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Abstract

"**Cloud**" is a collective term for a larger number of developments. It is not an invention, but more of a "practical innovation", combining a number of earlier inventions into something new and compelling and up-to-date. Cloud computing merges several already available technologies: **high bandwidth networks, virtualization, Web 2.0 interactivity, time-sharing, and browser interfaces**. Cloud Computing is a popular phrase that is shorthand for applications that were developed to be rich Internet applications that run on the Internet (or "Cloud"). Cloud computing enables tasks to be assigned to a combination of software and services over a network. This network of servers in the cloud. Cloud computing can help businesses transform their existing server infrastructures into **dynamic environments**, expanding and reducing **server capacity** depending on their requirements.

Keywords: Cloud, Bandwidth, dynamic environments, server, time-sharing, computing.

Table Of Contents :

Introduction

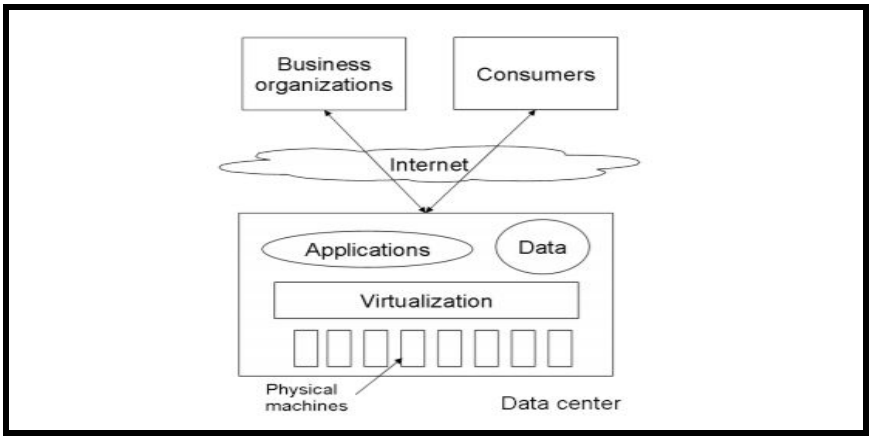
Cloud computing is a recently developing phenomenon based on distributed computing. Though it is not a new idea that emerged just recently. **In 1969 L. Kleinrock anticipated, "As of now, computer networks are still in their infancy. But as they grow up and become more sophisticated, we will probably see the spread of 'computer utilities' which, like present electric and telephone utilities, will service individual homes and offices across the country."** His vision was the true indication of today's utility-based computing paradigm. One of the giant steps towards this world was taken in the mid-1990s when grid computing was first coined to allow consumers to obtain computing power on demand. The origin of cloud computing can be seen as an evolution of grid computing technologies. The term Cloud computing was given prominence first by **Google's CEO Eric Schmidt in late 2006 (maybe he coined the term)** So the birth of cloud computing is a very recent phenomena although its root belongs to some old ideas with new business, technical and social perspectives. From the architectural point of view, the cloud is naturally **built on an existing grid-based architecture** and uses the grid services and adds some technologies like **virtualization and some business models**. In brief, the cloud is essentially a **bunch of commodity computers networked together in same or different geographical locations, operating together to serve a number of customers with different needs and workload on-demand basis** with the help of virtualization. Cloud services are provided to the cloud users as utility services like water, electricity, telephone using a pay-as-you-use business model. These utility services are generally described as **XaaS** (X as a Service) where X can be Software or Platform or Infrastructure etc. Cloud users use these services provided by the cloud providers and build their applications on the internet and thus deliver them to their end-users. So the cloud users don't have to worry about installing, maintaining hardware and software needed. And they also can afford these services as they have to pay as much they use. So the cloud users can reduce their expenditure and effort in the field of IT using cloud services instead of establishing IT infrastructure themselves. Cloud is **essentially provided by large distributed data centres.** These data centres are often organized as a grid and the cloud is built on top of the grid services. Cloud users are provided with virtual images of the physical machines in the data centres. This virtualization is one of the key concepts of cloud computing as it essentially builds the abstraction over the physical system.

Basics Of Cloud Computing :

Cloud computing is a paradigm of distributed computing to provide the customers on-demand, utility-based computing services. Cloud users can provide more reliable, available and updated services to their clients in turn. Cloud itself consists of physical machines in the data centres of cloud providers. Virtualization is provided on top of these physical machines. These virtual machines are provided to cloud users. Different cloud providers provide cloud services of different abstraction levels. E.g. Amazon EC2 enables the users to handle very low-level details where Google App-Engine provides a development platform for the developers to develop their applications.

