



BITS Pilani
Pilani Campus



CLOUD COMPUTING

Session 1

Dr. S. Prabakeran
Guest Faculty

Session Agenda



Cloud Computing – An Overview

- Introductions – Tutor, Course & Students
- Paradigms & Distributed Computing
- origins & Motivation for Cloud
- What is Cloud Computing
- Is Cloud Computing for me?

Types of Clouds & Service Deployment

- 3-4-5 Rule of Cloud Computing
- Cloud Infrastructure & Deployment

Wrap Up

- Perceived benefits of Cloud ecosystem
- Challenges to Overcome
- Advantages & Disadvantages
- Commercial offering of Cloud services
- Reality Check



Introductions



Course & Instructor

About Myself

Dr. S. Prabakeran

Associate Professor, Guest Faculty

prabakeran.s@wilp.bits-pilani.ac.in

About the Course

Objective :

| No | Course Objective |
|-----|---|
| CO1 | Students will learn the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges; |
| CO2 | Students will learn the basic ideas and principles in data centre design and management |
| CO3 | Students will learn about cloud components and technologies and relevant distributed file systems |
| CO4 | Students will learn a variety of programming models and develop working experience |

Evaluation Scheme

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

| No | Name | Type | Duration | Weight | Day, Date, Session, Time |
|------|--------------------|--------------------|------------------|--------|--------------------------|
| EC-1 | Quiz-1 | | * | 5% | September 1-10, 2024 |
| | Quiz-2 | | * | 5% | October 10-20, 2024 |
| | Assignment | | * | 5% | November 1-10, 2024 |
| EC-2 | Mid-Semester Test | <u>Closed Book</u> | 2 hours | 35% | Sunday, 22/09/2024 (AN) |
| EC-3 | Comprehensive Exam | <u>Open Book</u> | 2 <u>½ hours</u> | 50% | Sunday, 01/12/2024 (AN) |

Cloud Skills

Cloud engineer skills at a glance



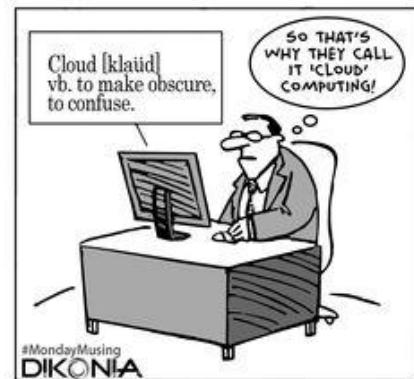


Cloud – An Introduction



What is Cloud Computing

Your Opinion ?



Why is it Called Cloud

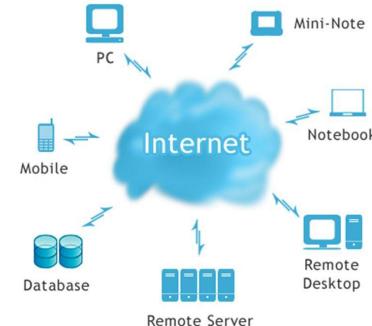
Cloud computing, eponymously is named after the cloud symbol used in architecture documents.

By now, you must be aware that this has no relation to its namesake from the meteorology department, but it simply means that we are using the internet to store data on remote servers, rather than storing them locally on our hard disks.

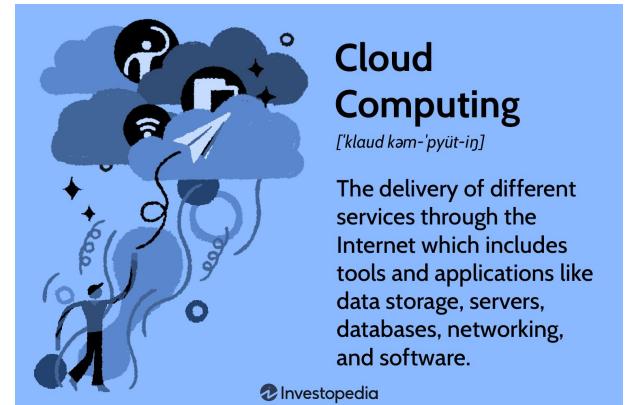
Many types of Cloud Computing Applications Exist. Depending on the need of your IT the type of cloud solution may vary.

Cloud Computing is up to 40 times more cost-effective for an SMB compared to running its own IT system or department.

Cloud Computing



Why is it called the cloud?



What's in the Cloud ??

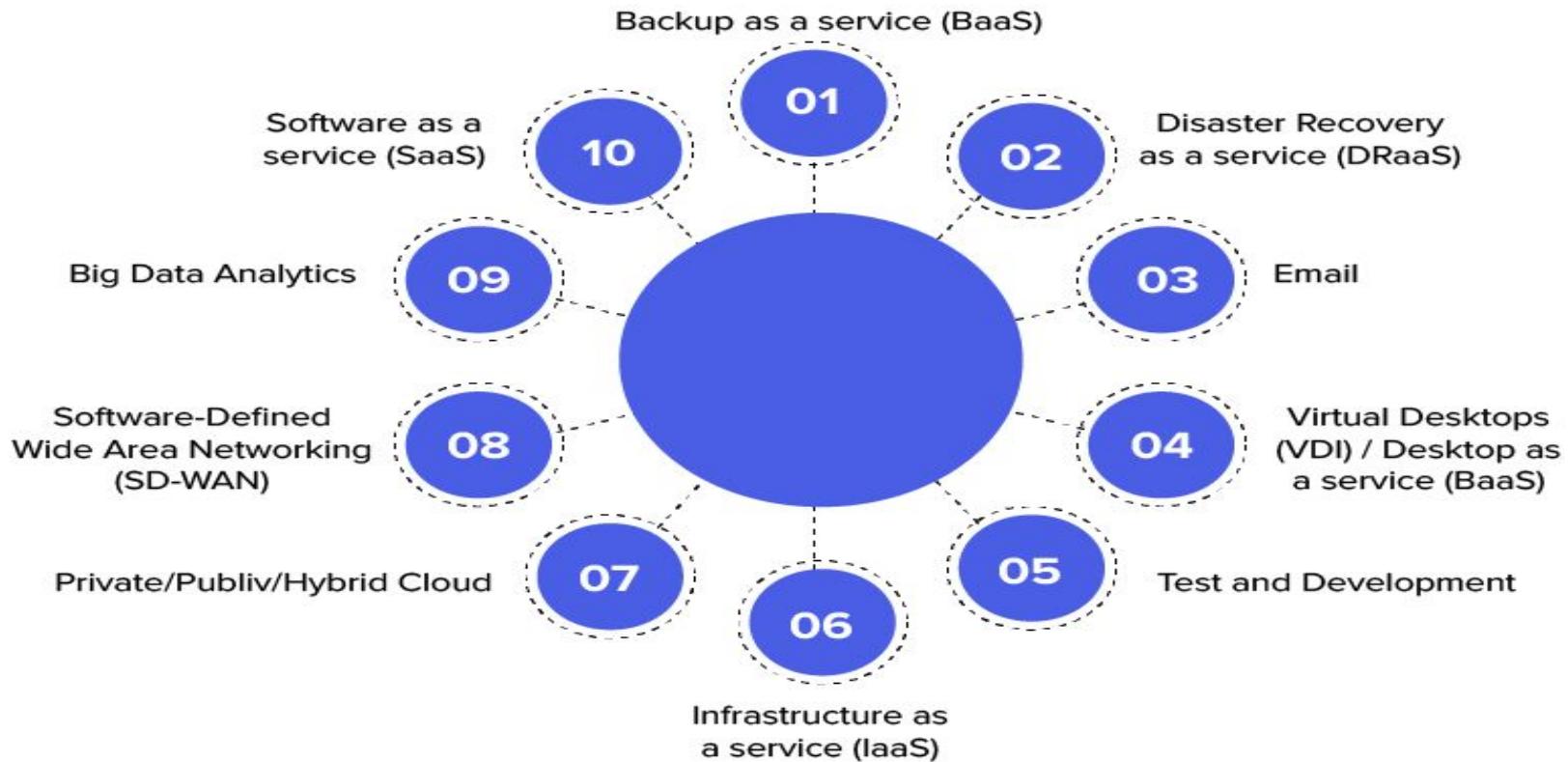
What is Cloud Computing?



HCL TECHNOLOGIES:
An Indian IT services company listed on the NSE and BSE.

