

Exploring Cloud Computing Services and Applications

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Abstract-Cloud computing, the use of more than one computer across the internet, to provide web base services, is a rapidly growing technology. It is enabling an ever increasing range of web services for businesses and the public. Cloud computing environment provides a great flexibility and availability of computing resources at a lower cost. This emerging technology opens a new era of e-services in different disciplines. In this paper, we explore cloud computing services and applications, we give examples for cloud services provided by the most common Cloud Service Providers (CSPs) such as Google, Microsoft, Amazon, HP, and Sales force and we studied innovative applications for cloud computing in e-learning, Enterprise Resource Planning (ERP) and e-governance. Our study helps individuals and organizations understand how cloud computing can provide them with customized, reliable and cost-effective services in a wide variety of applications.

Keyword- Cloud computing, Key services, ERP, e-learning, SaaS, Paas, IaaS, current cloud application.

INTRODUCTION

Cloud computing services provide technology (IT) as a service over the Internet or dedicated network, with delivery on demand, and payment based on usage. Cloud computing services range from full applications development platforms, to servers, storage, and virtual desktops .Cloud computing is a topic that received a great deal of attention by individuals and organizations from different disciplines in the last decade. This new environment implies great flexibility and availability of computing resources at different levels of abstraction at a lower cost. Cloud Service Providers (CSPs) (e.g., Google, Microsoft, Amazon) are vendors who lease to their customers cloud computing resources and services that are dynamically utilized based on customer's demand according to a certain business model. General services in different application areas such as business, education and governance are provided to the customers online and are accessed through a web browser, while data and software programs are stored on the cloud servers located in the data centres. These services are generally classified into three classes known as cloud service models and are shown in figure.

Cloud service models are a Service-Oriented Architecture (SOA) that describes cloud services at different levels of abstraction. These models are:

SaaS	Microsoft "Software Services", Google Apps
PaaS	Google AppEngine, Force.com
IaaS	AmazonEC2, Sun Grid, IBM Blue Cloud
DSaaS	Amazon S3, Cleversafe dsNet

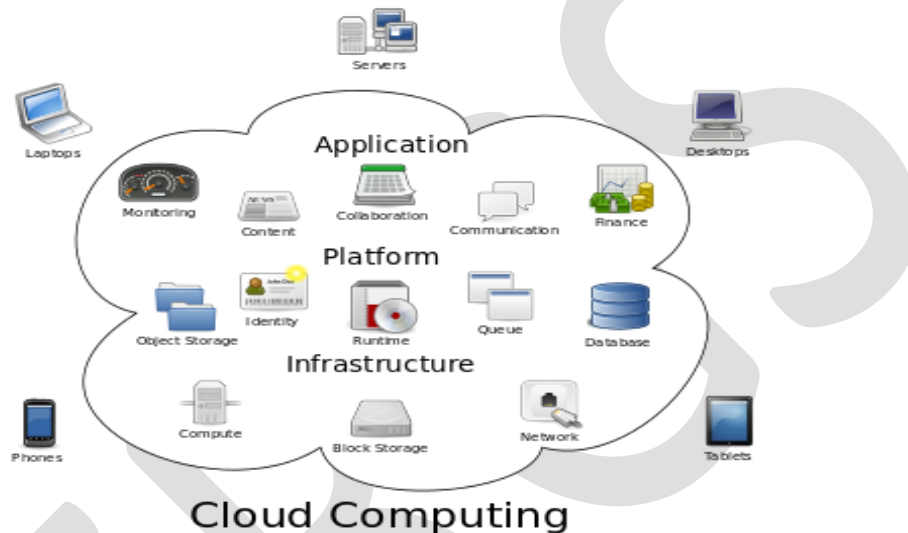
Fig: Services of cloud computing

Software as a Service (SaaS): The software applications like CRM, Office Suite, Email, etc., are offered as a service through the internet, instead of a shrink wrapped software on a physical medium (or in a downloadable form), which is the norm in the traditional desktop world. The applications are hosted on a highly scalable infrastructure and it is offered over the internet. Users can access it using an ordinary web browser, without any need to install software in their local computer. Companies like Google, Zoho, Salesforce, Microsoft, Wordpress offer their applications as a service to the end users.