Cloud Computing Architecture :

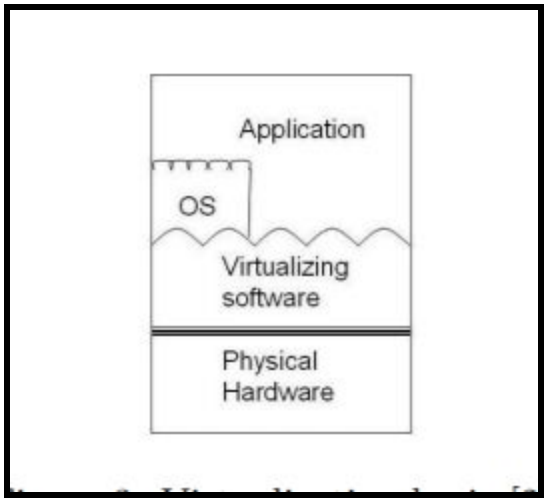
The cloud providers actually have physical data centres to provide virtualized services to their users through the Internet. The cloud providers often provide separation between application and data. This scenario is shown in Figure 1. The underlying physical machines are generally organized in grids and they are usually geographically distributed. Virtualization plays an important role in the cloud scenario. The data centre hosts provide the physical hardware on which virtual machines reside. Users potentially can use any OS supported by the virtual machines used.



- Figure 1

Operating systems are designed for specific hardware and software. It results in the lack of portability of the operating system and software from one machine to another machine which

uses a different instruction set architecture. The concept of virtual machines solves this problem by acting as an interface between the hardware and the operating system called system VMs [21]. Another category of a virtual machine is called a process virtual machine which acts as an abstract layer between the operating system and applications. Virtualization can be very roughly said to be software translating the hardware instructions generated by conventional software to the understandable format for the physical hardware. Virtualization also includes the mapping of virtual resources like registers and memory to real hardware resources. The underlying platform in virtualization is generally referred to as host and the software that runs in the VM environment is called as the guest. Figure 2 shows the very basics of virtualization. Here the virtualization layer covers the physical hardware. Operating Systems accesses physical hardware through the virtualization layer. Applications can issue instructions by using OS interface as well as directly using virtualizing layer interface. This design enables users to use applications not compatible with the operating system.



- Figure 2

Cloud Virtualization :

Virtualization in Cloud Computing is making a virtual platform for server operating systems and storage devices. This will help the user by providing multiple machines at the same time it also allows sharing a single physical instance of resource or an application to multiple users. Cloud Virtualizations also manage the workload by transforming traditional computing and make it more scalable, economical and efficient.

Types of Virtualization in Cloud Computing :

- **Operating System Virtualization**

In operating system virtualization in Cloud Computing, the virtual machine software installs in the operating system of the host rather than directly on the hardware system. The most important use of operating system virtualization is for testing the application on different platforms or operating systems.

- **Hardware Virtualization**

  Hardware virtualization in Cloud Computing, used in server platforms as it is flexible to use Virtual Machine rather than physical machines. In hardware virtualizations, virtual machine software installs in the hardware system and then it is known as hardware virtualization. It is used to control and monitor the process, memory, and other hardware resources.

- **Server Virtualization**

  In server virtualization in Cloud Computing, the software directly installed on the server system and used for a single physical server can divide into many servers on the demand basis and balance the load.