Familiar Use Cases

Cloud Computing Use Cases



Facts about Cloud

Here are our top cloud facts for 2022:

1. By 2022, more than 90% of enterprises will rely on a hybrid cloud environment to meet their infrastructure needs. ([Source](#))
2. The value of the cloud computing market is estimated to be \$832.1 billion by the end of 2025 (compared to \$371.4 billion in 2020). ([Source](#))
3. Cloud security is a top concern for 75% of enterprises. ([Source](#))
4. By 2025 there will be over 100 Zettabytes of data stored in the cloud (1 zettabyte = 1 billion terrabytes = 1 trillion gigabytes). ([Source](#))
5. 50% of companies reported higher cloud usage than planned during the Covid-19 pandemic. ([Source](#))
6. 61% of organizations want to optimize cloud spend, making it the top initiative for the 5th year in a row. ([Source](#))
7. The public cloud sector is expected to generate \$331 billion in revenue by 2022 (up from \$175.8 billion in 2018). ([Source](#))
8. Spending on IT infrastructure is predicted to reach \$55.7 billion by 2022. IDC predicts a 10.9% growth in demand for servers, switchers, and storage solutions.
9. Platform-as-a-Service (PaaS) grew in adoption to 56% in 2021, making it the fastest growing segment in cloud platforms. ([Source](#))
10. 93% of businesses have a multi-cloud strategy. As these deployments mature, cost containment and cybersecurity will be top priorities. ([Source](#))

Facts about Cloud - Now

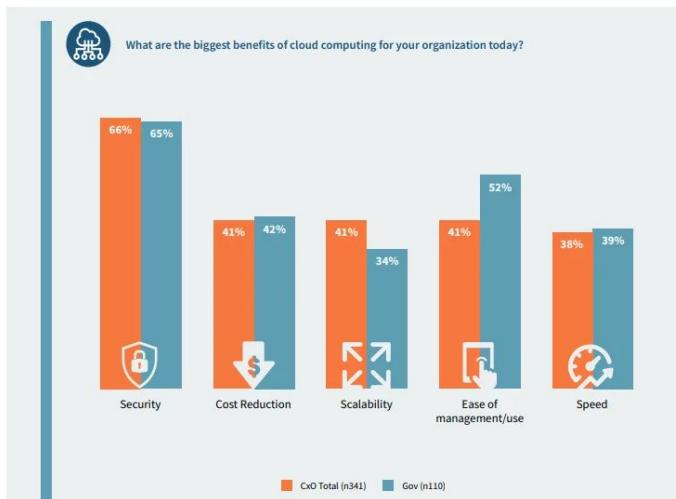
More than 90% of organizations use the cloud (Source: O'Reilly)

O'Reilly's latest Cloud Adoption report had some interesting numbers. Consider this:

- About two-thirds of respondents currently operate in a public cloud and 45% use a private cloud – versus 55% who still rely on traditionally managed on-premises systems.
- 48% plan to migrate at least half of their applications to the cloud in the next year; 20% intend to move all their applications to the cloud.
- 47% are pursuing a cloud-first strategy; 30% are already cloud-native; 37% intend to be cloud-native in about three years.
- Only 5% plan on switching from the cloud to on-premises infrastructure (cloud repatriation).

6 in 10 CxOs say cloud computing improves security (Source: Oracle)

Security is the top benefit of cloud computing, according to 60% of C-Suite executives – ahead of cost savings, scalability, ease of maintenance, and speed.



► What percentage of your workloads are in the cloud today?

TODAY

Up to 25%
35% | 18%

26% | 24%

51%-75%
39% | 19% → 27% | 58%
are running more than 50% of workloads in the cloud
+75% | 20% → 31%

Share of workloads in the cloud

► What percentage of your workloads will be in the cloud in the next 12-18 months?

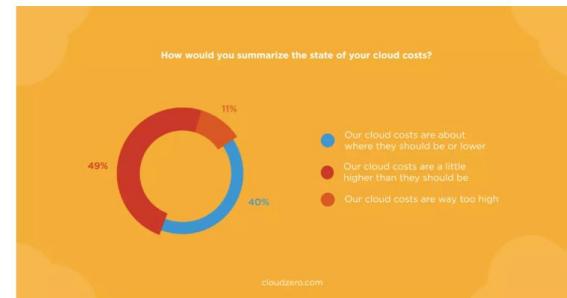
NEXT 12-18 MONTHS

Up to 25%
18% | 26% → 24%
51%-75%
39% | 19% → 27% | 58%
will be running more than 50% of workloads in the cloud
+75% | 20% → 31%

Cloud costs are higher than expected for 6 in 10 organizations (Source: CloudZero)

As companies invest more in the cloud, only 4 in 10 organizations have their cloud costs around where they expect.

Some 490 out of 1,000 respondents said their cloud costs were a little higher than where they should be while 110 reported cloud costs were way too high.





Cloud – Origins & Motivation



Origins

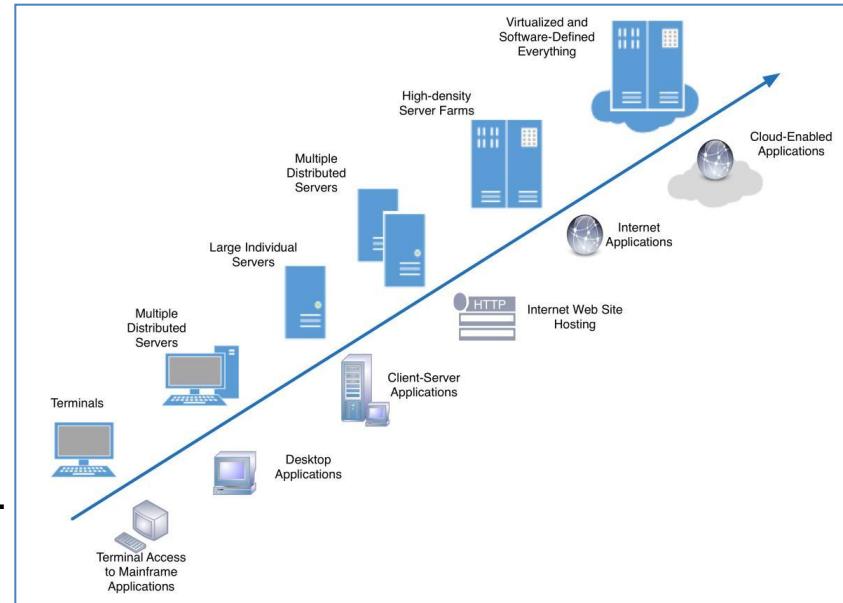
We are at a major inflection point in computing today.

Traditional computational models are now passé.

Amazon started the concept by renting spare computing power from their retail business.

Web and mobile technologies have resulted in information explosion. This means traditional computing power is not enough to process data.

To solve this challenge, we need to use large scale distributed networks. These distributed networks evolved to the Cloud technology.

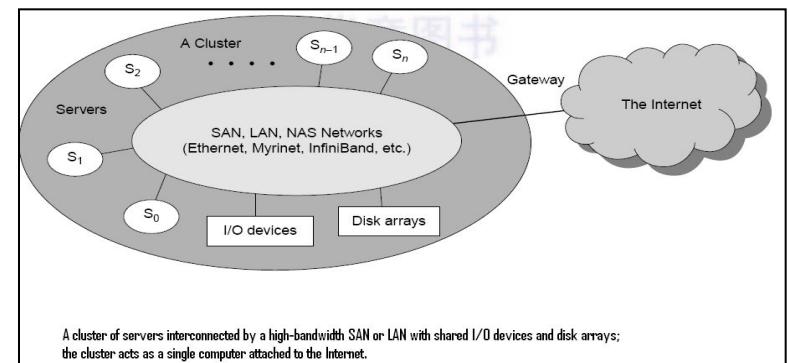


Paradigms

A *paradigm* is a standard, perspective, or set of ideas. A *paradigm* is a way of looking at something.

Types of Distributed Computing

- **Parallel Computing** : Parallel computing is a form of computation in which many calculations are carried out simultaneously, operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently ("in parallel")
- **Cluster** : A cluster is a group of loosely coupled computers that work together closely, so that in some respects they can be regarded as a single computer.
- **Grids** : Grid computing is the most distributed form of parallel computing. It makes use of computers communicating over the Internet to work on a given problem.



Paradigms

A *paradigm* is a standard, perspective, or set of ideas. A *paradigm* is a way of looking at something.

Cloud is the convergence of several traditional computing technologies

Web Technologies

Web Services

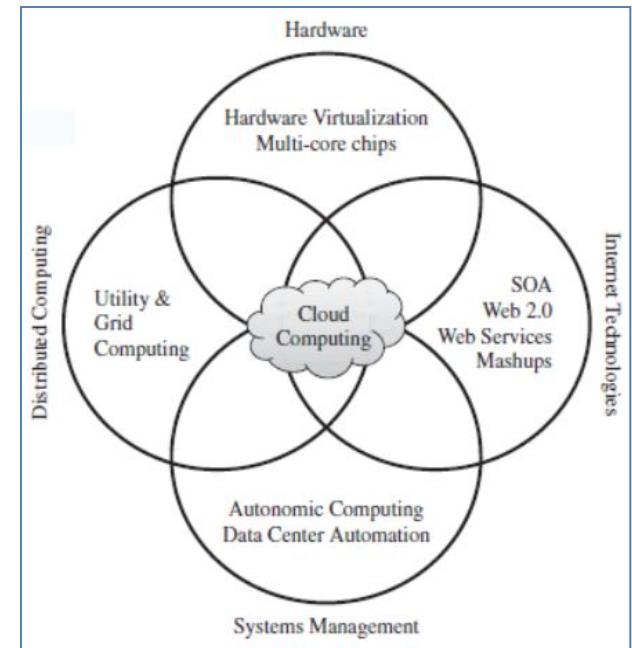
SOA (Service Oriented Architectures)

Distributed Computing

Grids

Clusters

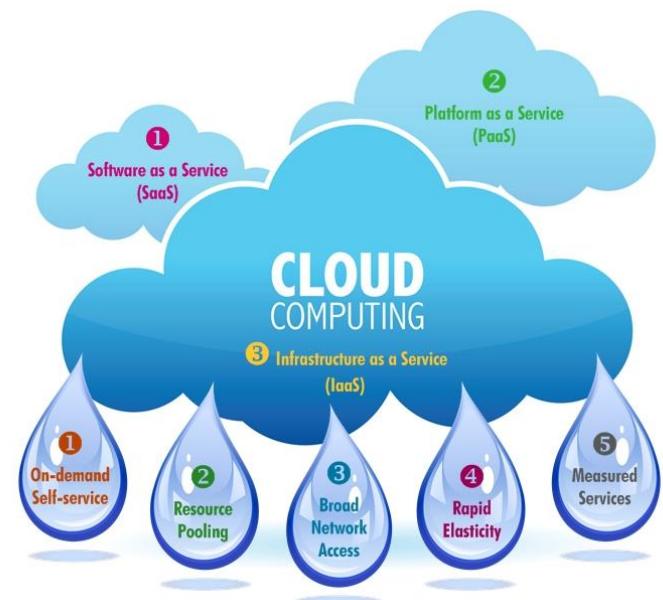
We are now experiencing computing as a service provided by professional organizations, which is served through the medium of high speed internet.



