



Cloud Computing

Lecturer

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Presentation Overview

- Cloud computing overview
- Advantages and disadvantages of Cloud computing
- Deployment models
- Types of cloud computing
- Factors influencing cloud computing
- Cloud computing overview in Uganda
- Future of cloud computing



Cloud Computing

It's a
journey



What is cloud computing?



"Cloud computing is a style of computing where scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies"

Source: Gartner, Inc. "Cloud Computing Key Initiative Overview" by David Cearley, February 5, 2010

OR

"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

Source: NIST "NIST Cloud Definition by Peter Mell & Tim Grance, July 10, 2010



A brief background...

Introduced in 1960s by John McCarthy....

"computation may someday be organized as a public utility". ... John McCarthy



A brief background...

The characteristics of cloud computing first explored in 1966 by Douglas Parkhill in his book, "*The challenge of the Computer Utility.*"

The history of term "Cloud" is originated from telecommunications world, where telecom companies started offering Virtual Private Network (VPN) services along with comparable quality of service at a much lower cost.

Cloud computing now extends this to cover servers and network



A brief background...

Many players in industries have jumped into cloud computing and implemented it.

Amazon has played a important role and launched the Amazon Web Service (AWS) in 2006.

Along with this Google and IBM also started research projects in Cloud Computing. Eucalyptus become the first open source platform for deploying the private clouds



Advantages of Cloud Computing

- 01 | Economical**
- 02 | Reliability**
- 03 | Manageability**
- 04 | Data Centralization**
- 05 | Proper Security**



Advantages of Cloud Computing



Economical

- One of the important benefits of Cloud Computing is the low cost. Cloud Computing provides service to the companies at the lowest rates possible.

Reliability

- The cloud computing platform is very reliable as the data stored is secured and cannot be tampered. There are several copies of the data are made

Manageability

- Cloud Computing helps to manage most of the things. The only thing, which the user has to do is get a device and an internet connection. The maintenance task is performed by the central administrations of resources, vendor managed infrastructure and SLA backed agreements.

Data Centralization

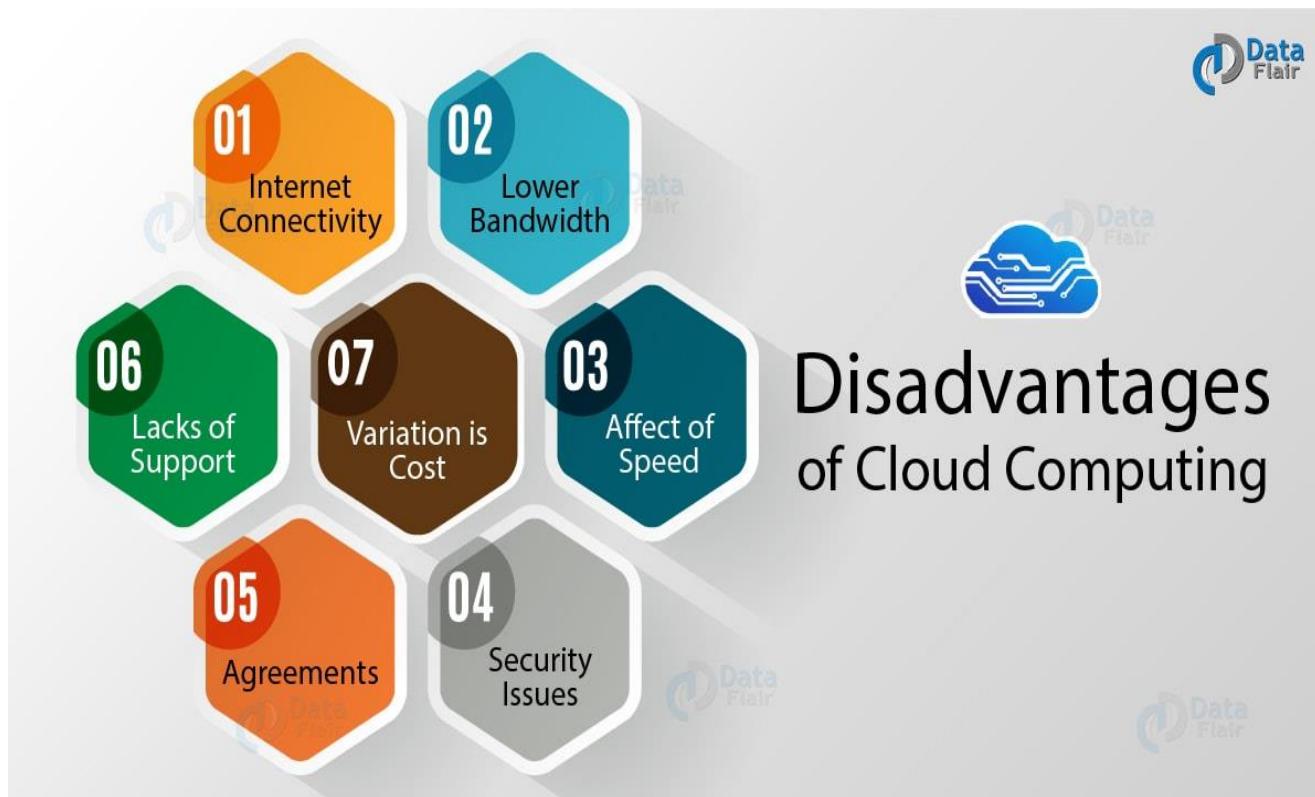
- It is also one of the benefits of Cloud Computing that all the data store in one location so that it can access from different remote places. There are many projects which stores in a particular place and can access at any time and anywhere.

Proper Security

- The service vendors select the highest level of security of the data. For which a user can set a proper audition, passwords, and encryption.



Disadvantages of Cloud Computing





Internet Connectivity

- Cloud Computing needs internet connectivity as if there will be no internet connection you won't be able to access the cloud

Lower Bandwidth

- Lower bandwidth reduces the benefits of the clouds such that it cannot use properly. A satellite connection can lead to quality disruption, due to higher latency or higher bandwidth.

Affect of Speed

- If a client is using an internet which is used by multiple users to download files such as music, documents, and many more. This will reduce the speed to use the Cloud.

Security Issues

- As Cloud Computing is very secure but still it requires an IT consulting firm's assistance and advice. Neglecting this can lead to the fact that the business will become vulnerable to the hackers and the threats.

Agreements

- There are many vendors available which have agreements that are non-negotiable. It is one of the disadvantages for the companies.