Platform as a Service (PaaS): Some vendors are offering application development platform as a service. Developers can code the applications and upload it into the platform (offered as a service) and run the application on the cloud infrastructure. It helps developers to scale their apps without worrying about building the infrastructure. The platform scales automatically based on the resource needs of the app, without any efforts from the developer. Services like Google App Engine, Bungee Connect and Force.com are examples for PaaS.

Infrastructure/Hardware as a Service (HaaS)

Vendors offer computing infrastructure as a service to end users. The term Hardware as a Service is a bit of a misnomer. It is actually computing power offered through a virtualized environment rather than a physical hardware. This service is offered either as raw computing power or storage or both. Some examples of services offered in this category include Amazon's EC2 and S3, Mozy, GoGrid, etc.



ANALYSIS OF CLOUD COMPUTING SYSTEMS

Cloud computing systems are classified as public cloud, private cloud, community cloud and hybrid cloud. These classes are known as deployment models and they describe the scope of services offered on the cloud to the customers.

- **Public Cloud:** In public clouds the infrastructure and other cloud services are made available to the general public over the Internet. The cloud is owned and managed by a CSP who offers services to consumers on a pay-per-use basis. Public cloud users are by default treated as untrustworthy; therefore, security and privacy are big concerns about this type of cloud. Many popular cloud services are public including Amazon EC2, Google App Engine and Salesforce.com.
- **Private Cloud:** In private clouds the computing resources are operated exclusively by one organization. It may be managed by the organization itself or a CSP. Private clouds are considered to be more secure than public clouds since their users are trusted individuals inside the organization. The other two deployment models, community clouds and hybrid clouds, fall between public and private clouds.
- **Community clouds:** Community clouds are similar to private clouds but the cloud infrastructure and computing resources are shared by several organizations that have the same mission, policy and security requirements. An example of a community cloud is the educational cloud used by universities and institutes around the world to provide education and research services.
- **Hybrid Clouds:** In hybrid clouds, the cloud infrastructure consists of a combination of two or more public, private or community cloud components. The cloud components are bound together by standardized technology and managed as a single unit, yet each cloud remains a unique entity. Hybrid clouds allow organizations to optimize their resources, so the critical core activities can be run under the control of the private component of the hybrid cloud while other auxiliary tasks may be outsourced to the public component. Figure below shows different cloud deployment models and table compares these models with each other.

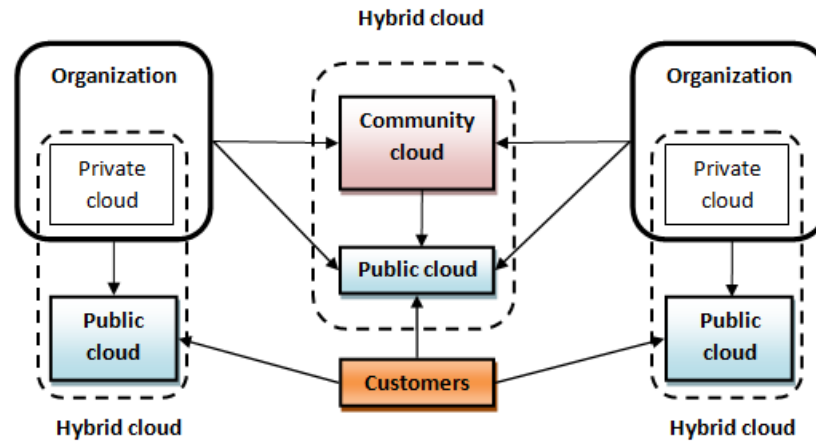


Fig. Cloud computing deployment model

Table: A Comparison of Cloud Deployment Models

Deployment Model	Scope of services	Owned by	Managed by	Security level	Location
Public	general public and large industry groups	CSP	CSP	Low	Off premise
Private	single organization	Single organization	Single organization or CSP	High	Off or on premise
Community	organizations that share the same mission, policy and security requirements	Several organization	Several organizations or CSP	High	Off or on premise
Hybrid	organizations and public	Organizations and CSP	Organizations and CSP	Medium	Off and on premise

WHO USES CLOUD COMPUTING SERVICES AND WHY?

