Survey and Comparison of Cloud Service Providers

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Abstract:

Cloud computing is fundamentally altering the expectations for how and when computing, storage and networking resources should be allocated, managed, consume and allow user to utilize services globally. Due to the powerful computing and storage, high availability and security, easy accessibility and adaptability, reliable scalability and interoperability, cost and time effective cloud computing is the top needed for current fast-growing business world. A client, organization or a trade that adopting emerging cloud environment can choose a well suitable infrastructure, platform, software and a network resource, for any business, where each one has some exclusive features and advantages. In this paper, we first develop a comprehensive classification for describing cloud computing architecture. This classification help in survey of several existing cloud computing services developed by various projects globally such as Amazon, Google, Microsoft and Alibaba. Then by using this survey results we identify similarities and differences of the architecture approaches of cloud computing.

1. INTRODUCTION:

Cloud computing is fundamentally satisfying the expectations for how and when computing, storage, and networking resources should be allocated, managed, consume and allow the user to utilize services globally. It is the development of parallel computing, distributed computing, and grid computing and it is the combination of virtualization, software-as-a-service (SaaS), infrastructure-as-a-service (IaaS) and platform- as-a-service (PaaS) which are demanded by various organizations. A web browser or a lightweight desktop or mobile application is required for accessing cloud-based applications by end users. Servers at a remote location are required to store business software and user's data. In the cloud, computing virtualization occurs on several levels. There are various platforms to set up cloud computing infrastructure taken in today's market, but it has to be taken into consideration so that the infrastructure is flexible, secure to display various applications natural features of computations and IT services deliverance which allows testing of IT capability. Hence different platforms are developed to manage the public, private and hybrid cloud. Some key benefits of cloud computing include hiding and abstraction of complexity, virtualized resources and efficient use of distributed resources. Some examples of emerging cloud computing platforms are Amazon EC2, IBM Blue Cloud etc.

2. CLOUD SERVICE MODELS:

According to NIST cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. Cloud computing provides on demand self-service, broad network access, resources pooling, rapid elasticity, measured service etc. Cloud computing supports 3 service models such as

2.1 Software as a Service (SaaS):

SaaS sometimes referred to as "Software on demand", which is a software that is connected to the internet to run on the firewall or personal computer. The applications are accessible from various client devices through either a client interface such as web browser. The examples of SaaS are email, CRM, ERP etc. In 2010 SaaS sales reached 10 billion and increased to 12.1 billion in 2011 i.e. 20.7% up from 2010.CRM leads to be the largest market for Sass. SaaS based on the multi- tenant architecture. This model enables all customers to use single version application with a single configuration.

2.2 Platform as a Service (PaaS):

PaaS facilitates the delivery of a computing platform and solution stack as a service. PaaS offers deployment of applications by reducing the cost and complexity of buying and maintaining hardware, software and provisioning hosting capabilities. PaaS also provides application services such as team collaboration, web service integration and marshaling, database integration, security, scalability, storage, persistence, application instrumentation and developer community facilitation. These services may be referred to as an integrated solution over the web. PaaS offers to create a composition of multiple web services. These services access databases and reuse services maintained inside private networks.

2.3 Infrastructure-as-a-Service (IaaS):

Infrastructure is the backbone of cloud computing. In IaaS the capability provided to the consumer is to provision processing, storage, networks and other fundamental computing resources where the consumer is able to deploy and run arbitrary software which includes operating systems and applications. IaaS delivers computer infrastructure typically a platform virtualization environment as a service. IaaS eliminate the need for administration and maintenance of hardware. It enterprises grade infrastructures for all subscribers. IaaS provides images in a virtual machine, image- library, file-based storage, firewalls, load balancers, IP addresses, software bundles etc. Examples of IaaS are Amazon Ec2, HP cloud, Joyent, Google compute engine etc.