How do we define Cloud ?

To summarize, cloud computing is the result of the mash-up of several existing disparate technologies, which were progressively modified to suit contemporary computing requirements.

- The applications and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards comes under Cloud computing. Cloud computing converts the technology, services, and applications that are similar to those on the Internet into a self-service utility. Communicate and coordinate actions by passing messages.
- Cloud computing is based on the concept of pooling physical resources and presenting them as a virtual resource. This computing model supports a new way of provisioning resources, staging applications and for using applications.
- It's bringing computing on an internet scale.



Terms to Remember

Cloud computing solely exists because of Virtualization technology & Abstraction

Abstraction :

The details of system implementation is hidden from users and developers.

Applications run on unspecified physical systems with unknown locations for data, with outsourced system administration of systems.

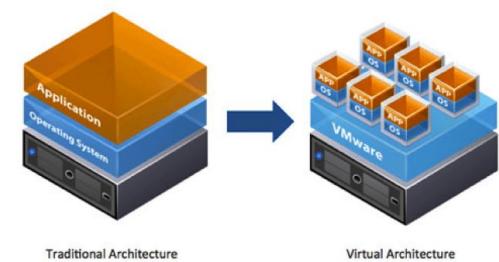


Virtualization:

The resources are pooled and shared among the users giving them the illusion that they are the sole owner of the resource.

Also resources scales up/down in really short time and without human intervention, charged on metered basis, with multi-tenancy support.

Virtualization Defined
For those more visually inclined...

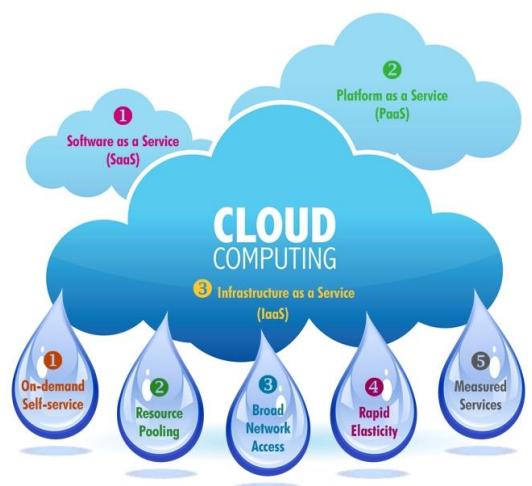


Traditional Architecture

Virtual Architecture

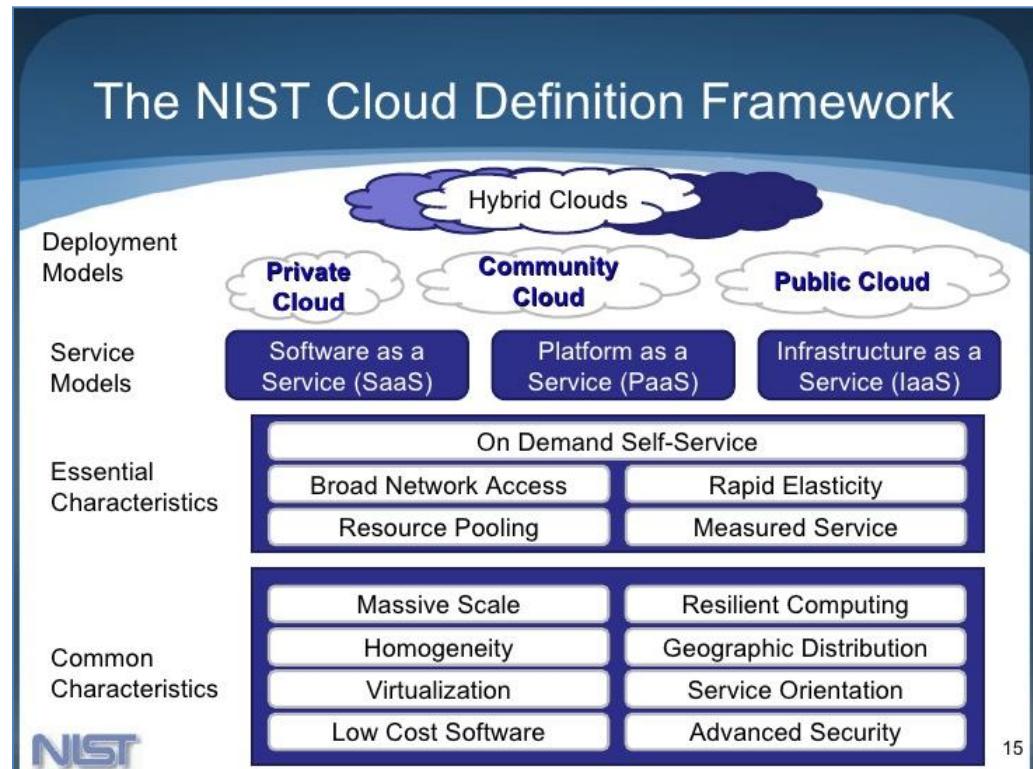
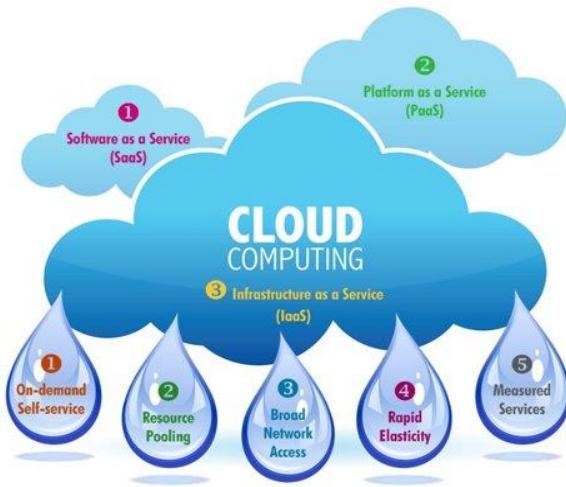


Cloud – NIST & the AAS es



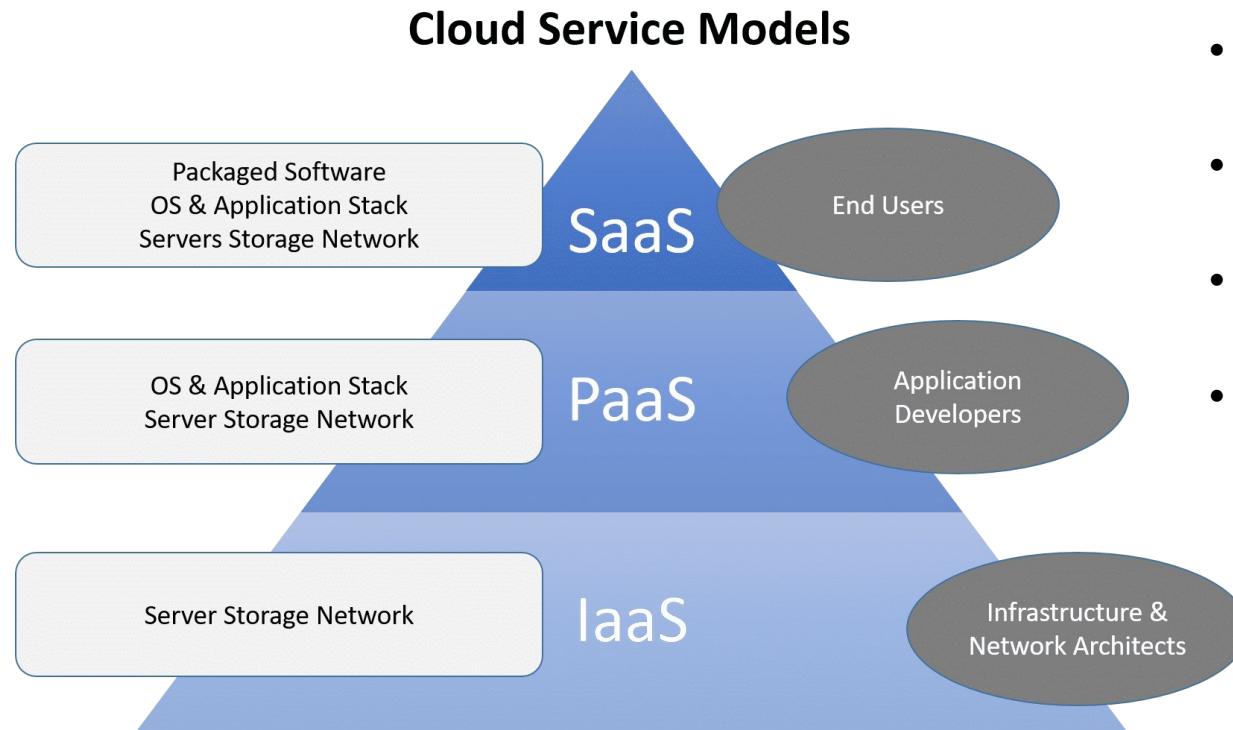
NIST 3-4-5 Rule for Cloud

- **3** cloud service models or service types for any cloud platform
- **4** Deployment models
- **5** Essential characteristics of cloud computing infrastructure



The applications and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards comes under Cloud computing.

