selection of a platform and may leverage as a starting point for a researcher.

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Introduction

Cloud Computing is a large-scale distributed computing paradigm in which a pool of abstracted virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet. It focuses on providing a wide range of users with distributed access to virtualized hardware and/or software infrastructure over the Internet.

With the significant advances in Information and Communications Technology over the last few years, there is an increasingly perceived vision that computing will one day be the 5th utility (after water, electricity, gas, and telephony). This computing utility, like all other four existing utilities, will provide the basic level of computing service that is considered essential to meet the everyday needs of the general community [1]. Cloud computing is a very current topic and the term has gained a lot of traction being sported on advertisements all over the Internet from web space hosting providers, through data centers to virtualization software providers. Cutting through the hype of cloud computing is not an easy task as a simple web search suffices to convince that there are nearly as many definitions on what constitutes 'cloud computing' as there are players in the market seeking to gain new territory in that promising new business field. IBM, Amazon, Microsoft, Google, Yahoo and Apple among others are very active in the area of cloud computing. They either already provide cloud computing commercial solutions in one form or another, or actively sponsor research centers, pursuing development of marketable technology. Since these companies have predominance in traditional service provisions and capital accumulation, most of these have more chance to adapt their services into such a new environment [2]. Though today more than 500 enterprises, big and small have entered the business of cloud providers [3]. Furthermore, comparisons of well known cloud providers for different types of services based on their features, architectures, scenarios, performance etc. are also available as white papers and seem to be broadly discussed

within the IT community. But still a fully functional & trusted method or tools are not available to compare different providers.

Cloud Computing is recognized as one of the top 10 technologies of 2010 by Gartner. It is said to be "transformative" – a new model of computer architectures. It is also said to be a promising paradigm designed to harness the power of networks of computers and communications in a more cost effective way. The coming shift to cloud computing is a major change in the IT industry. One of the most important parts of that shift is the advent of cloud platforms. As its name suggests, this kind of platform lets developers write applications that run in the cloud, or use services provided from the cloud, or both. Different names are used for this kind of platform today, including on-demand platform and platform as a service (PaaS). This new way of supporting applications has great potential. To see why, think about how application platforms are used today. When a development team creates an on-premises application (i.e., one that will run within an organization) much of what that application needs already exists.

An operating system provides basic support for executing the application, interacting with storage, and more, while other computers in the environment offer services such as remote storage. If the creators of every on-premises application first had to build all of these basics, we'd have many fewer applications today. Similarly, if every development team that wishes to create a cloud application must first build its own cloud platform, we won't see many cloud applications. Fortunately, vendors are rising to this challenge, and a number of cloud platform technologies are available today. Open Source community has also been very active in this technology, especially in developing solutions to manage clouds - mainly those employed in academic research around the world [3]. Thus many open source platforms and tools for cloud computing are also available today. In such situation, it becomes a necessity for a novice or a user whether an organization, developer or researcher to select best provider and service for their respective uses.

Tele:

E-mail addresses: khyati.kothari@gmail.com

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Cloud computing models

Cloud Computing can be categorized in two ways - according to the services it provides and according to the way it can be deployed.

Service Models

Services of cloud computing fits into 3 categories: Infrastructure as a service (IaaS) – delivers computer infrastructure, Platform as a service – delivers a computing platform and a solution stack as a service, Software as a service (SaaS) – delivers softwares over the internet eliminating the need to install them.

Deployment models

IT organizations can choose to deploy applications on public – cloud infrastructure made available to public and is owned by an organization selling cloud services, private – solely operated for an organization, hybrid – composition of public and private clouds or community clouds – shared by few organizations that has shared concerns , each of which has its trade-offs.