Corporate and government entities utilize cloud computing services to address a variety of application and infrastructure needs such as CRM, database, compute, and data storage. Unlike a traditional IT environment, where software and hardware are funded up front by department and implemented over a period of months, cloud computing services deliver IT resources in minutes to hours and align costs to actual usage. As a result, organizations have greater agility and can manage expenses more efficiently. Similarly, consumers utilize cloud computing services to simplify application utilization, store, share, and protect content, and enable access from any web-connected device.

HOW CLOUD COMPUTING SERVICES WORK?

Cloud computing services have several common attributes:

- **On-demand self-service:** cloud services such as web applications, server time, processing power, storage and networks can be provisioned automatically as needed by the consumers without requiring human interaction.
- **Broad Network Access (mobility):** consumers can access cloud resources over the Internet at anytime and from anywhere (i.e., ubiquitous) through different types of platform (e.g., mobile phones, laptops, and PDAs).

- **Resource Pooling:** physical and virtual computing resources are pooled into the cloud. These resources are location independent in the sense that the customer generally has no control or knowledge over their location.
- **Rapid Elasticity:** computing resources can be rapidly and elastically provisioned and released based on the demand of the consumer. Consumers view these resources as if they are infinite and can be purchased in any quantity at any time.
- **Measured Services:** cloud resources and services are monitored, controlled and optimized by the CSPs through a pay-per-use business model. Consumers utilize these services in a way similar to utilizing electricity, water and gas. Other cloud computing characteristics are:
 - **Multitenancy:** a cloud provides services to multiple users at the same time. Those users share cloud resources at the network level, host level and application level, however, each user is isolated within his customized virtual application instance.
 - **Scalability:** the infrastructure of cloud computing is very scalable. Cloud providers can add new nodes and servers to cloud with minor modifications to cloud infrastructure and software.
 - **Reliability:** is achieved in cloud computing by using multiple redundant sites. High reliability makes the cloud a perfect solution for disaster recovery and business critical tasks.
 - **Economies of scale:** in order to take advantage of economies of scale, clouds are implemented to be as large as possible. Other considerations are also taken to reduce cost such as locating the cloud close to cheap power stations and in low cost real estate.
 - **Cost effectiveness:** customers are allowed to lease computing resources and purchase IT services that match their needs instead of investing in complex and expensive computing infrastructure and services. This will lower the costs of the IT services for organization and individuals.
 - **Customization:** a cloud is a reconfigurable environment that can be customized and adjusted in terms of infrastructure and applications based on user demand.
 - **Efficient resource utilization:** delivering resources only for as long as they are needed allows for efficient utilization of these resources.
 - **Maintainability:** CSPs reduce software and hardware maintenance burden of the users.
 - **Collaboration:** PaaS allows for collaborative work between users within an organization or among Different organizations.
 - **Virtualization:** users do not need to worry about physical resources since the cloud isolates them at the virtual level.
 - **Green technology:** cloud computing shares resources between users and does not require large resources that consume a lot of power.
 - **High performance:** cloud computing technology provides users with a high performance computing environment due to extremely large storage and powerful computing resources of the cloud infrastructure.