Cloud Service Models (AAS es)



- There are 3 service models
- Infrastructure as a Service
- Platform as a Service
- Software as a Service

Infrastructure as a Service

Capability

IaaS provides the following

- Servers- compute, machines
- Storage
- Network
- Operating system



Why IaaS



Characteristics

Resources are distributed as a service

- Allows dynamic scaling (1...10....100.....)
- Has a variable costs-
- Generally includes multiple-users on a single piece of hardware. (**multi-tenancy**)



Enabler : Virtualization Technology

- ✓ Manageability and Interoperability
- ✓ Availability and Reliability
- ✓ Scalability and Elasticity



Models

IaaS can be obtained as

- (1) Public or
- (2) Private infrastructure or
- (3) combination of both

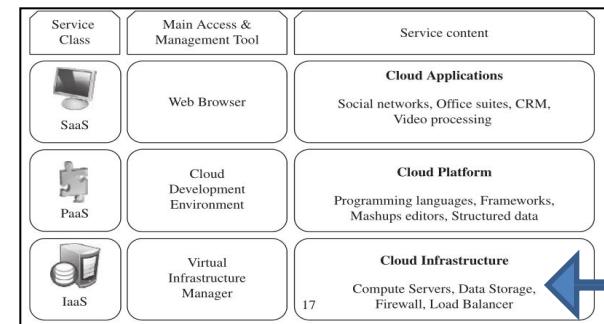
Benefit

The user instead of **purchasing**- servers, software, **data center space** or network equipment, **rent** those resources as a fully **outsourced** service on-demand model.



Infrastructure as a Service - Definition

- The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources.
- The consumer can deploy and run software, which can include operating systems and applications.
- The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).
- Offering virtualized resources (computation, storage, and communication) on demand is known as Infrastructure as a Service (IaaS).
- Infrastructure services are considered to be the bottom layer of cloud computing systems .
- Ex : Amazon EC2 : Elastic Compute Cloud, Eucalyptus, GoGrid, Rackspace Cloud



Infrastructure as a Service - Applicability

Where IaaS helps

1. Where demand is very **volatile**- encountering **spikes and troughs**.
2. For new enterprise without **capital to invest in hardware or** entrepreneurs starting on a shoestring budget.
3. Where the enterprise is **growing rapidly** and **scaling hardware** would be problematic.
4. For **specific line** of business, **trial** or **temporary** infrastructural needs
5. When you need **computing power on the go**, turn to IaaS.

What to Do with IaaS

- Test and development.** Teams can quickly set up and dismantle test and development environments, bringing new applications to market faster.
- Website hosting.** Running websites using IaaS can be less expensive than traditional web hosting.
- Storage, backup and recovery.** Organizations avoid the capital outlay. IaaS is useful for handling unpredictable demand and steadily growing storage needs. It can also simplify planning and management of backup and recovery systems
- Big data analysis.** Mining data sets to locate or tease out these hidden patterns requires a huge amount of processing power, which IaaS economically provides.

Platform as a Service - Overview

Capability

PaaS provides the following

- Tools to build applications
- Scripting Environment
- Database Platform



Why PaaS



Enabler : Runtime Environment Design

- ✓ Fault Tolerant Design
- ✓ Containerization
- ✓ Avoiding DLL Hell
- ✓ Secure



Models

PaaS can be obtained as

- (1) Public or
- (2) Private infrastructure or
- (3) combination of both

Characteristics

Collaborative platform for application development using workflows.
Platform which allows creation of proprietary data or application



Benefit

Development tools served up on a Platter a-la carte

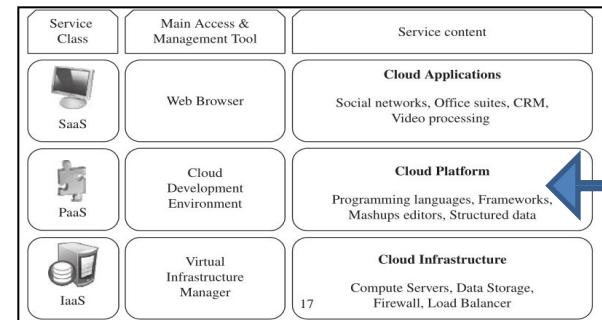


No need to worry about upgrading to newer platforms or worry about license costs

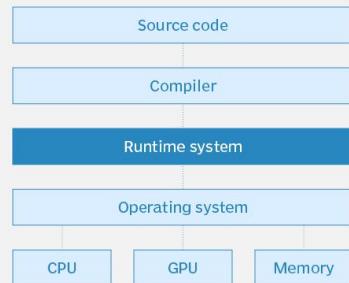


Platform as a Service - Definition

- The capability provided to the consumer is to **deploy** onto the **cloud infrastructure**, **consumer-created** or acquired applications created using programming languages and **tools supported by the provider**.
- The consumer **does not manage** or control the underlying **cloud infrastructure** including **network, servers, operating systems, or storage**, but has control over the **deployed applications** and possibly application **hosting** environment **configurations**.
- A **PaaS** platform offers an environment on which developers **create** and deploy applications and do not **necessarily** need to **know** how many **processors** or how much **memory** that **applications** will be **using**.
- In addition, multiple programming models and **specialized services** (e.g., data access, authentication, and payments) are offered as building blocks to new applications.
- **Google AppEngine, Azure, Force.com** are examples of Platform as a Service



Where the runtime system fits in



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Platform as a Service - Applicability

Where PaaS helps

PaaS allows developers to frequently **change** or **upgrade** operating system features.

- It also helps development teams **collaborate** on projects.
- **Security** is provided, including data security and backup and recovery.
- Adaptability; Features can be **changed** if circumstances dictate that they should.
- **Flexibility**; customers can have control over the tools that are installed within their platforms and can create a platform that suits their specific requirements.

What to Do with PaaS

• Application Services

- Services to develop, test, deploy, host and maintain applications in the same integrated development environment.
- Web based user interface creation tools help to create, modify, test and deploy different UI scenarios

• Multi Tenancy

- Construct architecture where multiple concurrent users utilize the same development application

• Collaboration

- Support for development team collaboration
- Tools to handle billing and subscription management

Software as a Service - Overview

Capability

- SaaS provides the following
- Hosted , Finished Product
 - Subscription to Services



Why SaaS



Characteristics

Not owned, but subscribed to from an external service provider.
Designed to be Multi Tenant
Customer Configuration instead of Application configuration
Centralized management



Models

- SaaS can be obtained as
- (1)Managed Service
 - (2)Monthly Subscription



Enabler : Web Service

✓ Accessibility & Portability

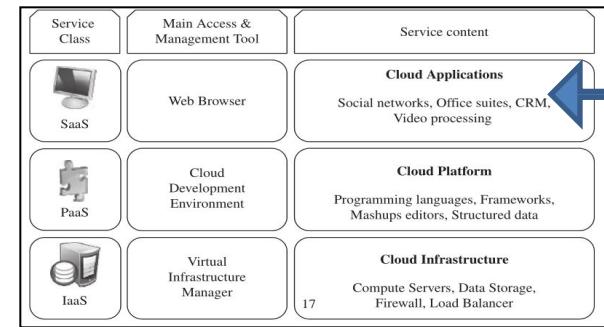
Benefit

No need to purchase Software or Licenses upfront
Centralized management helps SaaS Vendors
Lower TCO for users



Software as a Service - Definition

- The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure.
- The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email).
- The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.
- This model of delivering applications, known as Software as a Service (SaaS), alleviates the burden of software maintenance for customers and simplifies development and testing for providers.
- [Salesforce.com](#), SaaS model, offers business productivity applications (CRM) that reside completely on their servers, allowing customers to customize and access applications on demand.



Which AAS ?

WHICH CLOUD COMPUTING MODEL SHOULD YOU CHOOSE?

IAAS

Cover infrastructure maintenance and support

Save money and time vs purchasing hardware

Achieve flexibility and scalability when experiencing rapid growth

PAAS

Focus on app development instead of infrastructure management

Streamline workflows when multiple developers are working on the same project

Rapidly launch an application, reducing costs and time spent on hardware and middleware management

SAAS

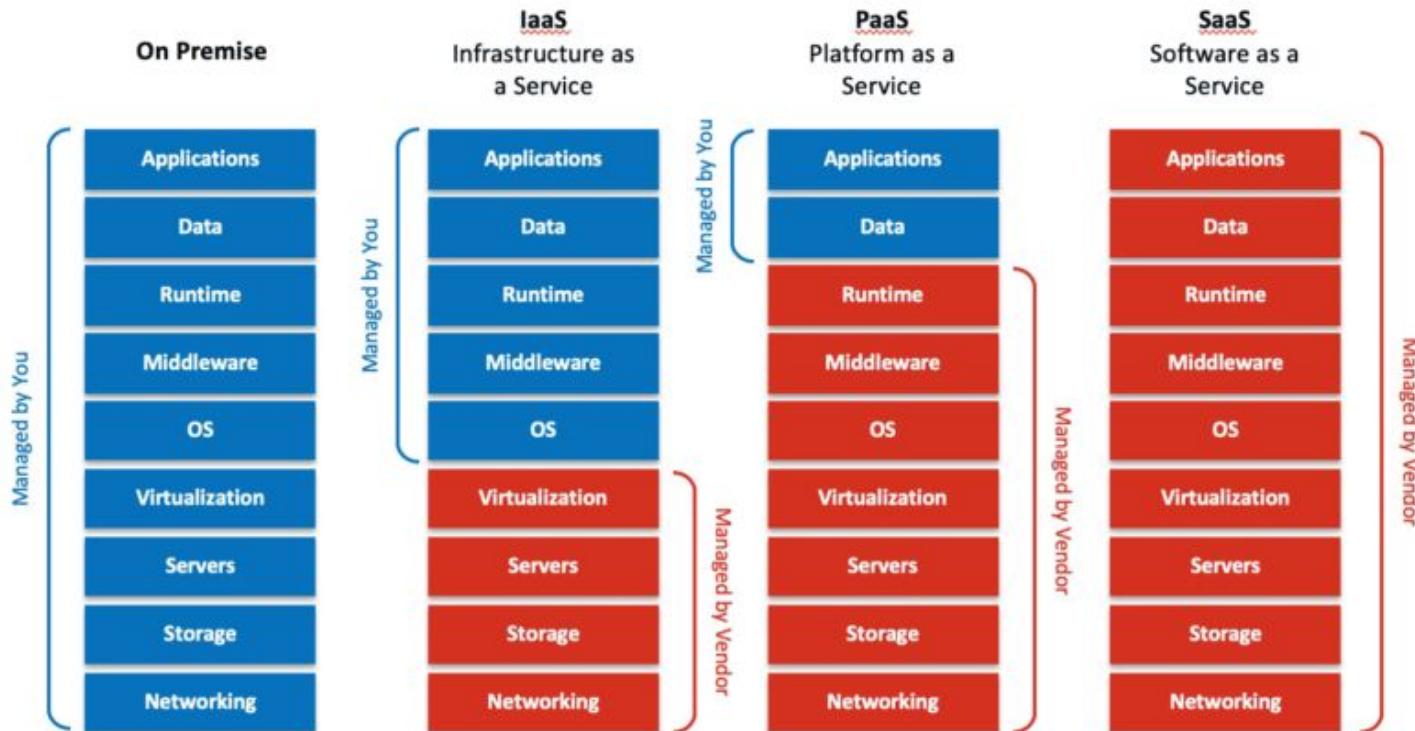
Create solutions with standardized core functionality