Lacks of Support

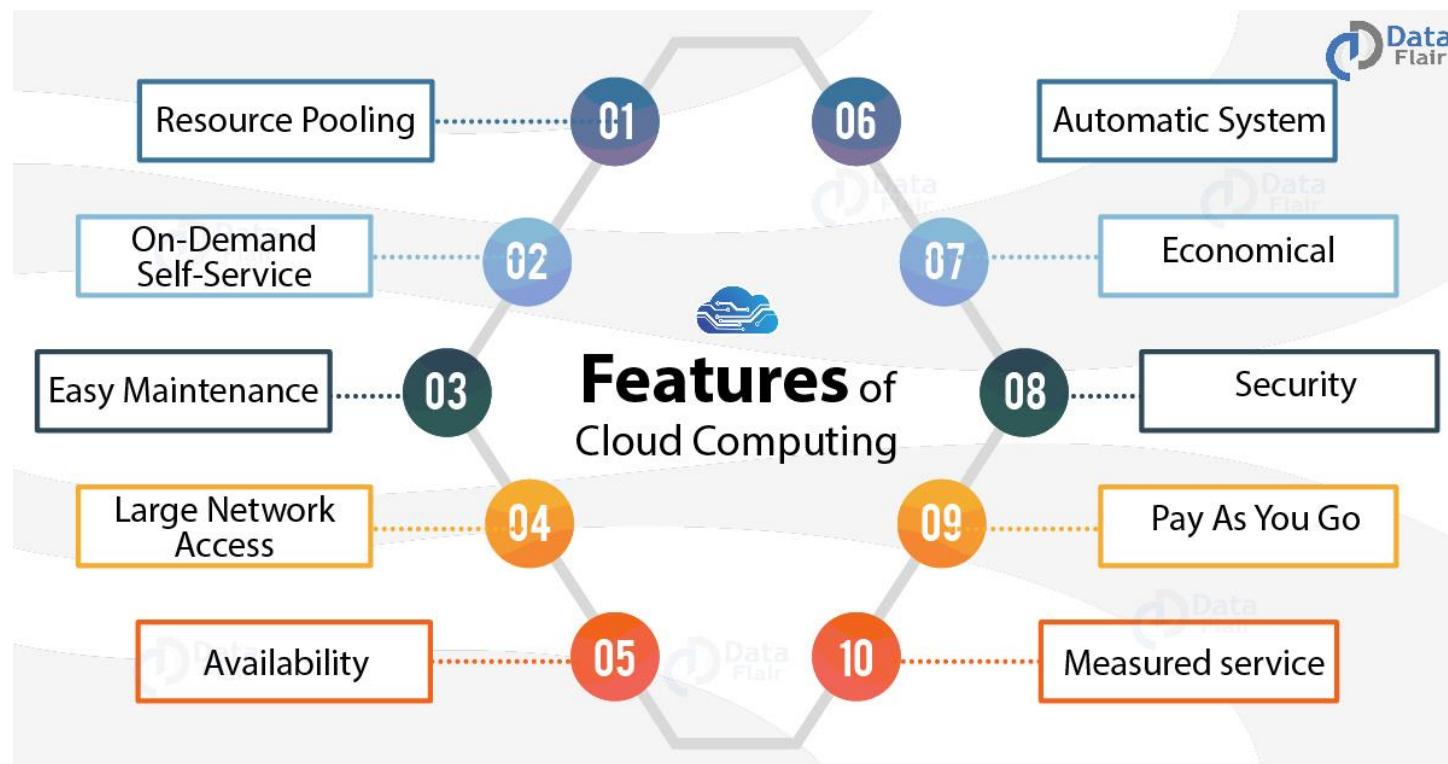
- Cloud Computing companies sometimes fail to provide proper support to the customers. Moreover, they want customers to depend fully on FAQs, which can be a tedious job.

Variation in Cost

- Cloud Computing is an economical option, but if you will consider the installation of the software it can be costly. Installation can lead to some costly features which can be non-beneficial in the future.



Characteristics of Cloud Computing





✓ Resources Pooling

- The Cloud provider pulled the computing resources to provide services to multiple customers with the help of a multi-tenant model.
- There are different physical and virtual resources assigned and reassigned which depends on the demand of the customer.

✓ On-Demand Self-Service

- The user can continuously monitor the server uptime, capabilities, and allotted network storage.

✓ Easy Maintenance

- The servers are easily maintained and the downtime is very low and even in some cases, there is no downtime.

✓ Large Network Access

- The user can access the data of the cloud or upload the data to the cloud from anywhere just with the help of a device and an internet connection.

✓ Availability

- The capabilities of the Cloud can be modified as per the use and can be extended a lot. It analyzes the storage usage and allows the user to buy extra Cloud storage if needed for a very small amount.

✓ Automatic System

- Cloud computing automatically analyzes the data needed and supports a metering capability at some level of services.
- Monitor, control, and report the usage-transparency



✓ **Economical**

- It is the one-time investment to buy the storage which saves the company from monthly or yearly costs. Only basic maintenance and a few more expenses

✓ **Security**

- Cloud Security, is one of the best features of cloud computing. It creates a snapshot of the data stored so that the data may not get lost even if one of the servers gets damaged.
- The data is stored within the storage devices, which cannot be hacked and utilized by any other person.

✓ **Pay as you go**

- The user has to pay only for the service or the space they have utilized.
- No hidden or extra charge thus economical - some space is allotted for free.

✓ **Measured Service**

- Cloud Computing resources used is recorded and monitored and thus this resource utilization is analyzed to support charge-per-use capabilities



Key advantages of Cloud computing

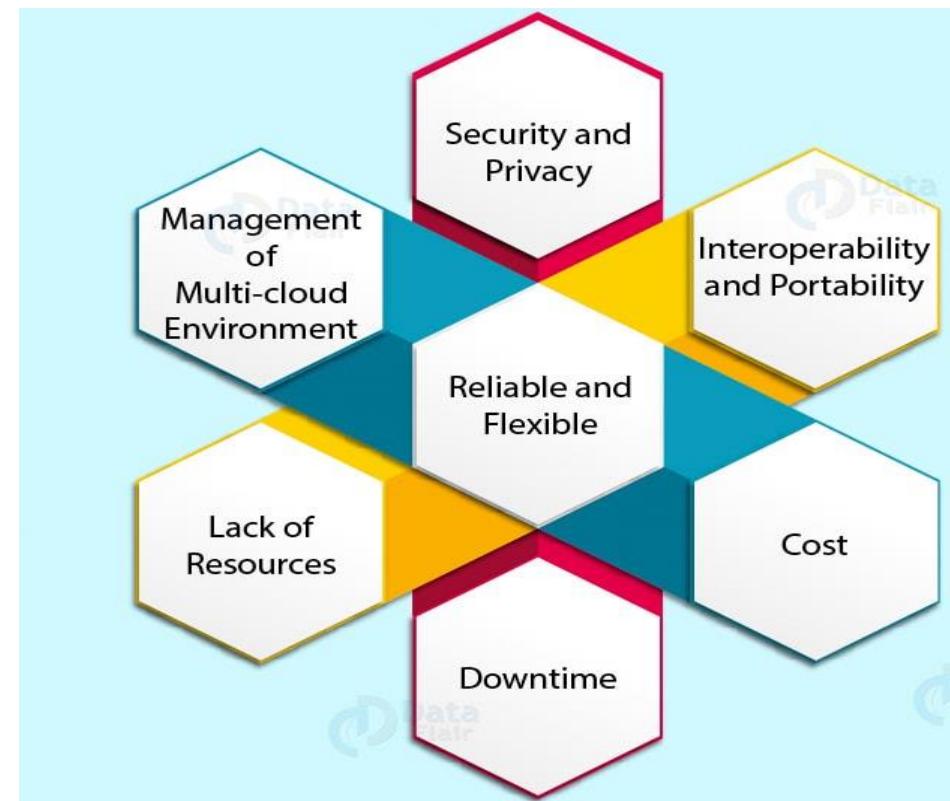




Challenges of Cloud Computing

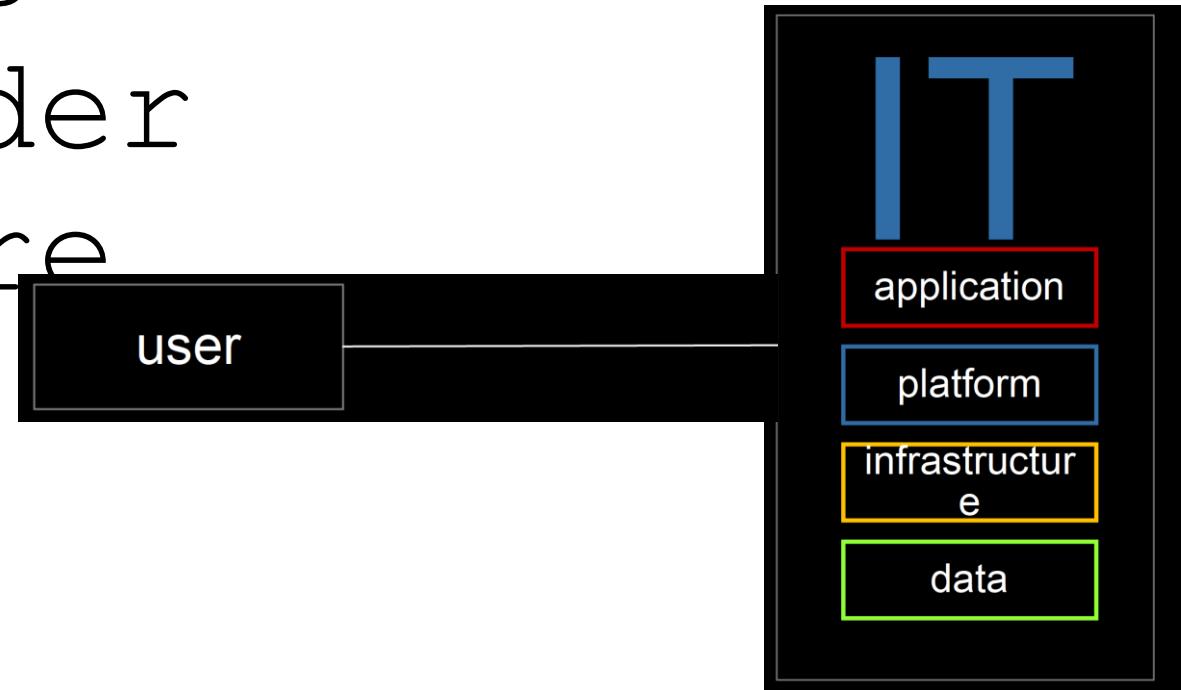
List of risks and challenges of Cloud computing