- **Storage Virtualization**

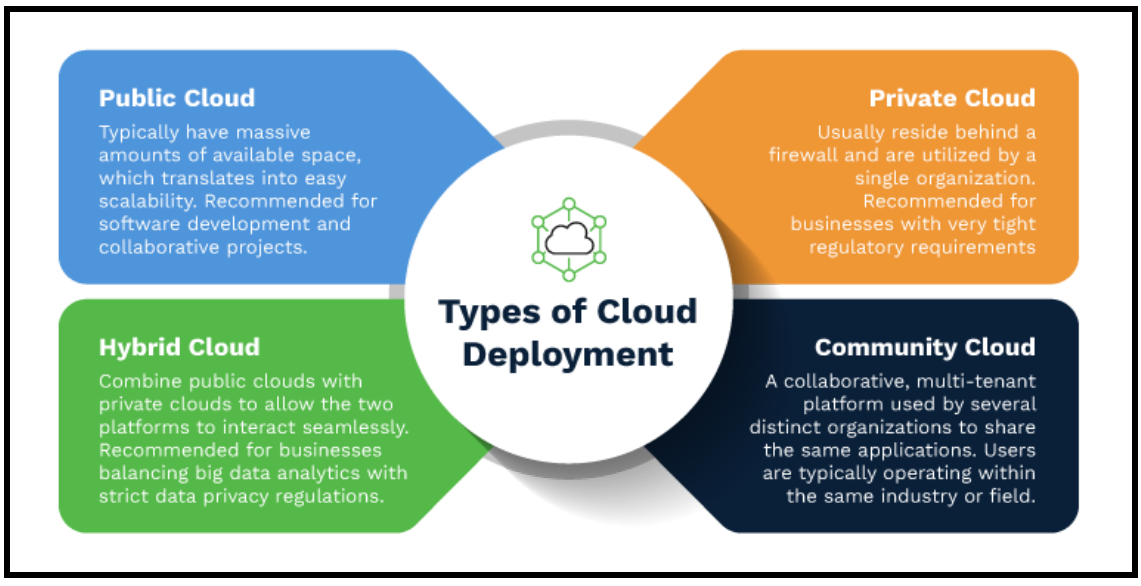
  In storage virtualization in Cloud Computing, a grouping is done of physical storage which is from multiple network storage devices. This is done so it looks like a single storage device.

How Virtualization Works?

Virtualization in Cloud Computing is a process in which the user of the cloud shares the data present in the cloud which can be application software etc. Virtualization relies on software to simulate hardware functionality and create a virtual computer system. This enables IT organizations to run more than one virtual system – and multiple operating systems and applications – on a single server. The resulting benefits include economies of scale and greater efficiency.

TYPES OF CLOUD COMPUTING :

Cloud deployment describes the way a cloud platform is implemented, how it's hosted, and who has access to it. All cloud computing deployments operate on the same principle by virtualizing the computing power of servers into segmented, software-driven applications that provide processing and storage capabilities.



- **Figure 3**

- **Public Cloud**

Some public cloud examples include those offered by Amazon, Microsoft, or Google. These companies provide both services and infrastructure, which are shared by all customers. Public clouds typically have massive amounts of available space, which translates into easy scalability. A public cloud is often recommended for software development and collaborative projects. Companies can design their applications to be portable so that a project that's tested in the public cloud can be moved to the private cloud for production. Most cloud providers package their computing resources as part of a service. Public cloud examples range from access to a completely virtualized infrastructure that provides little more than raw processing power and storage (Infrastructure as a Service, or IaaS) to specialized software programs that are easy to implement and use (Software as a Service, or SaaS).

- **Private Cloud**

Private clouds usually reside behind a firewall and are utilized by a single organization. A completely on-premises cloud may be the preferred solution for businesses with very tight regulatory requirements, though private clouds implemented through a colocation provider are gaining in popularity. Authorized users can access, utilize, and store data in the private cloud from anywhere, just like they could with a public cloud. The difference is that no one else can access or utilize those computing resources. Private cloud solutions offer both security and control, but these benefits come at a cost. The additional control offered by a private cloud makes it easier to restrict access to valuable assets and ensures that a company will be able to move its data and applications where it wants, whenever it wants. Furthermore, since the private cloud isn't controlled by an outside vendor, there's no risk of sudden changes disrupting the company's entire infrastructure. A private cloud solution will also not be affected by a public cloud provider's system downtime.

- **Hybrid Cloud**

Hybrid clouds combine public clouds with private clouds. They are designed to allow the two platforms to interact seamlessly. The primary advantage of a hybrid cloud model is its ability to

provide the scalable computing power of a public cloud with the security and control of a private cloud. Data can be stored safely behind the firewalls and encryption protocols of the private cloud, then moved securely into a public cloud environment when needed.

There are two commonly used types of hybrid cloud architecture. **Cloudbusting** uses a private cloud as its primary cloud, storing data and housing proprietary applications in a secure environment. When service demands increase, however, the private cloud's infrastructure may not have the capacity to keep up. That's where the public cloud comes in. A cloud bursting model uses the public cloud's computing resources to supplement the private cloud, allowing the company to handle increased traffic without having to purchase new servers or other infrastructure.

The second type of hybrid cloud model also runs most applications and houses data in a private cloud environment but outsources non-critical applications to a public cloud provider.