Develop ecommerce software rapidly, without spending time on server or software issues

Work on short-term projects and applications that need both web and mobile access

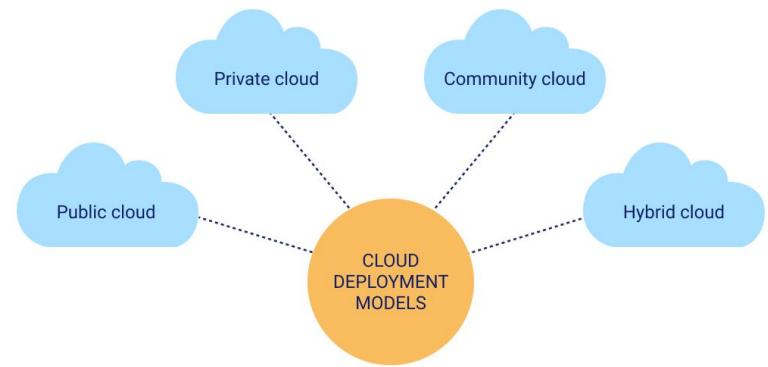
www.apriorit.com

Who Manages the AAS es?





Cloud Deployment Models

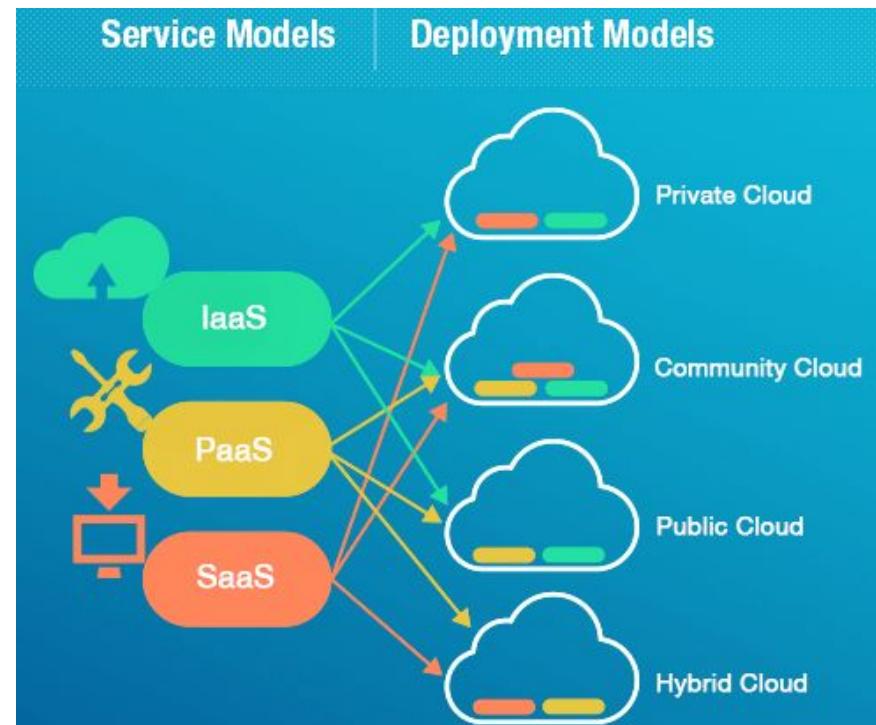


Deployment Models in Cloud

There are four primary cloud deployment models :

- Public Cloud
- Private Cloud
- Community Cloud
- Hybrid Cloud

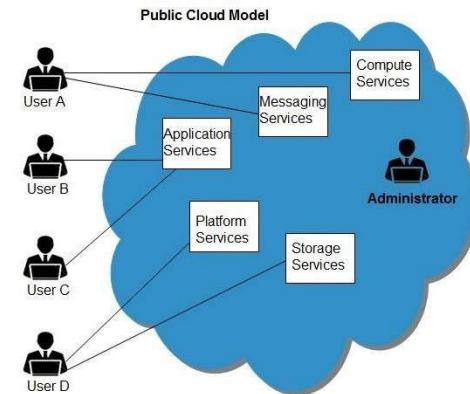
Each can exhibit the previously discussed characteristics; their differences lie primarily in the scope and access of published cloud services, as they are made available to service consumers.



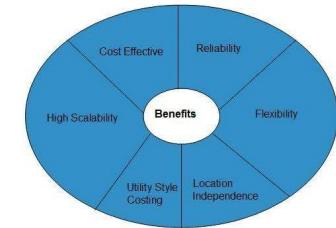
Public Cloud

- Public cloud is a cloud infrastructure **owned by a cloud service provider** that provides cloud services to the public for **commercial purposes**.
- Cloud infrastructure available for public consumption on a **pay per use basis**.
- Examples of public clouds include **Amazon Elastic Compute Cloud (EC2)**, IBM's Blue Cloud, Sun Cloud, Google AppEngine and Windows Azure Services Platform.
- **Characteristics**

- ✓ Homogeneous infrastructure
- ✓ Common policies , Shared resources and multi-tenant
- ✓ Leased or rented infrastructure, Economies of scale



Public Cloud - Advantage



Cost Effective

- Since **public cloud shares** same resources with large number of customers it turns out **inexpensive**.

Reliability

- The **public cloud** employs large number of **resources** from different locations. If any of the resources fails, public cloud can **employ** another one.

Flexibility

- The public cloud can **smoothly integrate** with **private** cloud, which gives customers a **flexible** approach.

Location Independence

- **Public cloud** services are delivered through Internet, ensuring location independence.

Utility Style Costing

- Public cloud is also based on **pay-per-use** model and resources are accessible whenever customer needs them.

High Scalability

- Cloud resources are made available on demand from a **pool of resources**, i.e., they can be scaled up or down according the requirement.

Public Cloud - Disadvantage

Low Security

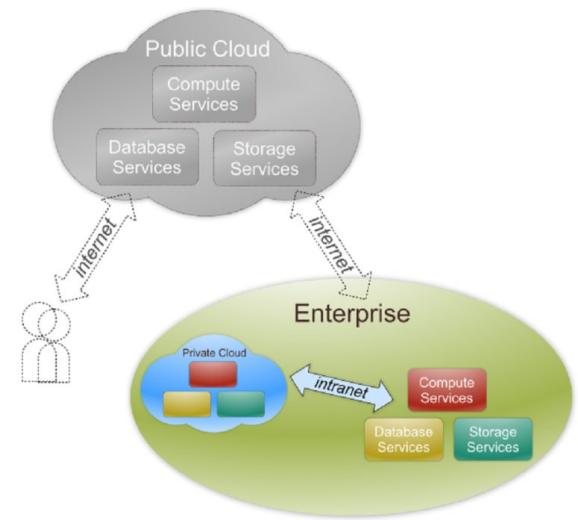
- In **public cloud model**, data is hosted off-site and resources are shared publicly, therefore does not ensure higher level of security.

Less Customizable

- It is comparatively less customizable than private cloud.

Private Cloud

- The **cloud infrastructure** is operated solely for an **organization**.
- It may be **managed** by the **organization** or a **third party** and may exist **on premise** or **off premise**.
- Also referred to as **internal cloud** or **on-premise** cloud, a private cloud **intentionally limits access** to its resources to **service consumers** that belong to the same organization that owns the cloud.
- **Characteristics :**
 - Heterogeneous infrastructure
 - Customized and tailored policies
 - Dedicated resources
 - In-house infrastructure
 - End-to-end control



Private Cloud - Advantage

High Security and Privacy

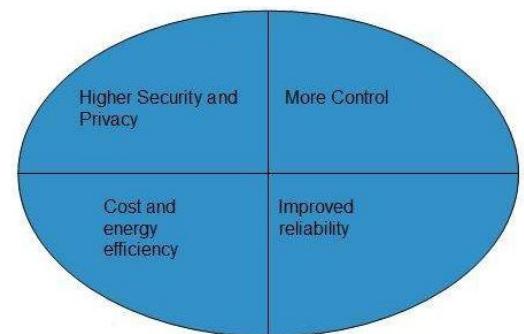
- Private cloud operations are not available to general public and resources are shared from distinct pool of resources. Therefore, it ensures high **security** and **privacy**.

More Control

- The **private cloud** has more control on its resources and hardware than public cloud because it is accessed only within an organization.

Cost and Energy Efficiency

- The **private cloud** resources are not as cost effective as resources in public clouds but they offer more efficiency than public cloud resources.



Private Cloud - Disadvantage

Restricted Area of Operation

- The private cloud is only accessible locally and is very difficult to deploy globally.