- Security & Privacy
- Interoperability & Portability
- Reliable and flexible
- Cost
- Downtime
- Lack of resources
- Management of Multi-Cloud Environment



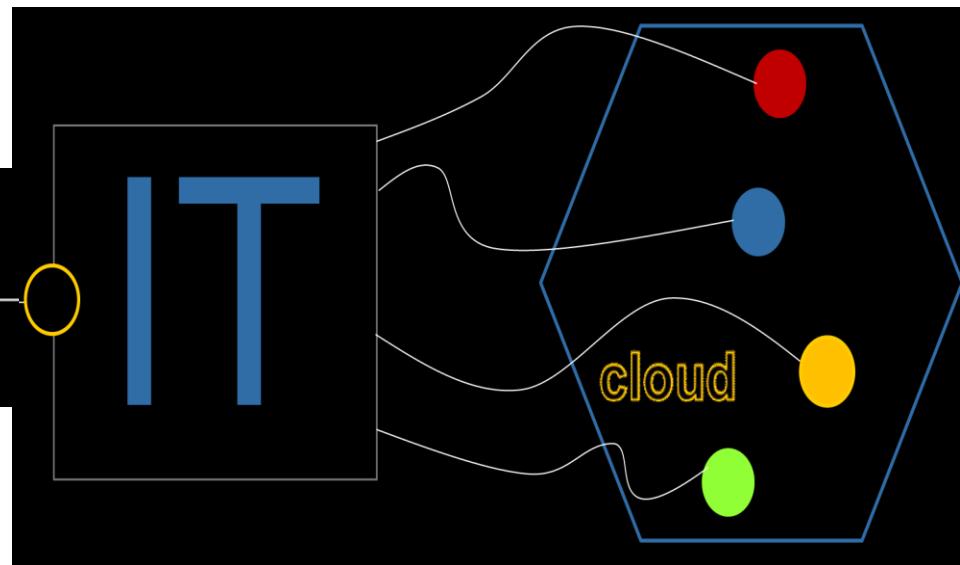


Technology silos are under pressure





Resulting in
a paradigm
shift in the
way IT is
consumed





The Cloud is composed of

Cloud

A diagram illustrating the components of the cloud. On the left, a large blue hexagon contains the word "Cloud". Three yellow dotted lines extend from the right side of the hexagon to three separate rectangular boxes, each containing a number and text. The top box contains "5 essential characteristics", the middle box contains "3 deployment models", and the bottom box contains "4 service models".

5 essential characteristics

3 deployment models

4 service models

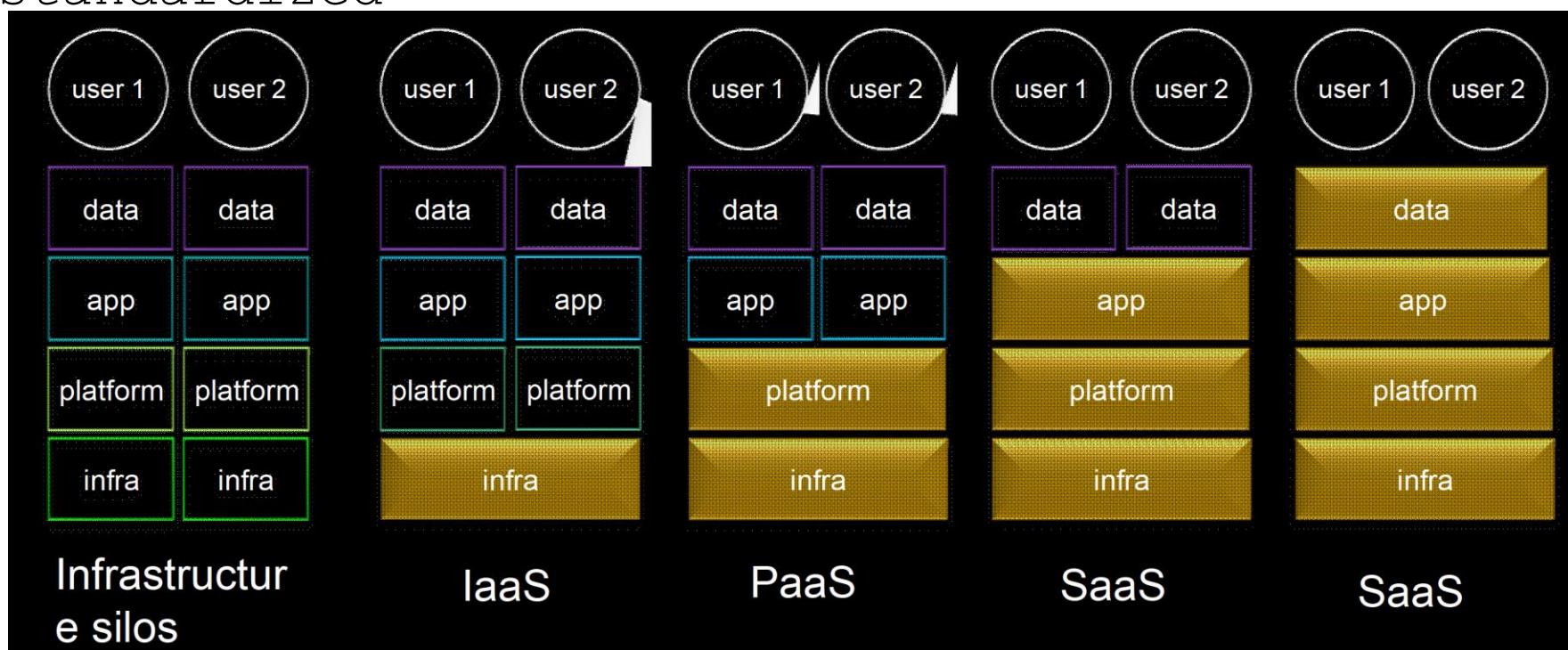


Essential characteristics

- **Service based**
- Massively scalable and elastic
- Shared
- Consumption based billing
- Delivered via Internet technologies

