

## Discovering Cloud Computing Services and Applications

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A cloud computing environment offers more affordability and more flexibility when it comes to computer resources. This new technology ushers in a new age of e-services across several fields. This paper examines cloud computing services and applications. It provides examples of cloud services from popular cloud service providers (CSPs) like Google, Microsoft, Amazon, HP, and Sales Force. It also presents cutting-edge cloud computing applications in e-governance, e-learning, and enterprise resource planning (ERP). Our research aids in the understanding of how cloud computing may provide individualized, dependable, and reasonably priced services to people and companies across a broad range of applications.

**Keywords:** Pay-Per-Use, SaaS, PaaS, IaaS, Cloud Computing, ERP, e-learning, e-government, Service-Oriented Architecture.

### OVERVIEW

Over the last ten years, cloud computing has drawn much interest from people and companies across all disciplines [1-20]. This new ecosystem suggests more flexibility and affordable access to computer resources at various abstraction levels. Cloud service providers, such as Google, Microsoft, and Amazon, rent out cloud computing resources and services to their clients based on a predetermined business model and dynamic consumer demand [7]. Customers may access general services in several application sectors, including business, education, and government, online via a web browser, and data and software are kept on cloud

servers housed in data centers [8]. Figure 1 illustrates how these services are often divided into three groups known as cloud service models. The Service-Oriented Architecture (SOA) used in cloud service models describes cloud services at various degrees of abstraction. These types of models are:

**Software as a Service (SaaS):** Under this paradigm, CSPs manage the operating system, computer resources, and application software. From the customer's perspective, the Software as a Service (SaaS) paradigm is a web-based application interface that allows services and complete software programs to be accessible using a web browser and supplied over the Internet. Customers may use various client devices, including computers, iPads, and mobile phones, to access hosted apps like Gmail and Google Docs. SaaS has the benefit of not requiring the user to purchase licenses, install, update, maintain, or execute software on their machine, in contrast to conventional software [26]. Additional benefits include multi-tenant efficiency, configurability, and scalability [27]. Zoho, Google Apps, and Salesforce.com are a few SaaS providers.

**Platform as a Service (PaaS):** In PaaS, a CSP supplies, manages, and keeps up an operating system and other system software. The customer administers and uses the application software under the operating system and on the virtual resources that the CSP provides. In contrast to SaaS, which offers customers fully functional applications, PaaS allows users to design, model, develop, and test applications directly on the cloud, giving them complete control over the software lifecycle [27]. The customer has little control over the operating system and hardware resources [26]. PaaS facilitates cooperative collaboration between project team members. For example, many users in several countries may work together to construct a website using a PaaS cloud service. Aptana Cloud, Google Apps Engine, and Windows Azure are a few PaaS vendors.

**Infrastructure as a Service (IaaS):** In this approach, a set of virtualized computer resources (such as memory, processing power, storage capacity, and network bandwidth) are made available by the CSP in the cloud. The client manages and

maintains the software applications and operating systems on these virtual resources. To transform physical resources into logical resources that can be dynamically provided and released by clients as required, Infrastructure as a Service (IaaS) leverages virtualization technologies [15–1723. IaaS vendors include Akamai, Amazon EC2, and Drop Box. Table 1 shows how cloud customers and CSPs are assigned to operate and maintain cloud resources under various service models.

CSPs may use several apps to provide cloud consumers with cloud services. This paper examines cloud computing applications and services. It gives examples of cloud services from popular cloud service providers (CSPs) like Google, Microsoft, Amazon, HP, and Sales Force. It also showcases creative uses of cloud computing in e-government, e-learning, and enterprise resource planning (ERP). Our research aims to educate people and companies on how cloud computing may provide them with specialized, dependable, and affordable services across a broad range of applications.

## 1. CLOUD COMPUTING SYSTEM ANALYSIS

There are four types of cloud computing systems: public, private, community, and hybrid [1,12,19,22,24,28,30,34]. These groups, called deployment models, outline the cloud services available to clients.

- **Public Cloud:** The general public may access the infrastructure and additional cloud services in public clouds over the Internet. A CSP that provides pay-per-use services to customers owns and operates the cloud. Users of public clouds are, by default, seen as unreliable. Therefore, security and privacy are significant issues with this kind of cloud [12]. Public access is available to well-known cloud services, such as Salesforce.com, Google App Engine, and Amazon EC2.