3. Cloud Service Providers Summary:

3.1. Amazon:

Amazon.com is one of the most popular CSPs, it offers a lot of cloud services including:

- Amazon EC2 (Amazon Elastic Compute Cloud): provides computing capacity on the cloud.
- Amazon S3 (Amazon Simple Storage Service): is dedicated for high reliable storage on the cloud.
- Amazon RDS (Amazon Rational Database Services): provides powerful tools for managing databases
on the cloud.
- Amazon Simple DB: provides the core database functions.
- Amazon Rout 53 (Amazon scalable DNS): provides secure routing servers over the Internet.
- Amazon CloudFront: is dedicated for managing and distributing contents over the Internet with high speed.
- Amazon Elastic MapReduce: is a web service that enables customers to process vast amount of data on the Cloud.

3.2. Google:

Google joint the cloud market in 2007 by simple services such as email, calendars, online documentation. Now, google has various cloud services such as:

- Compute Engine: an IaaS where customers can run large-scale workload in virtual servers hosted in Google's infrastructure.
- App Engine: a PaaS where customers can develop applications using built-in high-performance platforms.
- Cloud Storage: where customers can store any type of files with any size using secure, reliable, storage services from google.
- Cloud SQL: dealing with relational Databases with different DBMS.
- Cloud Datastore: a service to deal with unstructured database.
- BigQuery: with recent big data revolution google provides specific service to process large amount of data.

3.3. Microsoft:

In late of 2009, Microsoft starts the cloud services by introducing Microsoft windows Azure. Microsoft windows Azure is a platform on cloud that offers various types of services such as:

- Infrastructure: on-demand, scalable infrastructure with full support and high performance.
- Web development: provides very powerful platform that allows developers to build and deploy web applications.

- Mobile development platform provides services to build and test a mobile application on the cloud.
- Media: one of the competitive advantages of Microsoft windows azure and is dedicated for creating, editing, and publishing any type of media.
- Storage: a cloud storage solution to manage and process data even if they are regular or large-scale data

3.4. Alibaba:

In September 2009, Alibaba Cloud was founded, and R&D centers and operation centers are subsequently opened in Hangzhou, Beijing, and Silicon Valley. In November 2012, it Became the first Chinese cloud service provider to pass ISO27001:2005 (Information Security Management System). Like other Cloud Service Providers, Alibaba also provides some core features:

- The ability to choose from dozens of instance types.
- Support for virtual as well as bare-metal servers.
- Compatibility with a variety of Windows and Linux-based operating systems.
- The ability to create custom images.

3.5. HP:

HP is one of famous hardware company in the world with excellent market share in servers and data centres. In last years, HP started to offer cloud services such as:

- HP Cloud Compute: scalable processing power that customers can control and pay as you use.
- HP Cloud Storage: offers range of storage options for individuals and business sectors.
- HP Cloud CDN: refers to Content Delivery Networks and it is a web service that delivers data from HP Cloud Storage to customers around the world at high speed using global network of servers from HP and Akamai
- HP Cloud Relational Database: offers an environment for database developers to configure and process relational databases.
- HP Cloud Application platform: offers a platform that enables an enterprise to develop, deploy and scale application in the cloud.
- HP Cloud DNS: a user can manage his/her DNS zones securely and efficiently.
- HP Cloud Identity Service: provides a single method for managing HP cloud users' identities and authentication.

3.6. AT&T :

AT&T is the leader American international communication and information technologies company. It starts providing cloud computing service with four major services:

- Cloud Compute: provides computing resources for business and individual sectors.

- Cloud Storage: provides Storage as service.
- Network Enablement: provides networking services in cloud by providing VPN to customers.
- Platform as Service: provides platform for developers to develop an application on the cloud.

3.7. Salesforce:

Salesforces mainly focuses on specific cloud applications related to sales and customer relationship management. It provides some cloud products such as:

- Sales Cloud: a platform dedicated for Sales application on the cloud.
- Service Cloud: a platform dedicated for customer service management system on the cloud.
- Platform: as a majority of cloud providers they also provide platform as a service.