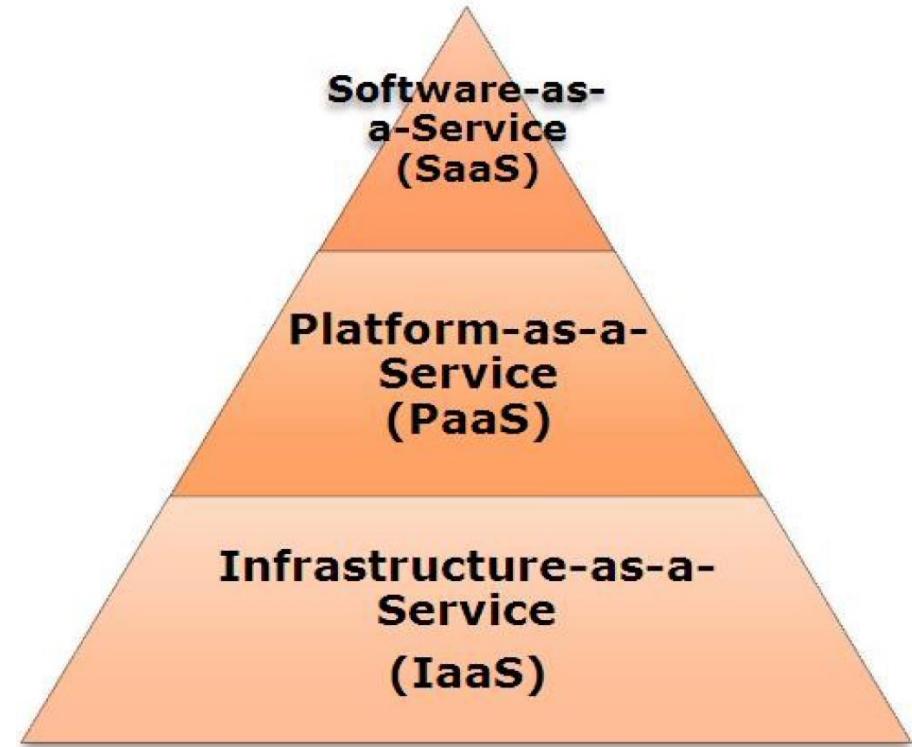
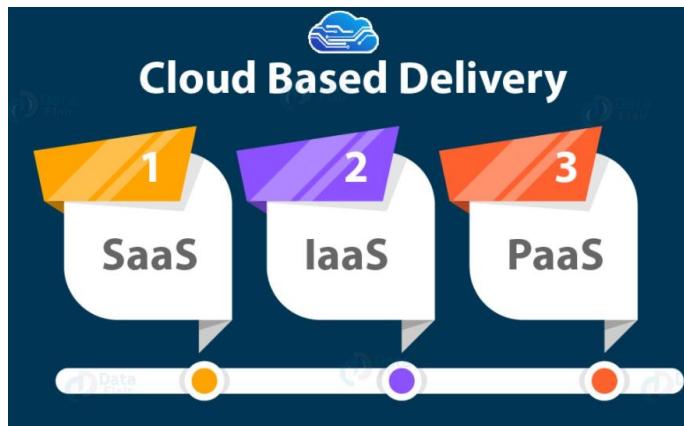


- Cloud infrastructure is shared and standardized





Deployment models





Cloud Delivery Methods

SaaS (Software as a service)

- The cloud provider provides software with the help of internet.
- It is scalable and provides a benefit that the system administrators can upload the applications to each of their own servers.
- The customers using SaaS can also access the application without installing the software.

IaaS (Infrastructure as a service)

- This means that taking the physical hardware and providing the virtual services. In this, there are businesses which pay the fee to run virtual servers, network, and storage from the cloud.

PaaS (Platform as a service)

- The third party provider delivers hardware and software tools. Best suited for application development.
- The host providing this service provides the hardware and software on its own. This benefits the user by not installing the software at their premises.



SaaS (Software as a service)

- Also known as;
 - Hosted software (applications)
 - On-demand software (applications)
 - Web-based software (applications)
- The cloud services are provided by the third party over the internet
- The software in SaaS is licensed on a subscription basis and centrally hosted
- Most common delivery models for many business applications; office software, messaging software, payroll processing software, etc.

SaaS Applications

- SaaS vendors are developing and managing their own applications
- Rely on the internet and web browser for access
- SaaS solution utilizes the architecture; an application serves multiple business and user and maintains the data accordingly



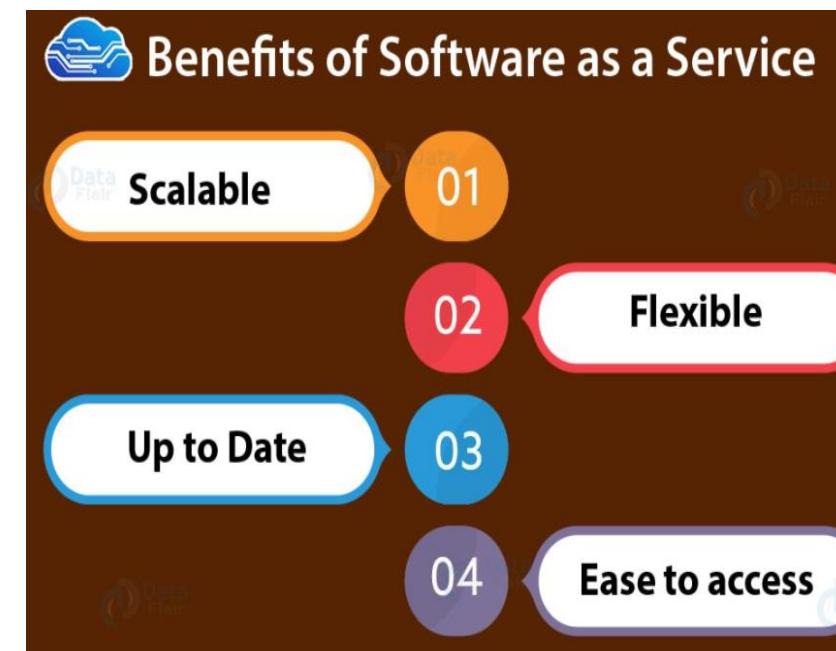
SaaS Architecture

- Multitenant Architecture:
 - Single configuration; operating system, hardware, network use for all the customers.
 - It's economical
- Virtualization:
 - Eliminates the cost of physical components



Advantages of SaaS

- Scalable
 - The service of Software as a Service (SaaS) is very scalable and provides various features to the customers as per their demand.
- Flexible
 - SaaS eliminates the cost to purchase. The pay-as-you-go service helps to reduce the cost. This allows business to exercise better and more predictable budgeting. The customer can stop using the service and the cost will be limited.
- Up to Date
 - With new updates, the SaaS is gradually improving. This reduces the burden of the staff and provides a better service.
- Ease of access
 - The SaaS applications can access with the help of the internet from anywhere. This makes it flexible for the customers and is easily available.





Disadvantages of Software as a Service

- Connectivity Demand
 - The SaaS is completely dependent on the internet and if your internet service fails, you'll lose access to your software or data
- Performance
 - The speed of SaaS can vary on the premises of the customer, therefore its price keeping performance in mind your, software not host on a local machine.
- Management
 - The management on the premises of the customer can serve better as compared to the hosted management wherever management resides with a 3rd party. Usually, everybody should use the newest version of the software application and can't defer upgrades or changes within the options.
- Security and Knowledge Considerations
 - The privacy of sensitive data and access management could be a major thought around cloud and hosted services.
- Limited Variety of Applications
 - There are limited functions of the applications. So they release features which lack some features. There are still several applications that do not provide a hosted platform.
 - The evaluation is done to make sure that the Software as a Service solution provides the features which are required to expand the business.





Varieties of Software as a Service

Vertical SaaS

- This is the software which manages the demand of a particular organization. This can be software for healthcare, agriculture, real estate, finance industries.

Horizontal SaaS

- This is the product which concentrates on the software such as marketing, tools, Human Resource, and many more.



SaaS providers and services



Provider	Services
Salseforce.com	On-demand CRM solutions
Microsoft Office 365	Online office suite
Google Apps	Gmail, Google Calendar, Docs, and sites
NetSuite	ERP, accounting, order management, CRM, Professionals Services Automation (PSA), and e-commerce applications.
GoToMeeting	Online meeting and video-conferencing software
Constant Contact	E-mail marketing, online survey, and event marketing
Oracle CRM	CRM applications
Workday, Inc	Human capital management, payroll, and financial management.