High Priced

- Purchasing new hardware in order to fulfill the demand is a costly transaction.

Limited Scalability

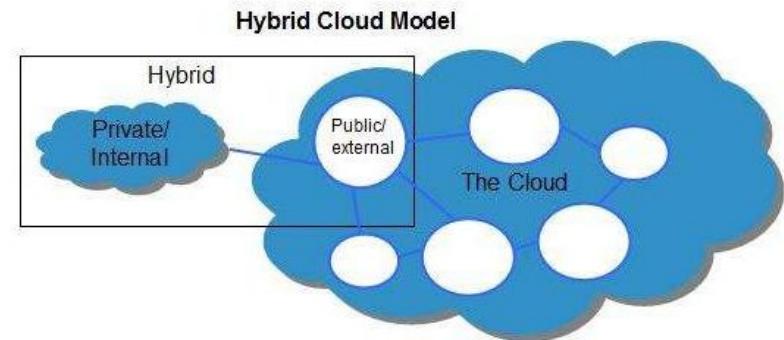
- The private cloud can be scaled only within capacity of internal hosted resources.

Additional Skills

- In order to maintain cloud deployment, organization requires skilled expertise.

Hybrid Cloud

- Hybrid clouds are mixtures of these different deployments.
- For example, an enterprise may **rent storage** in a **public** cloud for handling peak demand.
- The **combination** of the enterprise's **private cloud** and the **rented storage** then is a hybrid cloud.
- Clouds retain their **unique identities**, but are **bound together as a unit**.
- A hybrid cloud may offer **standardized** or **proprietary** access to data and applications, as well as application portability.



Hybrid Cloud - Advantage

Scalability

- It offers features of both, the public cloud scalability and the private cloud scalability.

Flexibility

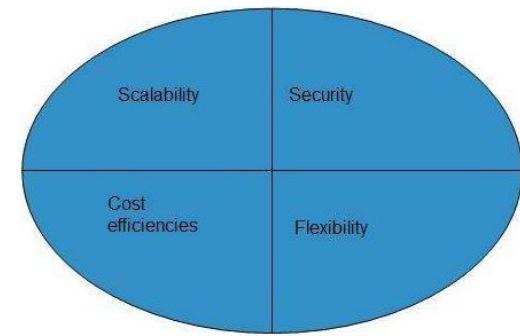
- It offers secure resources and scalable public resources.

Cost Efficiency

- Public clouds are more cost effective than private ones. Therefore, hybrid clouds can be cost saving.

Security

- The private cloud in hybrid cloud ensures higher degree of security.



Hybrid Cloud - Disadvantage

Networking Issues

- Networking becomes complex due to presence of private and public cloud.

Security Compliance

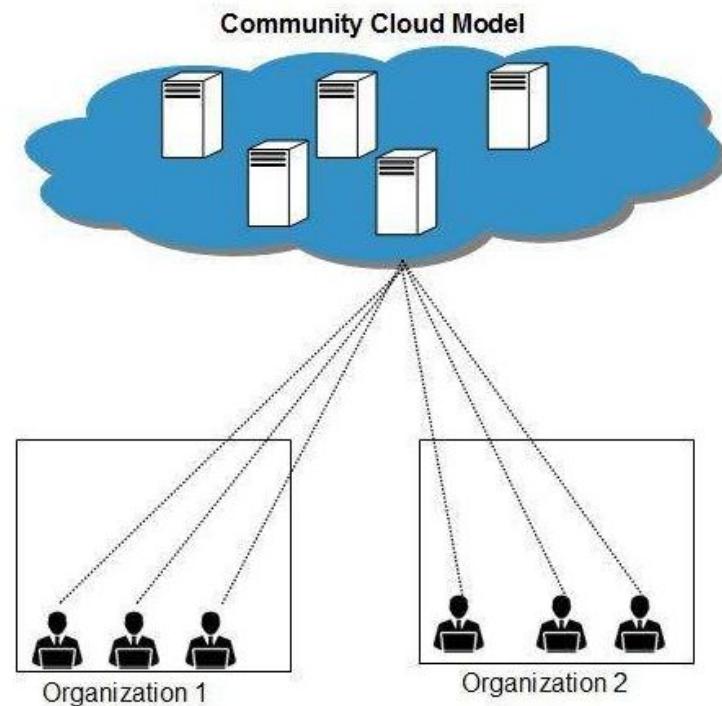
- It is necessary to ensure that cloud services are compliant with security policies of the organization.

Infrastructure Dependency

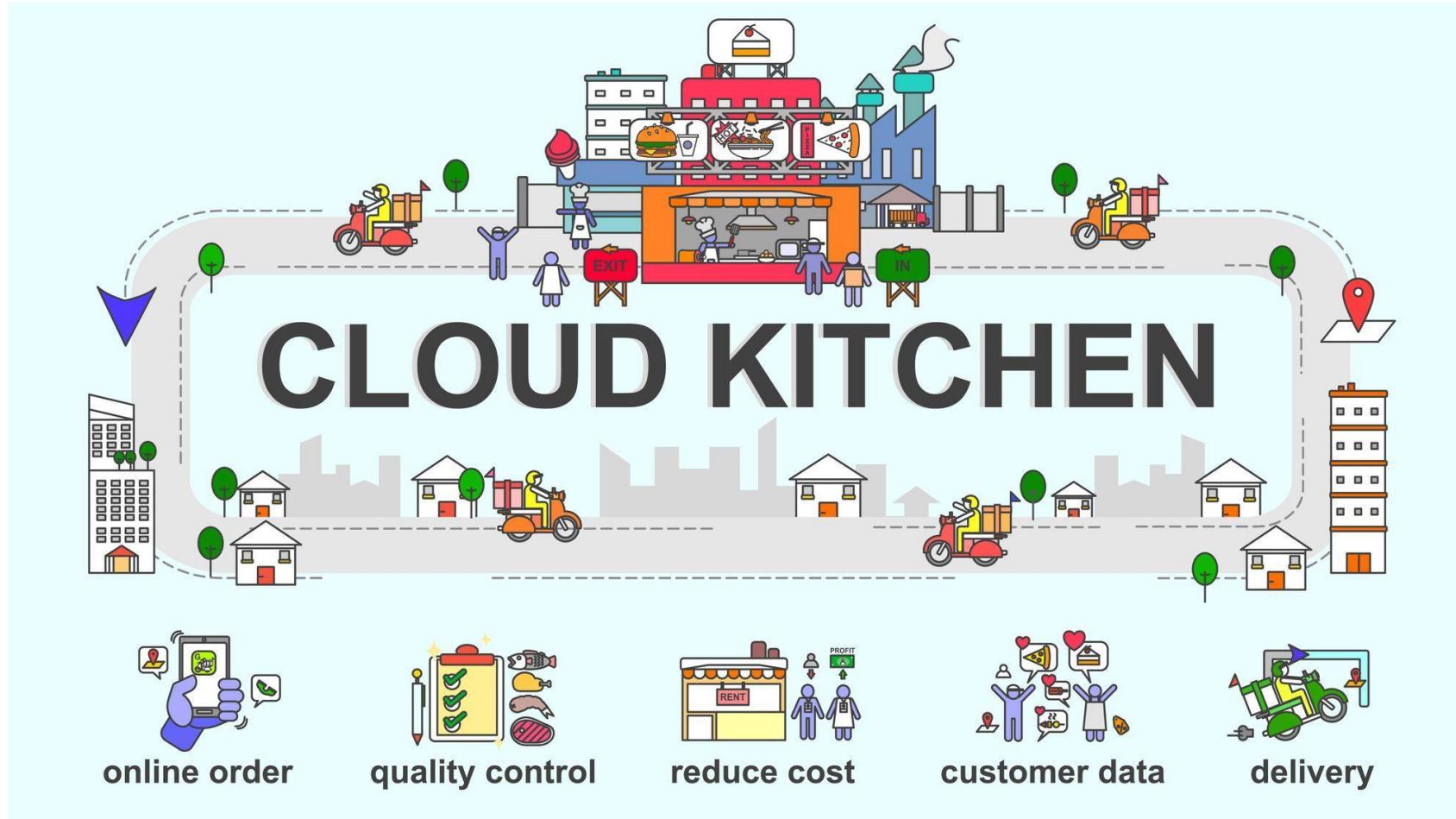
- The **hybrid cloud model** is dependent on internal IT infrastructure, therefore it is necessary to ensure redundancy across data centers.

Community Cloud

- Community Cloud is a cloud infrastructure shared by a community of multiple organizations that generally have a common purpose.
- An example of a community cloud is **OpenCirrus**, which is a cloud computing research testbed intended to be used by universities and research institutions.
- It may be for one organization or for several organizations, but they share common concerns such as their mission, policies, security, regulatory compliance needs, and so on.
- A community cloud may be managed by the constituent organization(s) or by a third party.



Community Cloud - Real Life



Community Cloud - Advantage

Cost Effective

- Community cloud offers same advantages as that of private cloud at low cost.