- **Community Cloud**

Although not as commonly used as the other three models, community clouds are a collaborative, multi-tenant platform used by several distinct organizations to share the same applications. The users are typically operating within the same industry or field and share common concerns in terms of security, compliance, and performance. The platform itself is managed privately, either in a data centre or on-premises. Authorized users are then segmented within that environment. These deployments are commonly used by government agencies, healthcare organizations, financial services firms, and other professional communities.

DIFFERENT CLOUD PROVIDERS :

There are different cloud service providers present in the current market which are based on either of the above-mentioned types. For example,

a. **Amazon Cloud Service**
b. **Microsoft Azure**
c. **Google Cloud Platform**

- **Amazon** :

Amazon web service is a platform that offers flexible, reliable, scalable, easy-to-use and cost-effective cloud computing solutions.

AWS is a comprehensive, easy to use computing platform offered by Amazon. The platform is developed with a combination of infrastructure as a service (IaaS), platform as a service (PaaS) and packaged software as a service (SaaS) offerings. AWS services were launched in 2002.

Amazon Web Services offers a wide range of different business purpose global cloud-based products. The products include storage, databases, analytics, networking, mobile, development tools, enterprise applications, with a pay-as-you-go pricing model.

- **Microsoft Azure :**

Microsoft Azure, formerly known as Windows Azure, is Microsoft's public cloud computing platform. It provides a range of cloud services, including compute,

analytics, storage and networking. Users can pick and choose from these services to develop and scale new applications, or run existing applications in the public cloud.

Once customers subscribe to Azure, they have access to all the services included in the Azure portal. Subscribers can use these services to create cloud-based resources, such as virtual machines (VM) and databases.

Developer support costs $29 per month, while Standard support costs $100 per month and Professional Direct support is $1000 per month.

- **Google Cloud Platform :**

Google Cloud Platform offers dozens of IaaS, PaaS, and SaaS services. GCP provides a **NoSQL** schemaless database for storing non-relational data. It's an alternative to Bigtable when **ACID** transactions are required, or the data stored is highly structured. **GCP** also provides the ability to manage service for building machine learning models using the TensorFlow framework.

ADVANTAGES OF CLOUD :

Cloud computing has been around for approximately two decades and despite the data pointing to the business efficiencies, cost-benefits, and competitive advantages it holds, a large portion of the business community continues to operate without it.
Cloud computing operates on a similar principle as web-based email clients, allowing users to access all of the features and files of the system without having to keep the bulk of that system on their own computers.

The advantages of using cloud services can be of technical, architectural, business etc :

1. **Cost Saving:-** Once you're on the cloud, easy access to your company's data will save time and money in project startups. And, for those who are worried that they'll end up paying for features that they neither need nor want, most cloud-computing services pay as you go.

2. **Security**:- A cloud host's full-time job is to carefully monitor security, which is significantly more efficient than a conventional in-house system, where an organisation must divide its efforts between a myriad of IT concerns, with security being only one of them. 94% of businesses saw an improvement in security after switching to the cloud, and 91% said the cloud makes it easier to meet government compliance requirements. The key to this amped-up security is the encryption of data being transmitted over networks and stored in databases. By using encryption, information is less accessible by hackers or anyone not authorised to view your data.

3. **Flexing**:- The cloud offers businesses more flexibility overall versus hosting on a local server. And, if you need extra bandwidth, a cloud-based service can meet that demand instantly, rather than undergoing a complex (and expensive) update to your IT infrastructure. This improved freedom and flexibility can make a significant difference to the overall efficiency of your organisation. This improved freedom and flexibility can make a significant difference to the overall efficiency of your organisation.

4. **Mobility**:- Cloud computing allows mobile access to corporate data via smartphones and devices, which, considering over 2.6 billion smartphones are being used globally today, is a great way to ensure that no one is ever left out of the loop.

5. **Increased Collaboration:-**Cloud computing makes collaboration a simple process. Team members can view and share information easily and securely across a cloud-based platform. Collaboration may be possible without a cloud-computing solution, but it will never be as easy, nor as effective.

6. **Quality Control:-** In a cloud-based system, all documents are stored in one place and in a single format. With everyone accessing the same information, you can maintain consistency in data, avoid human error, and have a clear record of any revisions or updates.

7. **Disaster Recovery:-** Cloud-based services provide quick data recovery for all kinds of emergency scenarios, from natural disasters to power outages. While 20% of cloud users claim disaster recovery in four hours or less, only 9% of non-cloud users could claim the same. In a recent survey, 43% of IT executives said they plan to invest in or improve cloud-based disaster recovery solutions.