CLOUD COMPUTING SERVICES

Examples of cloud services provided by the most common CSPs are given in this section

a. Google Cloud Computing Services

Google integrates many applications and provides many services to cloud customers. This integration makes Google one of the best CSPs since it allows cloud's customers to have their tasks accomplished easily. It also saves money and time since developing and maintaining software to provide all of these services and applications is a time consuming and an expensive process. Among the Services provided by Google clouds are:

- **Gmail:** is an email service that provides users with 25GB storage, less spam and mobile access. It has an integrated chat applet that stores conversation in the form of email.
- **Google Docs:** is a service that allows users to create spread sheets, word documents and power point presentations and store them on the cloud servers. The documents are available online so that they can be accessed from anywhere and at anytime. This helps team members located in different countries to cooperate in completing their work. Google docs are secure since the files are encrypted using advanced encryption technology and are only accessed by authorized users.
- **Google analytics:** is used to monitor the traffic come onto a website.
- **Google Ad words and Ad Sense:** which are advertising tools?
- **Picasa:** which is a tool used to exhibit product and uploading their images in the cloud.

b. Microsoft Cloud Computing Services

Microsoft provides a cloud platform called Windows Azure platform which consists of a set of cloud services offered to users and application developers. All services run in Microsoft data centers located around the world. These services include:

- **Windows Azure:** a windows environment for storing data and running applications in the cloud.
- **SQL Azure:** is a relational database services in the cloud that use a special version of Microsoft SQL server.
- **Windows Azure App Fabric:** provides an infrastructure for applications that run in the cloud or inside an organization.
- **Windows Azure Marketplace:** is an online market to buy and sell application software and data.

c. Amazon Web Services (AWS)

AWS provides a cloud computing platform for all business sizes. With AWS companies can provision a flexible and cost-effective IT infrastructure and services that can be scaled up and down based on their needs. AWS helps companies select the platform that is suitable for the problem they have and pay only for what they use. In addition, AWS applies advanced physical security and data privacy techniques to protect user's data. AWS has security certifications and audits such as ISO 27001, FISMA moderate, HIPAA and SAS 70 Type II. AWS is a comprehensive cloud service platform which provides many web services such as:

- **Amazon Elastic Compute Cloud (Amazon EC2):** is a web service that provides configurable computing resources in the cloud.
- **Amazon Simple Storage Services (Amazon S3):** is a scalable, secure and reliable storage for the Internet that can be used to ubiquitously store and retrieve data of any size on the web.
- **Amazon Virtual Private Cloud (Amazon VPC):** connects the company's existing IT infrastructure to AWS cloud via a Virtual Private Network (VPN).
- **Amazon CloudFront:** is a web service for content delivery that transfers customer's data with high speed and minimum delay using a global network of edge locations
- **Amazon Route 53:** is a scalable and highly available DNS service.
- **Amazon Relational Database Services (Amazon RDS):** is a web service that helps manage a relational database in the cloud.
- **Amazon Simple DB:** provides the core database functions.
- **Amazon Simple Queue Service (Amazon SQS):** is a scalable, reliable, hosted queue for storing messages.
- **Amazon SNS:** is a web service that helps manage and send notifications from the cloud.
- **Amazon Elastic Map Reduce:** is a web service that enables customers to process vast amount of data on the Cloud.

d. HP Cloud Services

HP provides several services through its public beta and we describe these services below:

- **HP Cloud Compute:** provides elastic scalable virtual servers that can be customized on user's demand as the workload changes. It allows customers to save time wasted in resource configuration and to save money since customers only pay for resources they provisioned. It also provides an open standards environment that ensures portability and prevents vendor lock-in and allows for collaborative work.
- **HP Cloud Object Storage:** an online massive storage capacity that allows customers to store large amount of data such as audio and video files. It can be scaled up and down on-demand to meet storage change needs and it achieves reliability by replicating objects many times in multiple availability zones so that customers can access their data when they need it.
- **HP Cloud Block Storage:** allows customers to store data on HP Cloud resources for as long as they need and easily move it from one compute resource to another.
- **HP Cloud CDN:** CDN refers to Content Delivery Networks and it is a web service that delivers data from HP Cloud Object Storage to customers around the world at high speed using global network of servers from HP and Akamai.
- **HP Cloud Relational Databases for MySQL:** is a web service that provides on-demand access to relational structured databases.
- **HP Cloud Identity Service:** provides a single method for managing HP cloud users' identities and authentication.