Platform evaluating factors

While there are many benefits of adopting the infrastructure, platforms & services offered by a Cloud Service provider, the applicability of these would depend on the nature & size of an enterprise or application. With an ever-growing list of cloud computing service providers, the decision for enterprises on how far to leverage computing platforms and with whom is a complex one. Thus selecting a cloud computing provider is becoming increasingly complex. As cloud environments mature, many cloud providers attempt to differentiate themselves by focusing on specific aspects of their offerings, such as technology stacks or service-level agreements (SLAs). In short, not all cloud providers are created equal. Choosing the best cloud provider for an application is a multidimensional problem [4]. Through the studies and survey, it has been found that every cloud infrastructure service is different. Each has a unique architecture for systems, network and storage, as well as a different pricing model, customer support model, set of self-service portal capabilities, performance technological stack and ability to security and compliance needs.

Providers of Infrastructure As A Service

IaaS consists of server, storage and local network resources made readily available to an enterprise and billed based on the level of each resource actually consumed during the billing period. With an IaaS, the provider gives the business more or less an empty container, in which the business customer installs its own operating systems, applications and storage data [5]. Customers buy resources, instead of having to set up servers, softwares and data center space themselves, and get billed based on the resources consumed. They deploy their own software on virtual machines and control and manage it. Virtual instances can be rented on as long as necessary. Amount of instances can also be scaled dynamically [6]. Technically, when you are able to delegate a program to execute on a remote OS running on the Web, you are leveraging IaaS. This is different from classic web hosting. Web hosting only hosts web pages and cannot execute code that needs low level access to the OS API. Web hosting cannot dynamically scale on demand. IaaS enables to run any computing task on virtually unlimited number of machines. Through IaaS, we have just moved a server running in the backyard into the Cloud. We pretty much own the managing, patching, securing and the health of the remote servers. Amazon

EC2, GoGrid, Rackspace, IBM Smart Business, Nimbus, Nirvanix are some of the examples of commercial IaaS offerings.

Amazon

Amazon is said to be the pioneer of cloud service provider under the name Amazon Web Services (AWS). It uses Elastic compute Cloud (EC2), Simple Storage Service (S3) & Elastic Block Storage (EBS) for storage, SimpleDB (SDB) for database, CloudFront for Content Delivery Network Service and Simple Queue Service (SQS) for cloud message service [7]. The Amazon development model involves building Xen virtual machine images that are run in the cloud by EC2 using which one can build its own Linux/Unix or Windows operating system image and upload it to be run in EC2. AWS has many pre-configured images that one can start with and customize to the needs. EC2 allows users to rent virtual computers on which to run their own computer applications. EC2 allows scalable deployment of applications by providing a web service through which a user can boot an Amazon Machine Image (AMI) to create a virtual machine, which is called an instance, containing any software desired. There are web service APIs (via WSDL) for the additional support services like S3, SDB, SQS & others.

- 1) Provides highly scalable, completely controlled, flexible, reliable & secure cloud computing platform.
- 2) Security services, firewalls & intrusion detection systems provided by Amazon VPC.
- 3) Persistent Storage by Elastic Block Storage (EBS) and Amazon S3.
- 4) Charges hourly per virtual machine or Data transfer charge, has special payment services – Amazon Flexible Payment Service & Amazon DevPay.
- 5) Supports many versions of Linux, supports Windows Server 2003/2008, OpenSolaris , Fedora OSs, Java, .NET, Python and Ruby languages.
- 6) Provides SLA with S3 commits to 99.9% uptime & EC2 of 99.5%.

Eucalyptus

Eucalyptus is an open source cloud computing provider mainly focused on academic research. It stands for Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems. It is an open source implementation of Amazon EC2 and all communication is made through Web Services standards. It implements virtualization depending on Linux and Xen/Ken hypervisors as EC2 does [8]. It supports 2 different classes of users: administrators & clients. Administrators manage the entire cloud, having access to all features of Eucalyptus. The later are the final users that can request and make use of VM instances directly from Eucalyptus, without administrator's intervention [3].

- 1) Deploys two virtual network interfaces of types: public and private.
- 2) Provides Walrus Storage Controller (WS3) compatible with Amazon's S3 providing persistent storage.
- 3) Supports versions of Linux like OpenSuse, Fedora, Ubuntu and Java programming language.
- 4) It is a freeware.

