

Cloud computing

↳ It refers to both the applications delivered as services over the Internet or the hardware and system software in the data centers that provide those services.

Cloud Model

↳ Features

- 1) ubiquitous / on demand as and when required
 - 2) convenient, broad network access
 - 3) Resource pooling
 - 4) Rapid elasticity
 - 5) Measured service
- ↳ Accessed via Internet with the help of Thin Client Device.
The service is accessible via a web browser or API
- 2) Capabilities are available over the network and accessed through standard mechanisms
 - 3) The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with physical & virtual resources dynamically assigned according to consumer demand.
↳ Resources: storage, processing, memory

User has no knowledge or control over the exact location of the provided resources

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- y) Capabilities can be elastically provisioned & released,
to rapidly outward & inward commensurate
with demand.

To the consumer, capability ~~comes~~ available for provisioning
often appear to be unlimited

- 5) Pay-as-per-use, resource usage can be monitored,
controlled, reported & providing transparency for both
provider & consumer

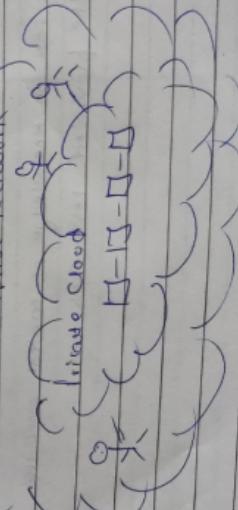
CLOUD

1 PRIVATE

2 PUBLIC

3 COMM

4 HPC



ON-SITE

CLOUD DEPLOYMENT MODEL

1 PRIVATE CLOUD

- ↳ It is provisioned for exclusive use by a single organization.
- ↳ It may be managed, owned and operated by the same organization, third company or both.
- ↳ It can exist on or off premises.

2 PUBLIC CLOUD

- ↳ provisioned for open use by the general public
- ↳ maybe owned by, managed, and operated by a business, academic or govt organization or combination of them
- ↳ exists on the premises of the provider

3 COMMUNITY CLOUD

- ↳ provisioned for exclusive use by a specific community of consumers from organizations that have shared concern
- ↳ maybe owned, managed by one or more organization in the community, third party too
- ↳ exist on or off premises

4 HYBRID CLOUD

- ↳ composition of two or more distinct cloud infrastructure that remain unique entities, but are bound together by standardized technology that enables data & application portability



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Cloud Service Models

Cloud Service Model	Definition
SaaS	google docs, facebook, instagram
PaaS	azure, hadoop, colab
IaaS	EC2, S3, vcloud, lightscale

Infrastructure As A Service

- ↳ deliver infrastructure on demand in the form of virtual hardware, storage & networking.
- ↳ These are created at user's request and on provider's infrastructure and the users are given tools and interfaces to ~~interact~~ configure software stack.
- ↳ pricing usually per hour on the basis of request

Responsibility

- ↳ provider: responsible for infrastructure
- ↳ consumer: responsible for everything they do such as creating app, backup, recovery, maintenance

Virtual storage is delivered in the form of object

PLATFORM AS A SERVICE

- ↳ deliver scalable & elastic runtime environment on demand and host the execution of application
- ↳ This approach increases the level of abstraction at which cloud computing is leveraged but also contains the user in a more controlled environment
- ↳ user does not have to know a thing about underlying infrastructure

RESPONSIBILITIES

- ↳ provider: provide scalability, fault tolerance, secured version, underlying infrastructure,
- ↳ user: responsible for the app we are developing, its maintenance & security, protection.

SOFTWARE AS A SERVICE

- ↳ provides application & services on demand

RESPONSIBILITY

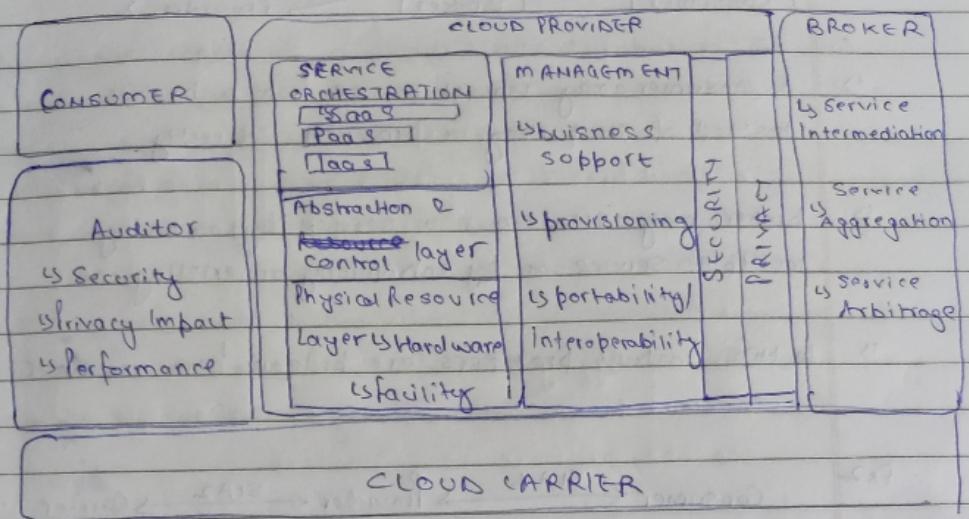
- ↳ user: responsible for the data we store
- ↳ provider: everything else such as deployment, configure, maintains & update the software application on a cloud infrastructure.