3.8. Rackspace:

Unlike previous providers, Rackspace Company focuses on cloud computing as main core business. They have about 11 different cloud services as follows:

- Cloud Servers: on-demand servers featuring local, powerful Intel® Xeon® processors, and 40Gbps of highly available throughput to every host.
- Block storage: fast, reliable storage for I/O-intensive apps. Use standard or SSD volumes, connected to Cloud Servers via fast network.
- Cloud Files: easy-to-use online storage for files and media. Deliver content globally to users over Akamai's content delivery network (CDN).
- Cloud backup: file-level backup for Cloud Servers. Cloud Backup lets users quickly protect and restore important files.
- Cloud Databases: high-performance MySQL databases in the cloud, with built-in redundancy and automated configuration to save time.
- Big Data Platform: production-ready, performance-tested big data clusters on OpenStack-powered cloud, supported by a broad ecosystem of partners.
- Load Balancers: easy-to-configure, reliable failover for high-traffic site or applications hosted on Cloud Servers or Cloud Databases.
- Cloud DNS: allows user to add, modify, and remove domains, subdomains, and records, as well as import and export domains and records.

4. Cloud Features & Pricing Comparison:

4.1. Google Cloud Platform:

The Google Cloud platform is a set of cloud computing tools that developers can use in the building and hosting of web applications. This platform began with services like the Google Engine App but later evolved to include more tools and services.

Google Cloud Features:

- Cloud Debugger
- Cloud Trace
- Cloud Save

Developers have the ability to assess and debug code in production thanks to the Cloud Debugger. Cloud Trace allows developers to quickly identify what may be causing a performance breakdown and enables them to fix it. The Cloud Save feature allows you to save as well as retrieve per user information and also facilitates the synchronizing of stored data across devices.

Pricing:

Google Cloud uses a per-minute billing and sustained use discounts pricing model. A 10-minute billing minimum starts followed by bills-per-minute for the remaining time. The sustained use discounts start after using a particular instance for at least 25 percent of a month where users get a discount for every incremental minute they use after reaching the 25 percent mark.

4.2. Amazon Web Services (AWS):

AWS is a cloud computing service provider that offers on-demand computing services and resources using a pay-as-you-go pricing model. AWS offers compute power, content delivery, database storage among other functionality to assist businesses grow. You can easily find free training courses online with certificates about AWS and other cloud platforms here. Millions of customers are leveraging the cloud products and solutions offered by AWS to create sophisticated applications with more reliability, scalability and flexibility.

AWS Features:

- Support for virtual and bare-metal servers
- Compatibility with a wide variety of operating systems (Linux and Windows)
- Supports creation of custom images
- Ability to choose from several instance types

Pricing:

AWS uses a pay-as-you-go model for pricing which is similar to how you would pay for utilities such as water and electricity I.e you will only be required to pay for the services you consume meaning there will be no termination fees or additional costs if you stop using their services.

4.3. Microsoft Azure

Microsoft Azure offers an integrated suite of managed services, tools and templates that will help

improve the productivity of IT professionals and developers by enabling them to create and manage enterprise, web, mobile as well as Internet of Things apps.

Azure Features:

- ExpressRoute for secure and faster data solutions
- Puppet and Chef tools for easier configuration management
- Cloud App Discovery (identifies what needs to be prioritized in your IT spend)
- Better cloud collaboration

Pricing:

Microsoft Azure uses a similar pricing scheme to AWS where you only pay for the services you use hence there are no upfront costs.

4.4. Alibaba Cloud

Alibaba Cloud provides cloud computing products and services to online businesses such as cloud hosting, data storage and big-data processing.

Alibaba Cloud Features:

- Flexible architecture
- Persistent data storage
- Multi-layer cyber security protection
- Data backup and one click recovery

Pricing:

Compared with other major competitors such as AWS, Alibaba Cloud is relatively cheaper with pricing models such as Pay-as-you-go and per-second billing.