- **Private Cloud:** Only one company operates the computer resources in a private cloud. Either the organization or a CSP may be in charge of managing it. Private clouds are considered more secure because their users are trusted company members than public clouds. Community and hybrid clouds are the

other two deployment options between public and private clouds [12].

- **Community clouds:** Community clouds are comparable to private clouds, but they share computing resources and cloud architecture across several companies with identical goals, rules, and security specifications [24]. The educational cloud, utilized by universities and other institutions worldwide to provide services for research and instruction, is an example of a community cloud.

- **Hybrid Clouds:** The cloud infrastructure of a hybrid cloud combines two or more elements from the public, private, or community cloud. Although the cloud's components are maintained as a unified unit and connected by standardized technologies, each is nonetheless distinct [24, 28]. Organizations may maximize their resources by using hybrid clouds. This means that the private component of the hybrid cloud can manage its essential functions while the public component can do various auxiliary duties. Several cloud deployment approaches are shown in Figure 2 below, and Table 2 contrasts these methods with one another [30].

Cloud computing systems meet intriguing requirements that make them attractive for upcoming IT services and applications. Below are the five crucial qualities that the National Institute of Standards and Technology (NIST) [14] has identified for cloud computing systems [1, 19, 24, 25, 34].

- **On-demand self-service:** Cloud services like web apps, server time, processing power, storage, and networks may be automatically supplied as users require them without human intervention.

- **Broad Network Access (mobility):** Using various platforms, including laptops, PDAs, and mobile phones, users may access cloud resources over the Internet at any time and from any location (ubiquitous).

- **Resource pooling:** the cloud combines virtual and physical computer resources. Since most customers have little control or awareness of their location, these resources are location-independent.

- **Quick Elasticity:** Depending on customer demand, computing resources may be deployed and released quickly and elastically. Customers see these resources as limitless, available for purchase at any moment and in any amount.

- **Measured Services:** Using a pay-per-use business model, the CSPs monitor, manage, and optimize cloud resources and services. Customers similarly use these services to use gas, water, and electricity.

Additional features of cloud computing include [28, 29] Multitenancy, which is the ability of a cloud to serve several users simultaneously. Although each user is isolated inside their virtual application instance, those users share cloud resources at the network, host, and application levels.

- **Scalability:** The cloud computing infrastructure is very scalable. Minor changes to the cloud's architecture and software allow cloud providers to add more nodes and servers.

- In cloud computing, reliability is achieved by using many redundant locations. Due to its high dependability, the cloud is an ideal alternative for disaster recovery and business-critical processes.

- **Economies of scale:** the most significant feasible clouds are deployed to benefit from economies of scale. Additional cost-cutting measures include situating the cloud in cheap real estate and next to inexpensive power plants.

- **Cost-effectiveness:** Clients may lease computing resources and buy IT services that suit their requirements instead of investing in intricate, expensive computer infrastructure and services. As a result, the price of IT services for businesses and consumers would decrease.

- **Customization:** Depending on user needs, a cloud may be reconfigured as an environment with rearranged applications and infrastructure.

- **Effective use of resources:** Resources may be used effectively if provided for the short time required.

- **Maintainability:** CSPs relieve users of the hassle of maintaining their hardware and software.
- **Collaboration:** A platform as a Service (PaaS) enables users to collaborate inside an organization or across companies.
- **Virtualization:** The cloud isolates physical resources at the virtual level, so users needn't worry about them.
- **Green technology:** cloud computing doesn't need massive, power-hungry systems; instead, it divides resources between users.
- **High performance:** Cloud computing technology offers customers a high-performance computing environment because of the cloud infrastructure's enormous storage capacity and potent processing power.

## 2. COMPUTING CLOUDS SERVICES

This section [32] provides examples of cloud services offered by the most popular CSPs:

### A. Services for Google Cloud Computing

Google offers a wide range of services and combines several apps for cloud users [36]. Because of this connection, Google is among the top cloud service providers (CSPs) since it makes cloud clients' jobs easier. It also saves time and money since building and maintaining the software needed to provide these services and apps takes a lot of effort and money. Google Cloud offers the following services, among others [36]:

- **Gmail:** a mobile email service with 25GB of storage, fewer spam, and other features. It has an inbuilt chat widget that saves email exchanges as conversations.
- **Google Docs:** a cloud-based service that lets users create and save word processing, spreadsheets, and PowerPoint presentations. The materials are accessible online, allowing users to view them anytime and anywhere. This makes it easier for team members across borders to collaborate and finish their tasks. Because Google Docs files are protected using cutting-edge encryption technology and can only be read by authorized users, they are safe.