Providers of platform as a service platforms

It is high-level integrated environment or software application stack to design, test, build, deploy and update online custom applications. In other words, these services make available all the tools, operating system platforms, and storage softwares necessary for developers to create new Web

applications. The advantage of PaaS is that the developers need not worry about installing, maintaining, securing and patching the server. The PaaS provider takes the responsibility of the infrastructure and exposes the platform alone as a service. Microsoft Azure, Google App Engine, Force.com are examples of PaaS.

Microsoft Azure

The Microsoft's Azure platform is a flexible cloud computing platform that focuses on solving business problems and addressing customer needs. It contains the following services – Windows Azure, SQL Azure and .NET Services. Windows Azure is the OS running in the Microsoft's cloud. It abstracts the underlying hardware and brings an illusion that it is just one instance of OS [9].

- 1) Provides secure network with its service Windows Azure Connect.
- 2) Storage is provided by SQL Azure – secure relational database service.
- 3) Pricing is based on compute, storage and data transfer: Compute: \$0.12/CPU hour, Storage: \$0.15/GB/month, \$0.01/10k transactions/month, Bandwidth: \$0.10 in/GB, \$0.15 out/GB
- 4) Supports Windows 7, Vista, Windows Server 2008 operating systems and VB.NET, C#, PHP languages.
- 5) Security is provided by Routers, Firewalls, Cryptographic message protection, centralized monitoring, Limited number of Microsoft personnel access customer information, All Microsoft administrative operations audited.
- 6) SLA of 99.9%.

Google App Engine

Google App Engine is a platform to deploy and run web applications on Google's infrastructure. AppEngine applications are easy to build, scale and maintain.

- 1) Uses Datastore – a schemaless blob for storage
 - 2) No set-up costs and no recurring fee, up to 500 MB of storage & around 5 million page views a month, absolutely free. When billing enabled, free limits are raised, pay for resources used above the free levels.
 - 3) Supports Linux, Microsoft Windows, Mac OS and Java, Python languages.
 - 4) Provides secure environment - limited access to the OS, application can't write to file system, can read, others can connect to GAE application, only using http/https request, opening & listening to sockets disabled.
 - 5) Doesn't provide SLA but guaranteed to be 100% uptime.
- Providers of software as a service

SaaS is a way of delivering applications over the Internet as a service. Instead of installing and maintaining software, you simply access it via the Internet, freeing yourself from complex software and hardware management. SaaS applications are sometimes called Web-based software, on-demand software, or hosted software. They run on a SaaS provider's servers. The provider manages access to the application, including security, availability, and performance.

Salesforce.com

A SaaS intended for corporate use is the Salesforce.com service, which offers business analysis and customer relationship management (CRM) tools for an enterprise. CRM is the set of business processes and underlying applications that helps manage all of the customer information, activities, and conversations. With CRM, company's sales, marketing, and customer service teams can understand every customer and

deliver the right message or answer. By analyzing this information, it can make better decisions to close more business, reduce the cost of service, and keep every customer satisfied. Instead of buying and maintaining expensive servers and software to manage customer conversations and information, companies can use Web-based i.e cloud applications to run their CRM—and get a high return on their investment. Salesforce.com offers a complete set of CRM cloud applications, a cloud platform, and a cloud infrastructure.

Google Apps

Google Apps is an office application suite offered as a SaaS. The major applications in Google Apps are Gmail, Google Talk, Google Calendar, and Google Docs, and you can also add Google Gadgets to your pages. The Standard Edition is free and offers the same amount of storage as regular Gmail accounts. The Premier Edition, which offers additional e-mail storage, is available for an annual fee. The Education Edition, which is free, combines features from the Standard and Premier editions.

Scenarios

Among the discussed providers of IaaS, PaaS and SaaS, which fits where and when is the most important concern.