5. CLOUD USER MANAGEMENT COMPARISON:

When companies move from on-prem workloads to the cloud, common concerns arise around costs, security, and cloud user management. Each cloud provider handles user permissions in a slightly different way, with varying terminology and roles available to assign to each of your end users. Let’s explore a few of the differences in users and roles within Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform, and Alibaba Cloud.

5.1 AWS IAM Users and Roles:

AWS captures all user and role management within IAM, which stands for “Identity and Access Management”. Through IAM, you can manage your users and roles, along with all the permissions and visibility those users and service accounts have within your AWS account.

There are a couple different IAM entities:

- Users—used when an actual human will be logging in

- Roles—used when service accounts or scripts will be interacting with resources

Both users and roles can have IAM policies attached, which give specific permissions to operate or view any of the other AWS services.

5.2 Azure RBAC:

Azure utilizes the RBAC system within Resource Manager for user permissions, which stands for “Role Based Access Control”. Granting access to Azure resources starts with creating a Security Principal, which can be one of 3 types:

- User—a person who exists in Azure Active Directory

- Group—a collection of users in Azure Active Directory

- Service Principal—an application or service that needs to access a resource

Each Security Principal can be assigned a Role Definition, which is a collection of permissions that they can utilize to view or access resources in Azure. There are a few built-in Role Definitions, such as Owner, Contributor, Reader, and User Access Administrator, but you can also create custom role definitions as well depending on your cloud user management needs. Roles may be assigned on a subscription by subscription basis.

5.3 Google Cloud Platform IAM:

Google Cloud Platform also uses the term IAM for their user permissions. The general workflow is to grant each “identity” a role that applies to each resource within a project. An identity can be any of the following:

- Google account—any user with an email that is associated with a Google account

- Service account—an application that logs in through the Google Cloud API

- Google group—a collection of Google accounts and service accounts

- G Suite domain—all Google accounts under a domain in G Suite

- Cloud Identity domain—all Google accounts in a non-G-Suite organization

Roles in Google Cloud IAM are a collection of permissions. There are some primitive roles (Owner, Editor, and Viewer), some predefined roles, and the ability to create custom roles with specific permissions through an IAM policy.

5.4 Alibaba Cloud RAM:

Alibaba Cloud has a service called RAM (Resource Access Management) for managing user identities. These identities work in slightly different ways than the other cloud service providers, though they have similar names:

- RAM-User—a single real identity, usually a person but can also be a service account

- RAM-Role—a virtual identity that can be assigned to multiple real identities

RAM users and roles can have one or more authorization policies attached to them, which in turn can each have multiple permissions in each policy. These permissions then work similarly to other CSPs, where a User or Role can have access to view or act upon a given resource.

6. COMPARISON BETWEEN THE DIFFERENT PLATFORMS:

Characteristics	**Cloud Service Providers (CSPs)**			
	Amazon	**Google**	**Microsoft**	**Alibaba**
Type of cloud services	Iaas, Paas, storage, Database	Iaas, Paas, storage, mobile Database, Big Data	Iaas, Paas, storage, mobile, media, Database, Big Data	Saas, Paas, storage, business application
Average monthly price	$66	$42	$66	$169
Payment plan	Pay per Use, monthly	Pay per Use	On demand or reserved	Pay as you Go or monthly
Operating systems supported	9	2	6	2
Easy of use	Good	Good	Good	Good
Security	High	High	High	High
API support	Yes	Yes	Yes	Yes

7. CONCLUSION:

Cloud Computing is one of the hottest trends in the technological world. With more and more businesses including healthcare and education using the cloud, we need better comparison models and transparent data to decide which CSP suits an organization or individual best. We believe this comparison will help individuals and organizations make a mindful decision about which CSP to choose after knowing the advantages and disadvantages of each CSP.

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