e. Sales force Cloud Services

Sales force provides cloud computing solutions such as Service Cloud and Sales Cloud:

- **Service Cloud:** is a platform for customer services that allows for thousands of conversations on the Cloud. It provides different conversation tools that help empower CRM around the world such as online communities, Social networks, Phone, email & chat, Partners and Search.
- **Sales Cloud:** provides a comprehensive and easy to customize tools that deliver information to users in real time, at anytime and from anywhere. These tools include: Chatter, Mobile, Files & libraries, App Exchange and Marketing & leads.

KEY SERVICES

Based on the strong experience in the development of Business Application Services, Zensar has developed following cloud based offerings: g it to the cloud platform with the help of questionnaire, workshop and pilot.

Cloud Application Management Services : These Cloud services allows development / maintenance of applications that runs on cloud infrastructure (public / private / hybrid) providing greater scalability / high availability and leveraging cloud services such as: Storage, Messaging, DB and NoSQL services.

Cloud Migration Services: Our Migration services are specifically for moving application from existing infrastructure to the Cloud using IaaS / PaaS / SaaS based service model and thereafter enhancing application considering other cloud services.

Cloud Integration Services : The Integration services on cloud platform using open standard APIs, ESB based framework or custom tools such as IBM Cast Iron, Informatica Cloud etc. to connecting from on-premise applications to cloud or cloud applications to another cloud infrastructure.

Cloud Infrastructure Services : Our Infrastructure services provides complete stack of servers, network / bandwidth capacities, storage and database services to the potential customers considering public / private and hybrid cloud scenarios along with backup & restore / DR strategy

BENEFITS OF CLOUD COMPUTING SERVICES

Cloud computing services offer numerous benefits to include:

- Faster implementation and time to value
- Anywhere access to applications and content
- Rapid scalability to meet demand
- Higher utilization of infrastructure investments
- Lower infrastructure, energy, and facility cost
- Greater IT staff productivity and across organization
- Enhanced security and protection of information assets

CLOUD COMPUTING APPLICATIONS

In this section, we present some applications for cloud computing:

a. Cloud Computing For E-Learning:

E-learning is a new trend in education that tries to make the best use of information technology (IT). Cloud computing is an attractive environment for students, faculty members and researchers. As an emerging IT, cloud computing can provide universities and research centers with powerful and cost-effective computational infrastructure. Students can connect to campus educational services through their personal mobile devices from anywhere. Faculty members can have efficient and flexible access to their course material in their class rooms. Researchers can find articles, models and run their experiments on the cloud faster than ever. And shorter payback period by leasing resources and services on the cloud rather than purchasing new equipments and software applications. This is important especially for small and medium scale business where budgets are limited.

b. India to use the 'Cloud' Services for e-governance:

India is to become one of the first countries in the world to deliver e-Governance services to citizens using cloud-based IT services. The government is in talks with software industry body, Nasscom, on the roll-out of e-Governance services using the emerging technology. The advantage of using this technology is that the IT infrastructure need not be set up by the government. In addition, because of the ability of the technology to handle large number of transactions, citizens can look forward to less congestion bottlenecks

CONCLUSIONS

Cloud computing is a new emerging technology that is expected to significantly change the field of IT in the next few years and lead it for the coming decades. Numerous services and applications can be provided in the Cloud due to its many interesting and promising characteristics. In this paper, we explored some of these services and applications and we are certain that many others will see the light in the near future. Cloud services and applications are expected to attract many individuals and organizations from different disciplines and our study helps them understand the impact of these services on their work, however, cloud computing technology is not free of risks and concerns. Security and privacy issues continue to be the biggest concern on cloud computing that limits its adoption in practice. The Multitenancy nature and resource and data outsourcing are the main reasons for the security issue in cloud computing. Organizations and individuals are still concerned about storing and processing their sensitive data and critical applications on the cloud.

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