Amazon:

- 1) When one needs a lot of CPU power at unpredictable times, and don't want to actually store anything that is for high-demand web applications with many thousands of users, this platform is best suited.
- 2) When one needs a lot of CPU power at unpredictable times, and don't want to actually store anything that is for high-demand web applications with many thousands of users, this platform is best suited.
- 3) It has been found that because of its elasticity, flexibility and scalability, it is suited for multimedia processing applications as well as parallel processing applications. The consumer industry of AWS itself says it. Common industries currently using AWS include: Federal Government, Game Hosting, Life Sciences, Media & Entertainment
- 4) For moderately-trafficked website, EC2 actually costs more. But EC2 doesn't come with the friendly control panels and easy site-management tools that shared hosts have. You would also have to purchase extra software, download an API implementation.

Eucalyptus

- 1) When Amazon doesn't fit in the budget and when small-medium sized industries don't want to spend much on the infrastructure, Eucalyptus is the best option. Best example is Puma.com.
- 2) Another reason can be, when we have a homogeneous pool of Xen or KVM hypervisors and want to offer a public cloud service to a community, in this case, the free version of Eucalyptus will fit very well
- 3) When the applications to be developed or migrated are Ubuntu friendly and EC2 compatible, Eucalyptus fits best.
- 4) Though it is not able to provide some important services like VM migration. Its allocation algorithms are simple and may not be efficient in some cases.

Microsoft Azure

- 1) When you want Paas with all the advantages of cloud computing that is scalability, flexibility, elasticity and efficient parallelism, Azure is the best option.
- 2) When money doesn't matter.
- 3) When the preferred development environment is .NET.

4) When you want to make extra super sure that you can never use any non-Microsoft technologies.

Google App Engine

- 1) When one wants only limited access to the underlying operating system.
- 2) Applications are restricted to being written either in Java (or at least, languages targeting the JVM) or Python.
- 3) When less money needed to be spent.
- 4) Not suited for creating applications which require parallel processing.

Salesforce.com

- 1) Best SaaS to manage customer and employee information for a business critical and large company.

Google Apps

- 1) Best freeware for the functionalities like Communication (Online Meetings, Real-time document editing/viewing, Information Collection-Forms & Spreadsheets), Personal Management (Integrated Tasks-Email, Calendar), Collaboration (Intranet Sites-Projects/Teams, Company Info, Customer Portals-Secure, Flexible)
- 2) Best to be integrated in large universities or academic institutions at free of cost for limited number of users.

Conclusions

Today everything is mobile, connected, interactive, immediate, and fluid. It is said that on any given day, it's all about service delivery. These services are needed to be done in a cost-effective, secure, and quick way. This is one of the driving forces behind the rise in cloud computing. Cloud computing can provide new levels of collaboration, agility, speed, and cost savings for enterprises of any size and type and for any type of user. Everything from generic word processing software to customized computer programs and applications designed for a specific company could work on a cloud computing system. This technology is still undoubtedly work in progress from technical perspective and business perspective.

With the recent buzz over cloud computing, there seems to be an ever growing sea of cloud service providers appearing. Making the decision to use one of these services is no trivial task since each one has its own unique features, pricing, flexibility and control. More and more companies have started to step into Cloud era providing services for public & private use. There is a long listing of the services provided by the leading companies today. A side-by-side comparison of some of their features like pricing, availability, architecture etc. can be used to differentiate them.

It can be figured out that though the implementation of these cloud platforms are quite different, there are much common functionalities between them like all are scalable, all provides services, all support Linux operation system and the development of application, all have provided some means of security and privacy, formal agreements etc. However, there are also many differences, say their network interfaces, structure

and reliability and so on. According to the one's use and application, one can choose the best provider for it use. Amazon has the most established, stable platform offering the widest array of support for different technologies - current king of cloud. Google is the only provider for free for small apps, however its use in enterprises is unknown at this stage. Security and Privacy of Cloud Providers is a bit sketchy at this stage with not a whole lot of documentation available on how data is protected. It is hoped that by understanding some of the main differences between them and looking at the scenarios, one may decide where and when each solution may be more appropriate for its use. The detailed analysis of providers for cloud computing forced to think that what-so-ever pitfalls or myths about Cloud Computing, the new era is coming. Hence one can say that "Tomorrow's leading enterprises will be those that master the art of service sourcing and service delivery today."

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