Platform as a Service (PaaS)

- Allows customers to develop, run, and manage the applications by providing them with the platform and diminishing the complexities of maintenance
- Enables to deliver from simple cloud-based applications to higher cloud-enabled applications
- Purchase of resources from the cloud service provider on a pay-as-you-go basis
- Resources accessed using internet
- Provides server, storage, and networking but also database, tools, business services, and many more.
- Perform building, testing, deployment, managing, and modification of the application

How PaaS is delivered

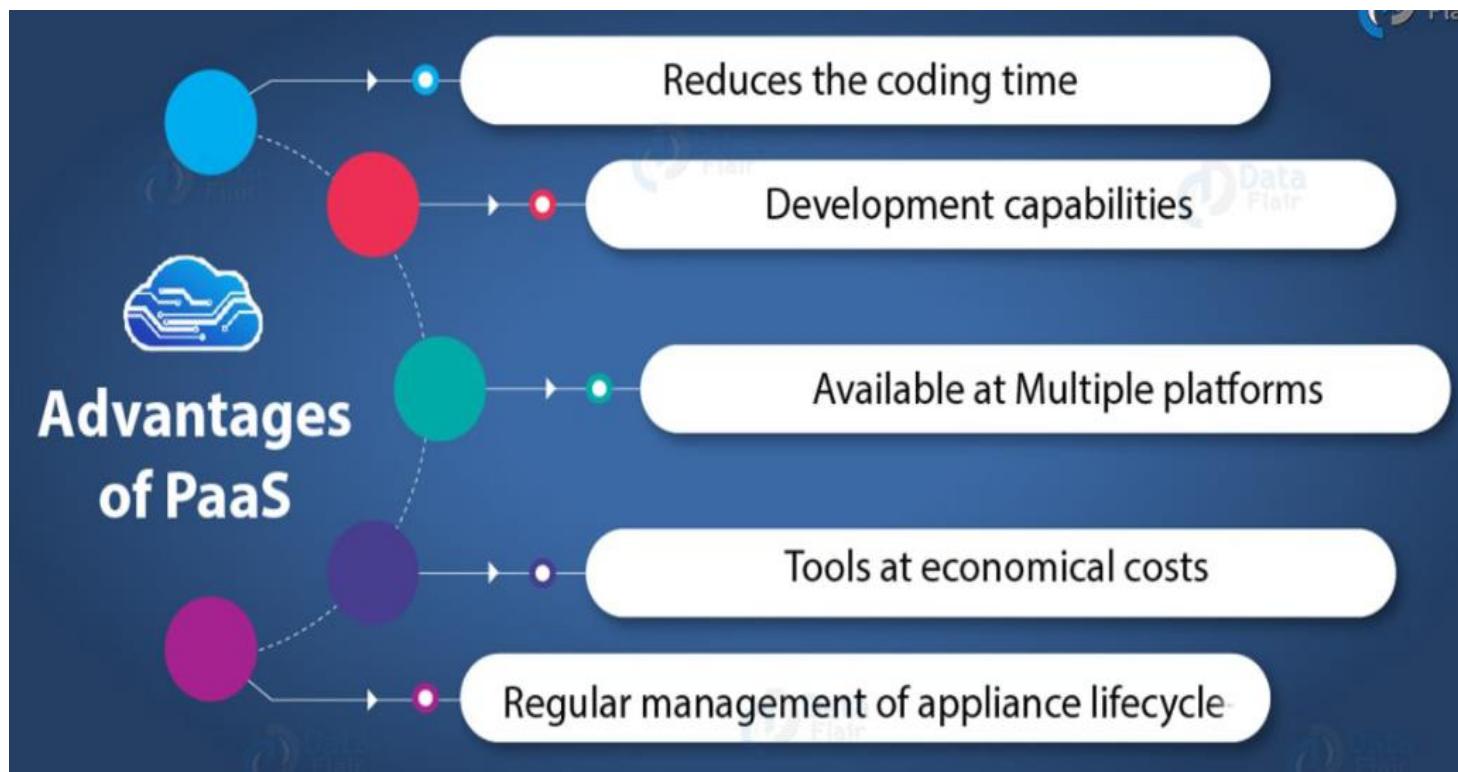
- Provider provides various functions such as networks, servers, storage, operating system, database, and configuration. Customer take care of the deployment
- As a personal service software which will be behind the firewall
- As software deployed on public IaaS

How PaaS is used

- Analytics and Business Intelligence; analyze the data by monitoring the demand of customers
- Framework; several built-in software which allows customers to built their own application
- Additional Services- workflow, directory, security, and scheduling that enhance the working of the existing applications



Advantages of PaaS





Advantages of PaaS

- Reduces the Coding Time
 - Coding new apps with pre-coded application parts design into the platform, like workflow, directory services, security measures and many others
- Enhances the Development Capabilities
 - PaaS parts will provide your development team new capabilities while you don't need to add workers having the specified skills.
- Available at Multiple platforms;
 - Mobile, tabs, and laptops
 - Multiple platforms; computers and browsers creating cross-platform apps faster and easier to develop.
- Tools at economical costs
 - Pay-as-you-go service
 - Use of subtle development package and business intelligence and analytics tools that they may not afford to get outright.
- Regular management of appliance lifecycle
 - Several capabilities support the whole net application lifecycle: building, testing, deploying, managing and change inside constant integrated setting

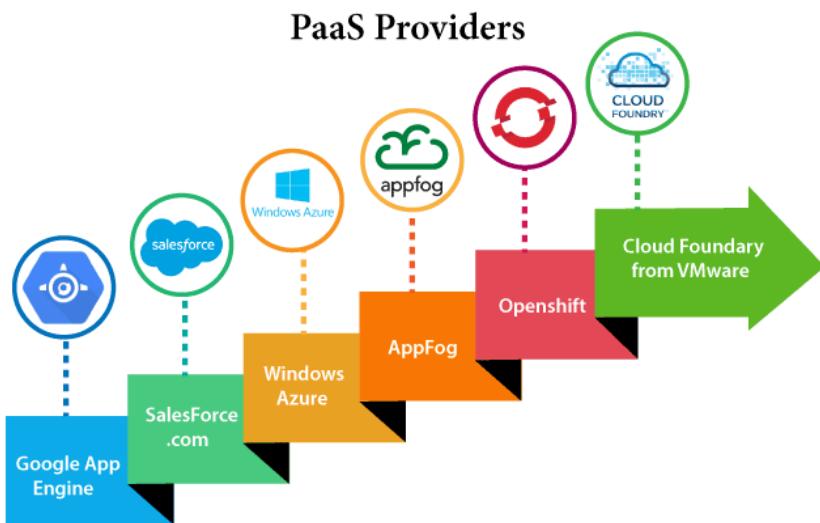


Disadvantages of PaaS

- Dependency on Vendor
 - One has to write the applications according to the platform provided by the PaaS vendor, so the migration of an application to another PaaS vendor would be a problem.
- Compatibility of Existing Infrastructure
 - It may happen that some applications are local, and some are in the cloud. So there will be chances of increased complexity when we want to use data which is in the cloud with the local data
- Security Risks
 - Corporate data, whether it can be critical or not, will be private, so if it is not located within the walls of the company, there can be a risk in terms of privacy of data



PaaS Providers and services

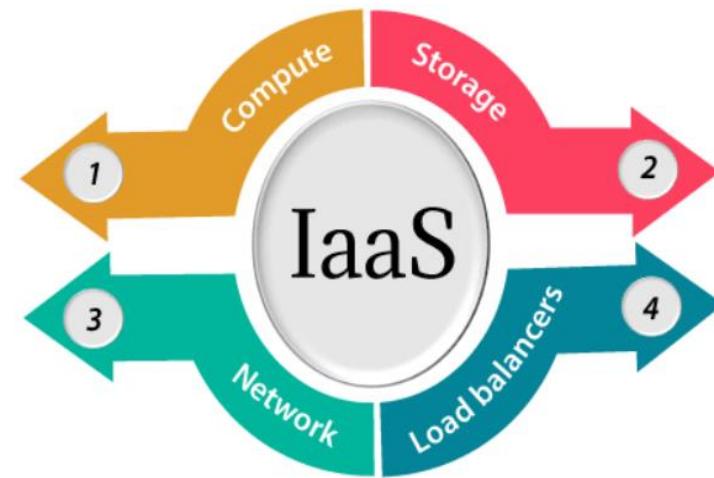


Providers	Services
Google App Engine (GAE)	App Identity, URL Fetch, Cloud storage client library, Logservice
Salesforce.com	Faster implementation, Rapid scalability, CRM Services, Sales cloud, Mobile connectivity, Chatter.
Windows Azure	Compute, security, IoT, Data Storage.
AppFog	Justcloud.com, SkyDrive, GoogleDocs
Openshift	RedHat, Microsoft Azure.
Cloud Foundry from VMware	Data, Messaging, and other services



Infrastructure as a Service (IaaS)

- Instant computing infrastructure which serves, manages, and monitors over the internet.
- Modified as per the demand of the customer
- Scale up and down; customer doesn't pay any extra charges.
- Reduces the burden to manage and maintain the servers
- Every resource has a separate component; rented as required.
- Management is done by the Cloud Service provider
- The installation, configuration, and management of the software are complete by the customer.