8. **Loss Prevention:-** If you aren't on the cloud, you're at risk of losing all the information you had saved locally. With a cloud-based server, however, all the information you've uploaded to the cloud remains safe and easily accessible from any computer with an internet connection, even if the computer you regularly use isn't working.

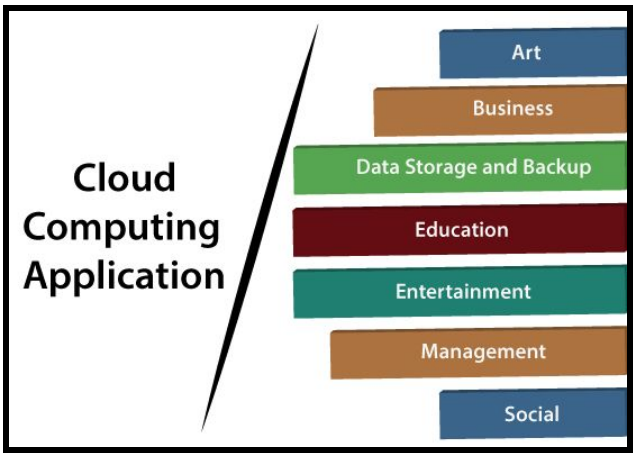
9. **Insight**:- Many cloud-based storage solutions offer integrated cloud analytics for a bird's-eye view of your data. With your information stored in the cloud, you can easily implement tracking mechanisms and build customised reports to analyse information organisation-wise. From those insights, you can increase efficiencies and build action plans to meet organisational goals.

10. **Competitive Edge:-** While cloud computing is increasing in popularity, there are still those who prefer to keep everything local. If you implement a cloud-based solution before your

competitors, you'll be further along the learning curve by the time they catch up. A recent study showed that 77% of businesses feel cloud technology gives them a competitive advantage, and 16% believe this advantage is significant.

APPLICATIONS OF CLOUD :

Cloud service providers provide various applications in the field of **art, business, data storage and backup services, education, entertainment, management, social networking, etc.**



The most widely used cloud computing applications are given below -

1. <u>Business Applications</u>: Business applications are based on cloud service providers. Today, every organization requires the cloud business application to grow their business. It also ensures that business applications are 24*7 available to users.

- **Paypal**

Paypal offers the simplest and easiest **online payment** mode using a secure internet account. Paypal accepts the payment through debit cards, credit cards, and also from Paypal account holders.

- **Slack**

Slack stands for **Searchable Log of all Conversation and Knowledge**. It provides a **user-friendly** interface that helps us to create public and private channels for communication.

- **Quickbooks**

Quickbooks works on the terminology "**Run Enterprise anytime, anywhere, on any device**." It provides online accounting solutions for the business. It allows more than 20 users to work simultaneously on the same system.

2. Data Storage and Backup Applications: Cloud computing allows us to store information (data, files, images, audios, and videos on the cloud and access this information using an internet connection. As the cloud provider is responsible for providing security, they offer various backup recovery applications for retrieving the lost data.

- **Box.com**

Box provides an online environment for **secure content management, workflow,** and **collaboration**. It allows us to store different files such as Excel, Word, PDF, and images on the cloud. The main advantage of using box is that it provides drag & drop service for files and easily integrates with Office 365, G Suite, Salesforce, and more than 1400 tools.

- **Mozy**

Mozy provides powerful **online backup solutions** for our personal and business data. It schedules automatically back up for each day at a specific time.

- **Google G Suite**

Google G Suite is one of the best **cloud storage** and **backup** applications. It includes Google Calendar, Docs, Forms, Google+, Hangouts, as well as cloud storage and tools for managing cloud apps. The most popular app in the Google G Suite is Gmail. Gmail offers free email services to users.

3. Education Application: Cloud computing in the education sector becomes very popular. It offers various online distance learning platforms and student information portals to the students. The advantage of using the cloud in the field of education is that it offers strong virtual classroom environments, Ease of accessibility, secure data storage, scalability, greater reach for the students, and minimal hardware requirements for the applications.

- **Google Apps for Education**

Google Apps for Education is the most widely used platform for free web-based email, calendar, documents, and collaborative study.

- **Chromebooks for Education**

Chromebook for Education is one of the most important Google's projects. It is designed for the purpose that it enhances education innovation.