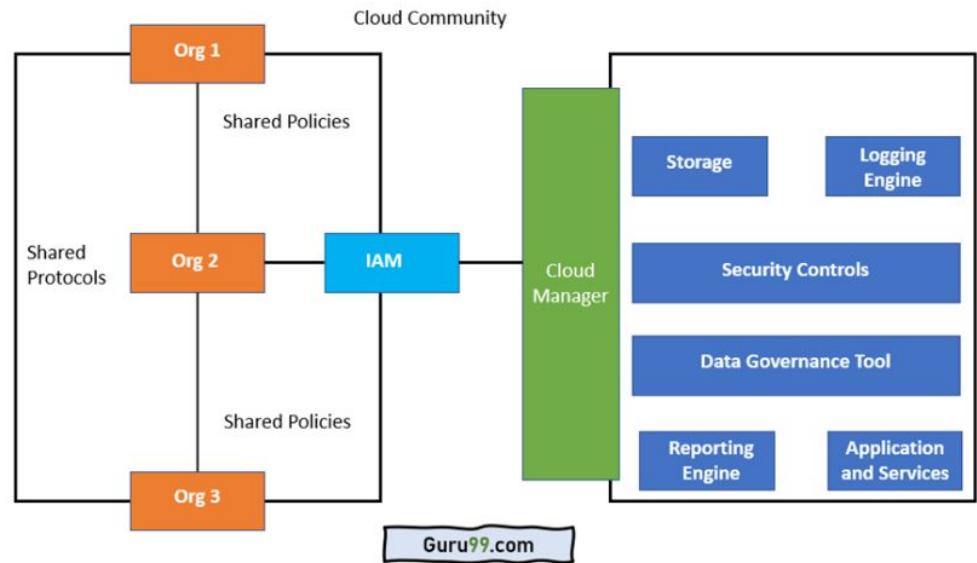
Sharing Among Organizations

- Community cloud provides an infrastructure to share cloud resources and capabilities among several organizations.

Security

- The community cloud is comparatively more secure than the public cloud but less secured than the private cloud.

Community Cloud Architecture



Community Cloud - Disadvantage

Logistics Issues

- Since all data is located at one place, one must be careful in storing data in community cloud because it might be accessible to others. It is also challenging to allocate responsibilities of governance, security and cost among organizations.

Control

- Participating organization will not have much control over the infrastructure and configuration options.

Security

- Since it's a community of several organizations, there is high risk that data breaches can occur due to an individual organization's weak security policy.

Integration

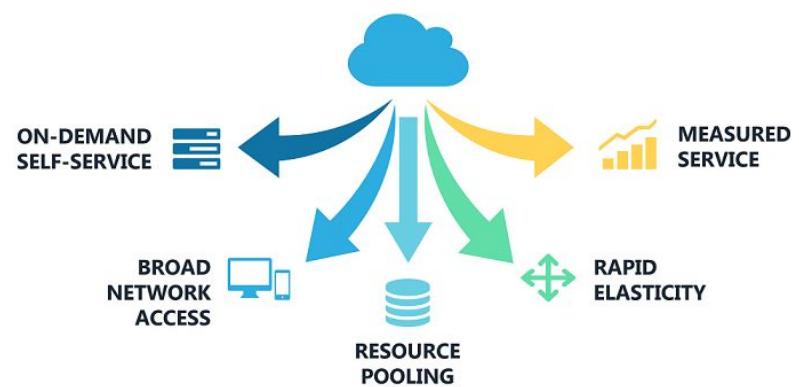
- Integration among various systems which are disparate can pose challenges.

Quick Comparison

| Parameters\Type | Public Cloud | Private Cloud | Hybrid Cloud | Community Cloud |
|-----------------|---|--|--|--|
| Description | In public cloud, services are available for public users. | Private cloud is build up with existing private infrastructure. This type of cloud has some authentic users who can dynamically provision the resources. | Hybrid cloud is a heterogeneous distributed system, resulting from a private cloud, which incorporates different types of services and resources from public clouds. | Different types of cloud are integrated together to meet a common or particular need for some organizations. |
| Scalability | Very High | Limited | Very High | Limited |
| Reliability | Moderate | Very High | Medium to High | Very High |
| Security | Totally Depends on service provider | High class security | Secure | Secure |
| Performance | Low to medium | Good | Good | Very Good |
| Cost | Cheaper | High Cost | Costly | Costly |
| Examples | Amazon EC2, Google AppEngine | VMWare, KVM, Xen | Microsoft, IBM, HP, VMWare vCloud, Eucalyptus | SolaS Community Cloud, VMWare |



Cloud Essential Characteristics



Essential Characteristics

5 Essential Characteristics of Cloud Computing

Ref: The NIST Definition of Cloud Computing

<http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>



On-demand
self-service



Ubiquitous
network
access



Location
transparent
resource
pooling



Rapid
elasticity



Measured
service with
pay per use

Source: <http://aka.ms/532>

Resource pooling

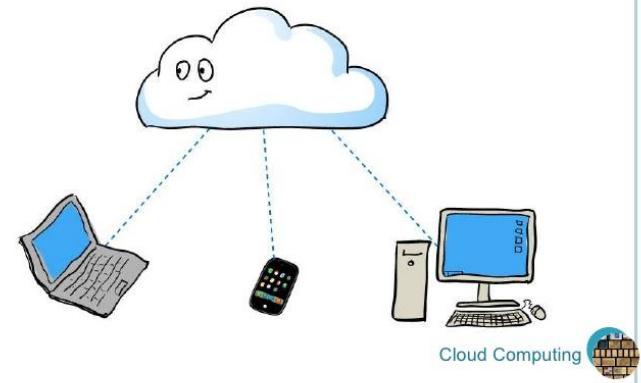
- Cloud services can support **millions of concurrent users**; for example, Skype supports 27 million concurrent users, while Facebook supported 7 million simultaneous users in 2009.
 - Clearly, it is **impossible to support** this number of users if **each user needs dedicated hardware**. Therefore, cloud services need to **share resources between users** and clients in order to **reduce costs**.
- ✓ **Resources** are drawn from a **common pool**.
- ✓ **Common resources** build **economies of scale**.
- ✓ **Common infrastructure** runs at **high efficiency**.
- ✓ Appropriate **management** of **security & privacy**.



Broad Network Access

- **Ubiquitous access** to cloud applications from **desktops, laptops to mobile devices** is critical to the success of a Cloud platform.
 - Thus, **connectivity** is a **critical requirement** for effective use of a **Cloud Application**.
 - For example, cloud services like Amazon, Google, and Yahoo! are available world-wide via the Internet.
 - They are also accessible by a wide variety of devices, such as mobile phones, iPads, and PCs.
- ✓ Users **abstracted** from the implementation
- ✓ Near **real-time delivery** (seconds or minutes)
- ✓ Services accessed through a **self-serve web interface**.

Broad Network Access



On Demand Self Service

On demand self-service: The compute, storage or platform resources needed by the user of a **cloud platform** are **self-provisioned** or **auto-provisioned** with **minimal configuration**.

For example is possible to log on to Amazon Elastic Compute Cloud (a popular cloud platform) and obtain resources, such as virtual servers or virtual storage, within minutes.

- ✓ Open standards and APIs
- ✓ Almost always IP, HTTP, and REST
- ✓ Available from anywhere with an internet connection



Rapid Elasticity

A **cloud platform** should be able to **rapidly increase** or **decrease** computing **resources** as needed.

Further, the time taken to provision a new server is very small, on the order of minutes.

- ✓ Resources dynamically-allocated between users.
- ✓ Additional resources dynamically-released when needed.
- ✓ Fully automated

This also increases the speed with which a new infrastructure can be deployed.



Metered by Use

One of the **compelling business** use cases for cloud computing is the ability to “**pay as you go**,” where the **consumer pays** only for the **resources** that are **actually used** by his applications.

Commercial cloud services, like Salesforce.com, measure resource usage by customers, and charge proportionally to the resource usage.

- ✓ Services can be cancelled at any time
- ✓ Pay as you go approach





Summary – Wrap Up

Session
WRAP UP

Cloud Advantages

Reduced costs : Significant cost reductions are achieved due to higher efficiencies and greater utilization of cloud networks

Ease of utilization: The upfront cost involved in the purchase of hardware and software licenses is lowered a lot. Due to that one can easily make utilization of cloud services.

Quality of Service: Service level agreements with vendor assure the Quality of service

Reliability: The resource scaling and load balancing with fault tolerance capabilities emphasize the high availability of systems.

Outsourced IT management: It results into considerable reduction in IT management complexities and the associated cost.

Simplified maintenance and upgrade: Always latest features are provided to the users removing the need of constant update and up gradations.

Low Entry Barrier: Upfront infrastructure investments are not needed for moving to the cloud.

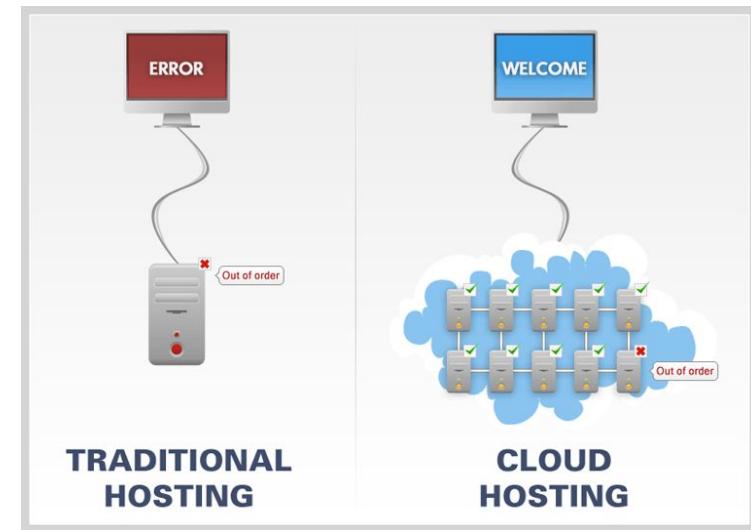
Cloud vs Hosted

Cloud apps are web apps in the sense that they can be used through web browsers but not all web apps are cloud apps.

For your web app to evolve into a cloud app, it should exhibit certain properties such as True multi-tenancy to support unique requirements & needs for individual consumers.

Support for virtualization technology, which plays a starring role for cloud era apps.