IaaS Services

- **Compute:** Includes virtual CPU and RAM for the VMS that is provisioned to the end-users.
- **Storage:** Back-end storage.
- **Network:** Network as a Service (NaaS) provides networking components such as routers, switches, and bridges for the VMS.
- **Load balancers:** It provides load balancing capability at the infrastructure layer.



- Scalability; Available for 24 hours and accessible anywhere.
- Pay-as-you-go; Economical
- Secure; Snapshots of the data are stored
- Save time and cost; Hardware maintenance and management



Advantages of IaaS

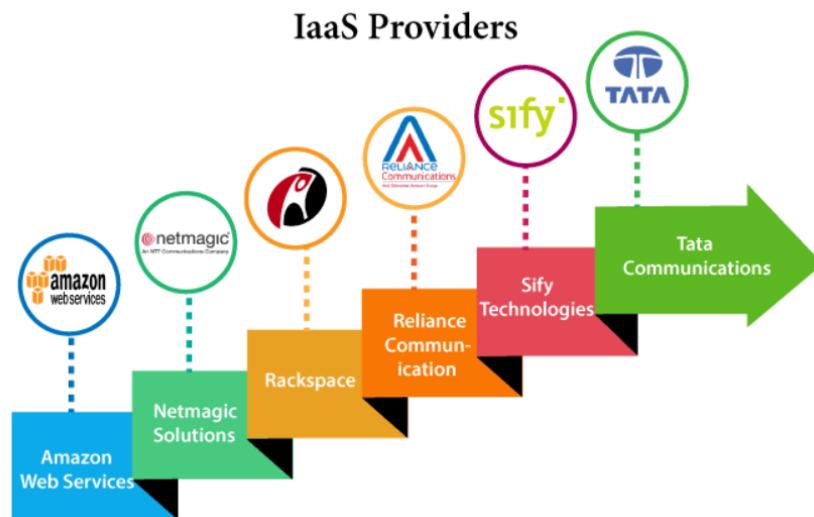
- **Shared infrastructure**
 - IaaS allows multiple users to share the same physical infrastructure.
- **Web access to the resources**
 - IaaS allows users to access resources over the internet.
- **Pay-as-per-use model**
 - IaaS providers provide services based on the pay-as-per-use basis. The users are required to pay for what they have used.
- **Focus on the core business**
 - IaaS providers focus on the organization's core business rather than on IT infrastructure.
- **On-demand scalability**
 - Users do not worry about upgrading software and troubleshoot the issues related to hardware components.

Disadvantages of IaaS

- **Security**
 - Security is one of the biggest issues in IaaS. Most of the IaaS providers are not able to provide 100% security.
- **Maintenance & Upgrade**
 - Although IaaS service providers maintain the software, but they do not upgrade the software for some organizations.
- **Interoperability issues**
 - It is difficult to migrate VM from one IaaS provider to the other, so the customers might face problem related to vendor lock-in.



IaaS Providers and platform

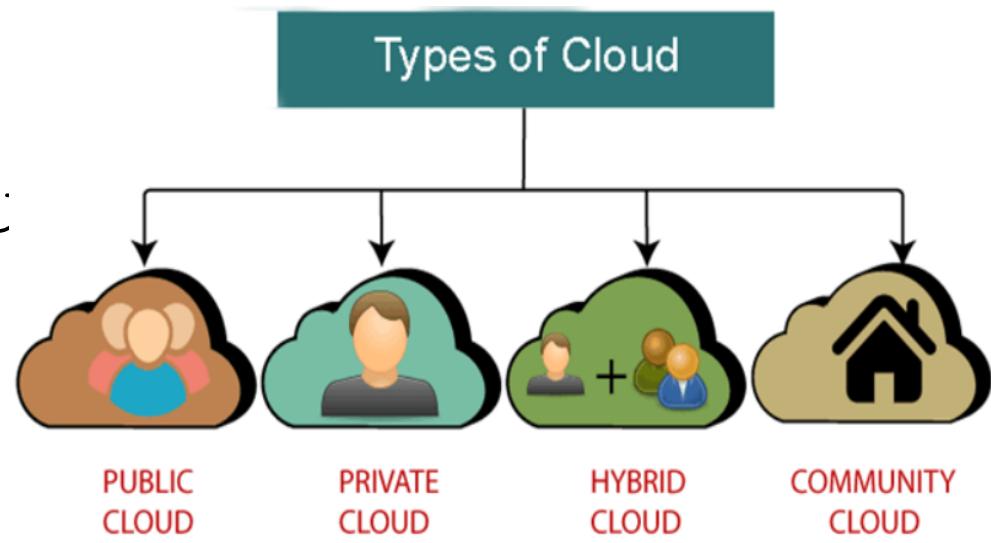


IaaS Vendor	IaaS Solution
Amazon Web Services	Elastic, Elastic Compute Cloud (EC2) MapReduce, Route 53, Virtual Private Cloud, etc.
Netmagic Solutions	Netmagic IaaS Cloud
Rackspace	Cloud servers, cloud files, cloud sites, etc.
Reliance Communications	Reliance Internet Data Center
Sify Technologies	Sify IaaS
Tata Communications	InstaCompute



Cloud Services Models

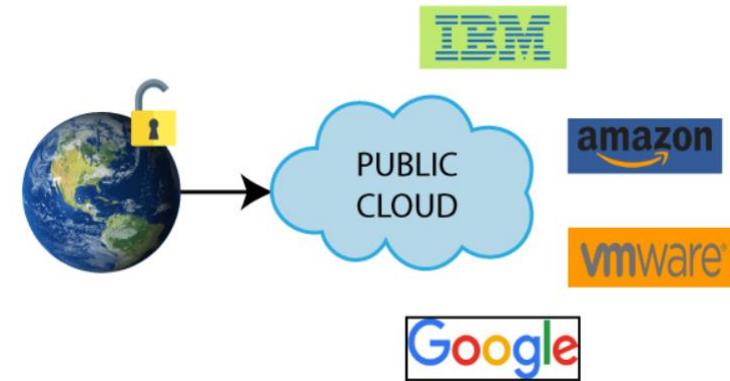
- Private cloud
- Community cloud
- Public cloud
- Hybrid cloud





Public Cloud

- Public cloud is open to all to store and access information via the Internet using the pay-per-usage method.
- In public cloud, computing resources are managed and operated by the Cloud Service Provider (CSP) .
- It is basically used by the private individuals; infrastructure, security
- Data Center; many companies rather than the single company



Examples of cloud providers; Amazon elastic compute cloud (EC2), IBM SmartCloud Enterprise, Microsoft, Google App Engine, Windows Azure Services Platform.



Advantages of Public Cloud

- Cheap: Lower cost than the private and hybrid cloud.
- Maintenance: The cloud service provider, so do not need to worry about the maintenance.
- Easier to integrate: offers a better flexibility approach to consumers.
- Location independent: Services are delivered through the internet.
- Highly scalable: Usage depends on the requirement of computing resources.
- Public access: No limit to the number of users.

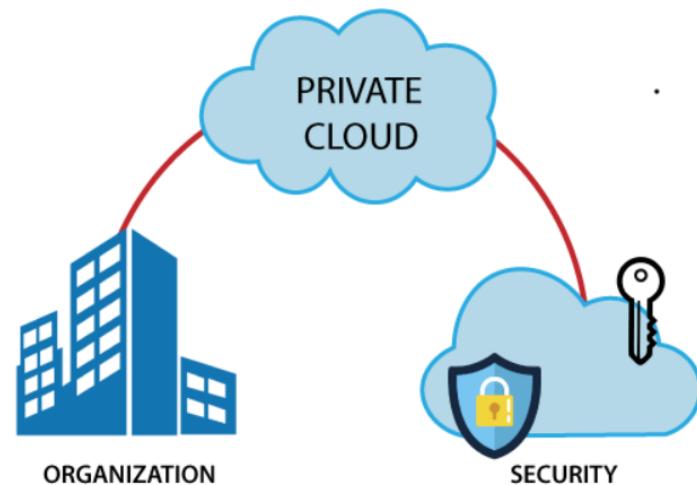
Disadvantages of Public Cloud

- Less secure because resources are shared publicly.
- Performance depends upon the high-speed internet network link to the cloud provider.
- The Client has no control of data.