- Google Ad Words and Ad Sense are advertising solutions. Google Analytics is used to track website visitors.
- Picasa: a product display platform that allows users to upload photographs to the cloud.

## **B. Services for Microsoft Cloud Computing**

Microsoft offers a suite of cloud services known as the Windows Azure platform, which is accessible to both consumers and application developers. Every service is hosted in one of Microsoft's global data centers. Among these services are [37]:

- **Windows Azure:** a cloud computing platform built on Windows that allows users to store and execute apps.
- **SQL Azure:** this cloud-based relational database solution uses a specific Microsoft SQL Server version.
- **Windows Azure App Fabric:** offers an internal or external organization-hosted application infrastructure.
- **Windows Azure Marketplace:** an online marketplace where data and application software may be purchased and sold.

## **C. AWS, or Amazon Web Services**

AWS offers a cloud computing platform suitable for all sizes of businesses. Businesses may use AWS to provide adaptable, affordable IT services and infrastructure that can be scaled up or down to their requirements. Companies may choose the platform that best fits their needs and only pay for what they use with the assistance of AWS. Furthermore, AWS utilizes cutting-edge physical security and data privacy strategies to safeguard user information. With security assessments and certifications including SAS 70 Type II, FISMA Moderate, HIPAA, and ISO 27001, AWS is a full-featured cloud service platform that offers a wide range of online services [33, 35]:

One online service that offers cloud computing capabilities that may be customized is Amazon Elastic Compute Cloud, sometimes known as Amazon EC2.

- **Amazon Simple Storage Services (Amazon S3):** This widely used online storage solution is scalable, safe, and dependable and can store and retrieve data of any size.

- **Amazon Virtual Private Cloud (Amazon VPC):** a Virtual Private Network (VPN) links the business's current IT infrastructure to the AWS cloud.

- **Amazon CloudFront:** a web service for content delivery that uses an extensive global network of edge sites to convey client data quickly and efficiently.

A highly accessible and scalable DNS service is Amazon Route 53.

Amazon Relational Database Services (Amazon RDS) is an online service that assists with managing a relational database in the cloud.

- **Amazon Simple DB:** offers the essential database features.

- **Amazon Simple Queue Service (Amazon SQS):** a hosted queue that is scalable and dependable for message storage.

One online service that assists with managing and sending alerts from the cloud is Amazon SNS.

- **Amazon Elastic Map Reduce:** this online solution lets users handle enormous volumes of data in the cloud.

#### **D. Cloud Services from HP**

Through its public beta, HP offers several services, which we have listed below [21]:

- **HP Cloud Compute:** offers virtual servers that are elastic, scalable, and adaptable to the user's needs as workloads vary. Customers may save money by only paying for the resources they supply, and they can also avoid wasting time on resource setup. Additionally, it offers an environment with open standards that guarantees portability, avoids vendor lock-in, and facilitates teamwork.

- **HP Cloud Object Storage:** a vast online storage space that enables users to store big data, including music and video files. Its on-demand scalability allows it to adapt to changing storage requirements, and its multi-availability zone replication ensures stability and timely client access to data.

- **HP Cloud CDN:** Also known as Content Delivery Networks, CDN is a web service that uses a global network of servers from HP and Akamai to deliver data from HP Cloud Object Storage to customers worldwide at high speeds. Customers can store data on HP Cloud resources for as long as they need and move it quickly from one computing resource to another.

One online service that offers on-demand access to relational structured databases is HP Cloud Relational Databases for MySQL.

- **HP Cloud Identity Service:** offers a unified identity and authentication management approach for HP cloud users.

## **E. Cloud Services sales force**

Cloud computing technologies like Service Cloud [38] and Sales Cloud [39] are offered by Sales Force:

- **Support Cloud:** an online customer support platform that facilitates hundreds of online chats. It provides many conversational technologies supporting global CRM, including online communities, social networks, phone, email, chat, partners, and search.

- **Sales Cloud** gives users access to a wide range of easily customizable tools that can be used anywhere, at any time, to get real-time information. These tools include Chatter, Mobile, Files & Libraries, App Exchange, and Marketing & Leads.