Web applications should either be built to support this or re-engineered to do so



Cloud Challenges

Security and Privacy of Cloud

- ❖ The data store in the cloud must be secure and provide full confidentiality. The **cloud provider** should take necessary **security measures** to **secure** the data of the customers.
- ❖ Security is also the **responsibility of the customer** as they should provide a strong password, should not share the password with anyone, and regularly change the password when we did.
- ❖ Hacking can lead to **data loss**; disrupt the encrypted file system and many other problems.



Cloud Challenges

Interoperability and Portability

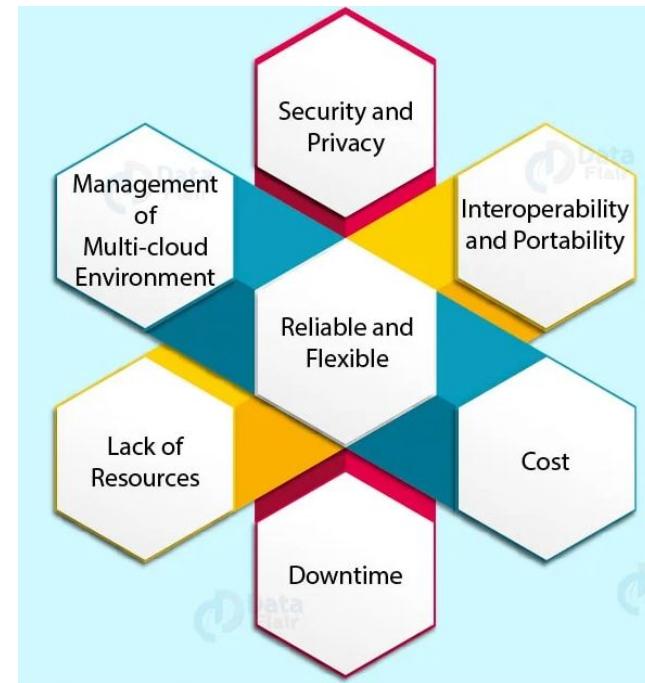
- ❖ The customer must be provided with the services of migration in and out of the cloud – no holds barred.

Reliable and Flexible

- ❖ Reliability and flexibility means that the **data provided** to the cloud should **not leak** and the host **should provide trust to the customers**.
- ❖ To eliminate this challenge the **services provided** by the third party should be **monitored** and **supervision** should be done on **performance, robustness** and business dependency.

Cost

- ❖ Cloud computing is **affordable** but tailor-made deployment based on customer's demand can be **expensive**. Use **Multitenancy to minimize costs**



Cloud Challenges

Downtime

- ❖ Downtime is the common challenges of cloud computing as no cloud provider guarantees a platform that is free from downtime. **Apply redundancy and or DR to minimize.**

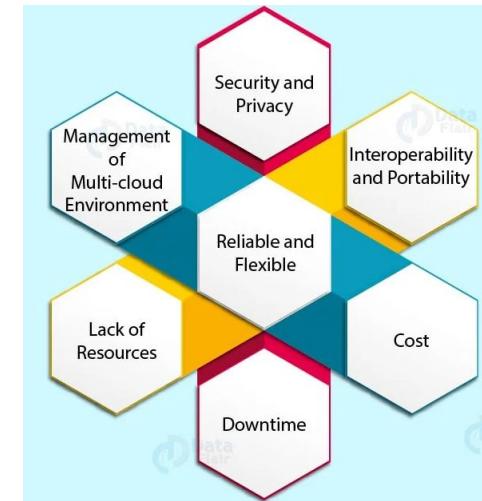
Lack of resources

- ❖ Lack of resources and expertise is also one of the major challenges faced by the cloud industry and many companies are hoping to overcome this challenge by hiring more workers which are more experienced. **Use Automation**

Automation

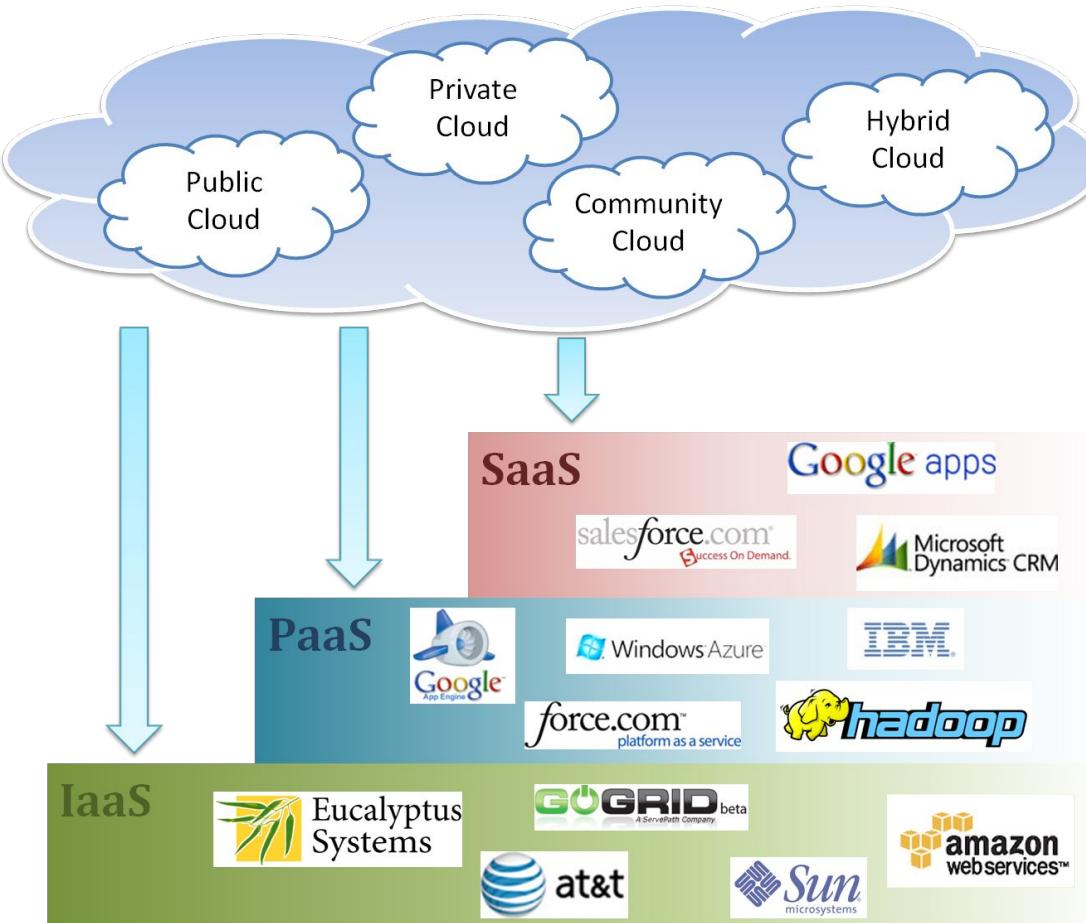
Management of Multi-Cloud Environment

- ❖ Companies nowadays do not use a **single cloud** instead they are using **multiple clouds**. On an average company are using 4.8 different **public and private clouds** due to which their management is hindered. **Invest in a good Cloud monitoring tool**



Cloud ecosystem

What is cloud computing in your mind
Clear or Cloudy?



Cloud computing is a new paradigm shift in the way we make use of computing resources. Cloud computing can provide high quality of service at perceived cost benefits. We are moving to an era of computing where we can use code to setup infrastructure on an ad-hoc basis. Service models and deployment models provide services that can be used to

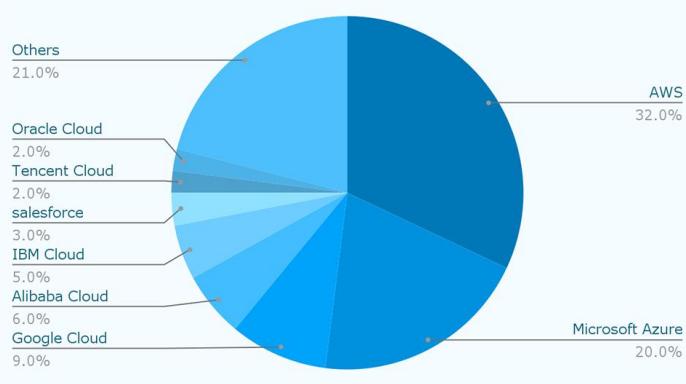
- Rent fundamental computing resources
- Deploy and develop customer-created applications on clouds
- Access provider's applications over network (wired or wireless)

Cloud Failures

2021 Major Public Cloud Outages



Cloud Services Market Share 2020



| Date | Description |
|----------------------|---|
| 12 th Dec | One of the mission-critical AWS cloud units us-east-1 was hit with an outage that took down services like Disney+, Netflix, Slack, Ticketmaster, stock trading app Robinhood, and the crypto exchange Coinbase. Key internal tools like Flex and AtoZ apps used by Amazon warehouse and delivery workers were affected as well. |
| 12 th Nov | Google Cloud went down in mid-November and with it took services like Home Depot, Snap, and Spotify. What caused the outage? A glitch in a network configuration. Yet another scenario showing that betting on a single provider to manage all your apps is pretty risky |
| 20 th Oct | Facebook and its subsidiaries – Messenger, Instagram, WhatsApp, Mapillary, and Oculus – became unavailable for 6 to 7 hours and the world went crazy. Many desperate users flocked to Twitter, Discord, Signal, and Telegram and this resulted in disruptions on these apps' servers. |

<https://www.crn.com/slideshows/cloud/the-10-biggest-cloud-outages-of-2021-so-far->



Points to Ponder

Session
WRAP UP

Points to Ponder

1. Do you think Cloud is a boon or a bane
2. What is your trust level of any cloud you use
3. What do you Understand by
 1. Hosted Application
 2. Cloud enabled
 3. Cloud native
 4. Cloud Agnostic
4. What do you think will be your main considerations when choosing a cloud provider?