Private Cloud

- Private cloud is also known as an internal cloud or corporate cloud.
- It is used by organizations to build and manage their own data centers internally or by the third party.
- It can be deployed using Opensource tools such as Openstack and Eucalyptus.
- Based on the location and management;
 - On-premise private cloud
 - Outsourced private cloud





Private Cloud Cont'd

Advantages

- Private cloud provides a high level of security and privacy to the users.
- Private cloud offers better performance with improved speed and space capacity.
- It allows the IT team to quickly allocate and deliver on-demand IT resources.
- The organization has full control over the cloud because it is managed by the organization itself. So, there is no need for the organization to depend on anybody.
- It is suitable for organizations that require a separate cloud for their personal use and data security is the first priority.

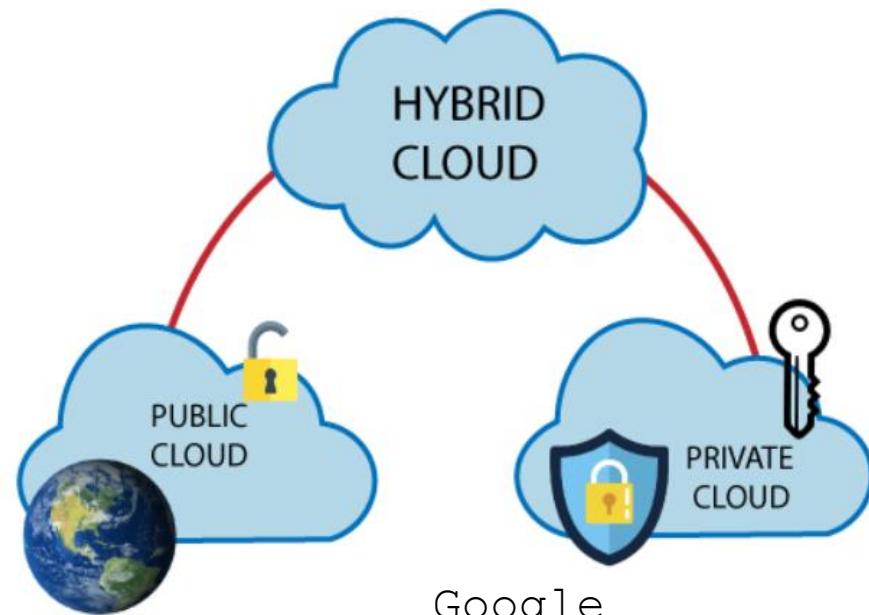
Disadvantages

- Skilled people are required to manage and operate cloud services.
- Private cloud is accessible within the organization, so the area of operations is limited.
- Private cloud is not suitable for organizations that have a high user base, and organizations that do not have the prebuilt infrastructure, sufficient manpower to maintain and manage the cloud.



Hybrid Cloud

- Combination of the public cloud and the private cloud;
- \bullet ***Hybrid Cloud = Public Cloud + Private Cloud***
- Partially secure;
 - Services are running on the public cloud
 - Services are running on a private cloud



Google

Application Suite (Gmail, Google Apps, and Google Drive), Office 365 (MS Office on the Web and One Drive), Amazon Web Services.



Hybrid Cloud Cont'd

Advantages

- Hybrid cloud is suitable for organizations that require more security than the public cloud.
- Hybrid cloud helps you to deliver new products and services more quickly.
- Hybrid cloud provides an excellent way to reduce the risk.
- Hybrid cloud offers flexible resources because of the public cloud and secure resources because of the private cloud.

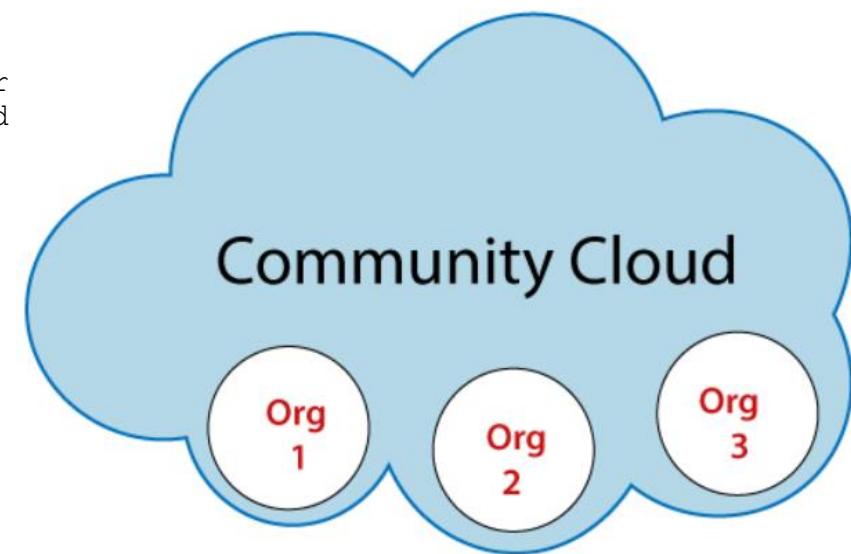
Disadvantages

- In Hybrid Cloud, security feature is not as good as the private cloud.
- Managing a hybrid cloud is complex because it is difficult to manage more than one type of deployment model.
- In the hybrid cloud, the reliability of the services depends on cloud service providers.



Community Cloud

- Systems and Services is accessible by a group of several organizations to share the information between the organization and a specific community.
- It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.



Health Care commun



Community Cloud Cont'd

Advantages

- Community cloud is cost-effective because the whole cloud is being shared by several organizations or communities.
- Community cloud is suitable for organizations that want to have a collaborative cloud with more security features than the public cloud.
- It provides better security than the public cloud.
- It provides collaborative and distributive environment.
- Community cloud allows us to share cloud resources, infrastructure, and other capabilities among various organizations.

Disadvantages

- Community cloud is not a good choice for every organization.
- Security features are not as good as the private cloud.
- It is not suitable if there is no collaboration.
- The fixed amount of data storage and bandwidth is shared among all community members.



Comparison between public, private, hybrid, and community clouds

Parameter	Public Cloud	Private Cloud	Hybrid Cloud	Community Cloud
Host	Service provider	Enterprise (Third party)	Enterprise (Third party)	Community (Third party)
Users	General public	Selected users	Selected users	Community members
Access	Internet	Internet, VPN	Internet, VPN	Internet, VPN
Owner	Service provider	Enterprise	Enterprise	Community



Major Cloud Service Providers (CSP)



Google Cloud Platform



DigitalOcean



Microsoft Azure



IBM Cloud Services



VMware



Alibaba Cloud



Cloud computing in Uganda

- NITA-U IT Survey review
- National Guidelines on Cloud Computing-GOU
- Cloud Services providers (CSP)
- Cloud computing services
- Barriers/Challenges