### 3. ADVANCED COMPUTING APPS

We provide a few cloud computing apps in this section:

#### A. Using Cloud Computing in E-Learning

A recent educational development is e-learning, which aims to maximize information technology (IT) use. Students, professors, and researchers find the atmosphere of cloud computing to be appealing. Cloud computing, an emerging IT, may provide research institutions and universities access to robust and reasonably priced computational infrastructure. Students may use their mobile devices to access university educational services anywhere. Instructors may quickly and conveniently retrieve the necessary course materials in their classrooms. Researchers may discover publications and models on the cloud and conduct tests more rapidly than before [31]. An e-learning cloud's services are shown in Figure 3. Cloud Computing for ERP

There are several drawbacks to conventional enterprise resource planning (ERP) solutions. Different software programs could be required as an organization's operations expand to handle data in various areas, including administration, finance, payroll, and human resources. Acquiring, setting up, and maintaining many different software programs is challenging for expanding businesses. Additionally, the performance, availability of resources, and accessibility for many users are all restricted in conventional ERP systems. ERP cloud [40] is installing ERP systems on cloud infrastructure (servers in data centers, for example) so enterprises can access them from anywhere via a network connection. Thanks to this technology, project managers no longer worry about deploying, updating, and maintaining apps throughout their enterprises. ERP cloud also offers multitenant accessibility, high data and application availability, and reasonably priced scalable resources to enterprises. Leasing resources and services in the cloud instead of buying new hardware and software may help businesses lower their capital costs, increase ROI, and shorten their payback time. This is crucial, particularly for small and medium-sized enterprises with tight finances. An ERP cloud's services are shown in Figure 4.

## **B. Cloud Processing for Electronic Governance**

Conventional e-governance encounters several obstacles, including [41]:

- Resources are not flexible enough to adjust to changing needs. This might lead to duplicate or inadequate resources.
- Time and money must be spent on the regular upgrades and maintenance of SW and HW.
- It is necessary to obtain new SW licenses.
- The system must function around the clock.
- Limited recovery and storing of data
- A secure environment with access control and authentication is required.
- Insufficient responsibility

A government's ability to cooperate with other governments, serve its residents and institutions, and run its operations may all be significantly enhanced by cloud computing technologies. It may assist in overcoming these obstacles by offering an elastic, scalable, personalized, and

accessible setting. Additionally, it frees governments from upgrading, maintaining, and licensing SW, freeing them up to concentrate on their primary duties. In addition, file replication and numerous installations in geographically dispersed places may be used for data recovery during a catastrophe. Scalable and affordable data storage can also be offered. Security methods and procedures may be used in the cloud to stop harmful behavior and safeguard data integrity and confidentiality [6,12,13,19,22,25,28,29,30,34]. The services provided by e-governance Cloud are shown in Figure 5.

## **CONCLUSIONS AND FUTURE WORK**

Cloud computing, a new and developing technology, is anticipated to revolutionize the IT industry in the next few years and shape it for decades. The Cloud offers intriguing and exciting features, making supplying a wide range of services and applications possible. We looked at a few of

these services and used them in this article, and we do not doubt that many more will be implemented soon. Cloud computing technology is not without hazards and worries. Still, cloud services and applications are anticipated to draw many people and organizations from all disciplines, and our research helps them understand the influence of these services on their work. Concerns about security and privacy remain the main obstacles to cloud computing's practical adoption. The many tenancy nature and resource and data outsourcing are the main reasons for the security issues in cloud computing. Organizations and individuals are still concerned about storing and processing sensitive data and critical applications on the cloud. They continue to raise many questions for their CSPs, such as [6, 34, 46, and 47]: Where is their data located and who manages and accesses it, why is their personal information requested and who uses it, and what is the fate of their data in case of disasters or when the CSP went out of business.

Unsurprisingly, much of the future work in cloud computing will focus on developing approaches to address its security issues. Currently, several methods, including those from the CloudSecurity Alliance [42], the Jericho Forum Self-Assessment Scheme [43], the Shared Assessments questionnaires for vendor/service provider assessment [44], the ENISA Cloud Computing Risk Assessment Report [45], and the NIST [14], concentrate on identifying particular cloud security risks in various areas and offering recommendations and guidelines for security and privacy in public cloud computing. In our upcoming research, we aim to examine the security issue with cloud computing and provide a framework and security model that addresses and reduces security threats. This work will motivate businesses and individuals to continue utilizing this technology.