- **AWS in Education**

AWS cloud provides an education-friendly environment to universities, community colleges, and schools.

4. Entertainment Applications

Entertainment industries use a **multi-cloud strategy** to interact with the target audience. Cloud computing offers various entertainment applications such as online games and video conferencing.

- **Online game**

  Today, cloud gaming becomes one of the most important entertainment media. It offers various online games that run remotely from the cloud. The best cloud gaming services are Shallow, GeForce Now, Vortex, Project xCloud, and PlayStation Now.

- **Video Conferencing Apps**

Video conferencing apps provide a simple and instant connected experience. It allows us to communicate with our business partners, friends, and relatives using a cloud-based video conferencing. The benefits of using video conferencing are that it reduces cost, increases efficiency, and removes interoperability.

5. Social Applications: Social cloud applications allow a large number of users to connect with each other using social networking applications such as Facebook, Twitter, Linkedin, etc.

There are the following cloud-based social applications -

- **Facebook**

Facebook is a **social networking website** which allows active users to share files, photos, videos, status, more to their friends, relatives, and business partners using the cloud storage system. On Facebook, we will always get notifications when our friends like and comment on the posts.

- **Twitter**

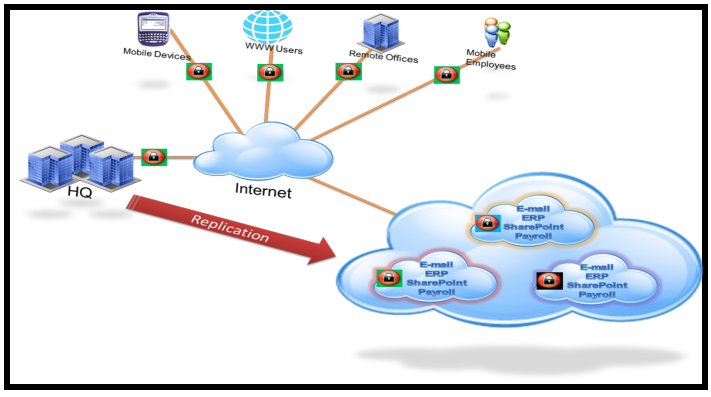
Twitter is a **social networking** site. It is a **microblogging** system. It allows users to follow high profile celebrities, friends, relatives, and receive news. It sends and receives short posts called tweets.

- **LinkedIn**

LinkedIn is a **social network** for students, freshers, and professionals.

DATA RECOVERY AND BACKUP IN CLOUD :

- ## Recovery



Cloud disaster recovery is a service that enables the backup and recovery of remote machines on a cloud-based platform. Cloud disaster recovery is primarily an infrastructure as a service (IaaS) solution that backs up designated system data on a remote offsite cloud server. It provides updated recovery point objective (RPO) and recovery time objective (RTO) in case of a disaster or system restore.Also known as cloud DR or cloud DRP. A cloud-based disaster recovery solution enables the user to scale up the entire cloud DRP solution from some-to-many. The user is normally billed

on a monthly basis only for the storage and client software licenses. Most Cloud DR also provisions backup and recovery for critical server machines that host enterprise-level applications like MS-SQL, Oracle, etc.

Cloud disaster recovery typically provides similar services as an on-premises or company-maintained off-premises disaster recovery plan (DRP) facility, but in an economical, efficient and provider-managed platform. A cloud DRP vendor provisions users and storage space and continuously updates designated systems with client software installed on each system. Users have the ability to add, edit and delete systems and storage capacity, without having to consider the back-end supported infrastructure.

Cloud Backup:

Cloud backup, or *cloud computer backup*, refers to backing up data to a remote, cloud-based server. As a form of cloud storage, cloud backup data is stored in and accessible from multiple distributed and connected resources that comprise a cloud.

For enterprises, enterprise-grade cloud backup solutions are available that typically add essential features such as archiving and disaster recovery. Archiving features help to satisfy an enterprise's legal requirements for data retention, and as part of a company's disaster recovery plan, the remote, off-site storage provided by cloud backup helps ensure the data remains safe should the enterprise's local data be jeopardized by a disaster such as a fire, flood, hacker attack or employee theft.

To update or restore a cloud backup, customers need to use the service provider's specific client application or a Web browser interface. Files and data can be automatically saved to the cloud backup service on a regular, scheduled basis, or the information can be automatically backed up anytime changes are made (also known as a "cloud sync").