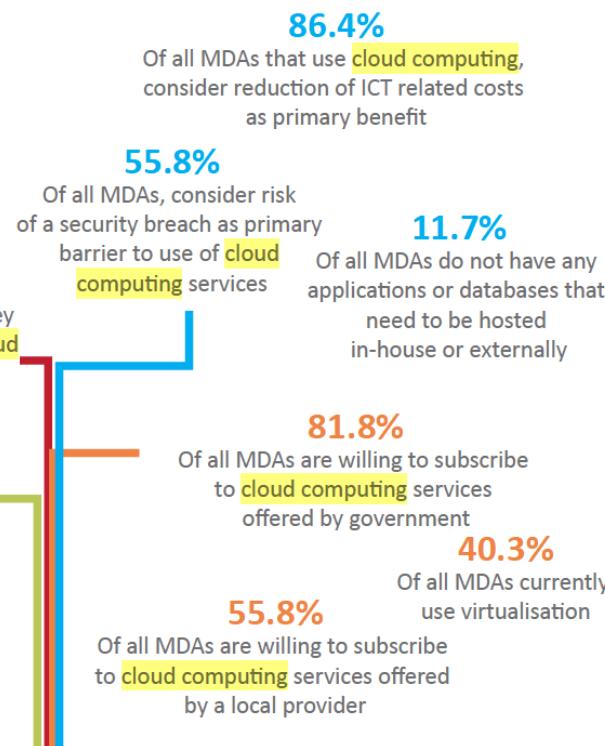
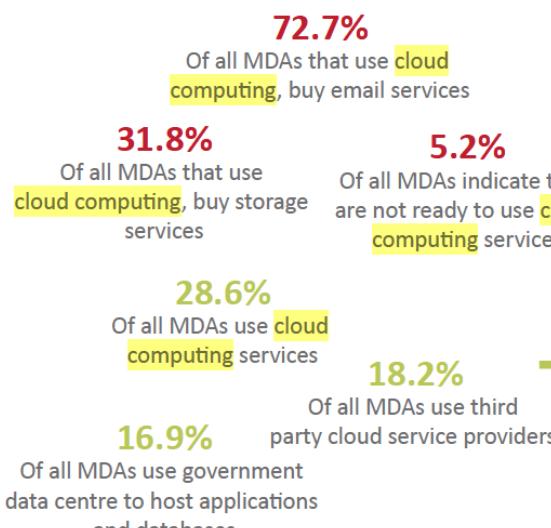
National Guidelines on Cloud Computing

- Establishment of a Government Cloud due to;
 - The ownership of organizational data
 - Privacy and security challenges of organizational data
 - Vendor lock-in challenges
- National Data Centre to promote e-government;
 - Hosting services
 - Data center services
 - Disaster recovery services
- Uganda for cloud services exceptions
- Adhere to the use of 'Cloud First' for the design of IT enabled services
- Ensure that all information assets classified as OFFICIAL, SECRET and TOP SECRET
- Utilize the Government Cloud when procuring new ICT requirements;



NITA-U IT Survey review

Clouding computing indicators



Source: [https://www.nita.go.ug/sites/default/files/publications/National IT Survey April 10th.pdf](https://www.nita.go.ug/sites/default/files/publications/National%20IT%20Survey%20April%2010th.pdf)



Cloud Services Providers in Uganda

DataNet
a BringCom company



GATEWAY
TECHNOLOGIES LIMITED

cf Computer Facilities
Technical Services
ICT Solutions Service & Support

Services offered

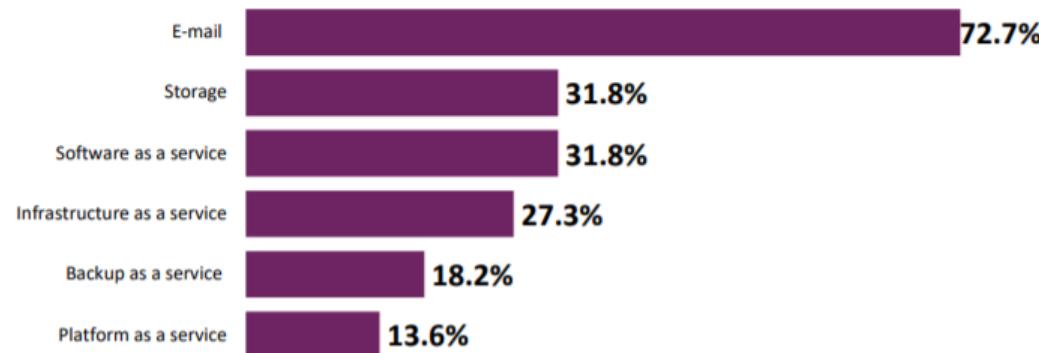
- Security
- Business Class e-mail
- Managed Services
- Compute Facilities
- Daily Backups
- Cloud Integration Services
- Cloud-Based Backup Services etc



Most used cloud services in Uganda

Cloud computing services bought by MDAs

Does your institution buy any of the following cloud computing services used over the internet? (multiple-select, ranked)



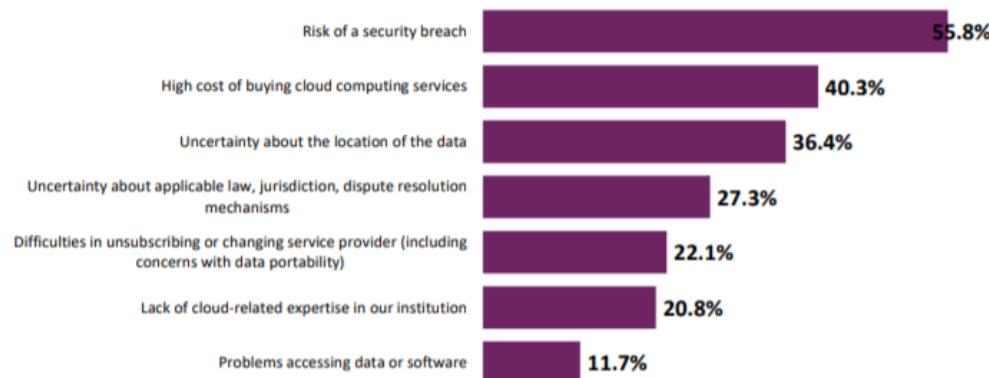
Source: [https://www.nita.go.ug/sites/default/files/publications/National IT Survey April 10th.pdf](https://www.nita.go.ug/sites/default/files/publications/National%20IT%20Survey%20April%2010th.pdf)



Barriers/ Challenges

Barriers to MDA use of cloud-computing

What factors prevent or limit your institution from using cloud computing services? (multiple-select, top 7, ranked)



Source: [https://www.nita.go.ug/sites/default/files/publications/National IT Survey April 10th.pdf](https://www.nita.go.ug/sites/default/files/publications/National%20IT%20Survey%20April%2010th.pdf)



Top drivers for public sector Cloud adoption

Driver

- Cost reduction
- Speed to implement
- Agility
- Access to expertise
- Virtualisation

Focus

- CAPEX pressures
- Driving efficiency
- Changing regulatory conditions
- Maximise hardware utilisation



Top inhibitors for Public Sector cloud adoption

Inhibitors

- Data location
- Security
- Privacy
- Auditability
- E-discovery

Focus

- Know, control, audit data location(s)
- FISMA, ISO 27001, SAS-70 Type II
- Sufficient data protection of personal information
- Access and support of audit requirements
- Compliant data retention, recovery and management



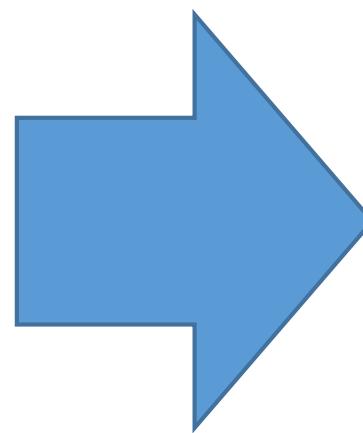
The Future....

- **Quantum computing:** Quantum computers use the principles of quantum physics to perform complex algorithm calculations and process massive datasets in quick time
- **Automation:** Helps business organizations improve their productivity without spending too much time and effort
- **Big data Analytics:** Statistics on big data generation show that 2.3 trillion gigabytes of data are created every day. **Challenges;** storing, processing and managing data efficiently.
- **Artificial intelligence:** Continuous innovations in **cloud computing**, support emerging technologies
- **Serverless architecture:** Give developers a quick way to create systems and applications
- **Leaps in Security and cloud compliance:** security compliance is a shared responsibility of all the stakeholders involved overseeing the security operations of the organization, by proper resource usage.
- **Internet of Things (IoT):** The IoT devices can leverage cloud computing as it offers, high speed, performance, flexibility, and ample storage space to keep the data safe, find resources, and share information





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**THANK YOU
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