CHARACTERISTICS & BENEFITS

Characteristics that bring benefits to both cloud service providers & consumers

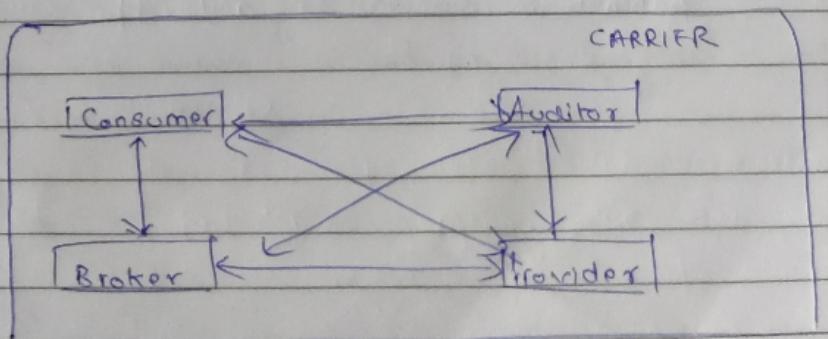
- ↳ No front up commission
- ↳ on demand access
- ↳ nice pricing
- ↳ simplified scaling
- ↳ efficient resource allocation
- ↳ energy efficiency
- ↳ seamless creation & use of third party service
- ↳ increased economical return due to reduced maintenance cost & operational cost
- ↳ end users benefit by having their data & the capability of operating on it always available, from anywhere at any time & through any device

CLOUD COMPUTING, REFERENCE ARCHITECTURE

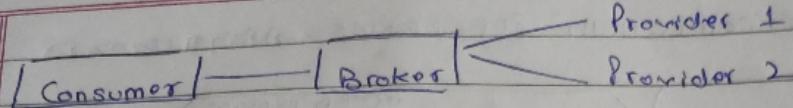


5 ACTORS

- ↳ Cloud provider
- ↳ Cloud consumer
- ↳ Cloud Auditor
- ↳ Cloud Broker
- ↳ Cloud Carrier

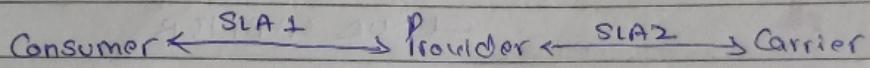


Ex1



- ↳ A consumer may request service from a broker instead of contacting a provider directly
- ↳ broker may create a new service by combining multiple service or by enhancing an existing one
- ↳ In this, actual providers are hidden from consumer

Ex2



1. CLOUD CONSUMER

- ↳ principal stakeholder for the cloud computing service.
- ↳ a consumer represents a person or an organisation that maintains a business relationship with, and uses the services of cloud provider.
- ↳ consumer may be billed for the service provided.
- ↳ SLA b/w consumer & provider cover terms regarding QoS, security, remedies for performance failures, as well as the limitations & obligations consumer must accept.

2. AUDITOR

- ↳ a party that can perform an independent examination of cloud service with the intent to express an opinion thereon.
- ↳ audits are performed to verify conformance to standards through review of objective evidence.
- ↳ Audit in terms of security, privacy, performance, etc.
- ↳ Auditing also include with ~~ensuring~~ verifying the provider's compliance with regulation & policies.

3. CLOUD BROKER

- ↳ Broker can provide services in 3 categories

↳ Service Implementation

A cloud broker enhances a given service by improving some specific capability & providing value-added services to cloud consumers.

↳ Service Aggregator

A cloud broker combines & integrates multiple services into one or more new services.

The broker provides data integration & ensures the secure data movement between cloud consumer and multiple cloud providers.

3. Service Arbitrage

Similar to aggregation except the services being aggregated are not fixed.

The broker has the flexibility to choose services from multiple agencies

BENEFITS

- ↳ Integrated Service management
- ↳ Access to IT resources anytime, anywhere
- ↳ Lower cost of ownership
- ↳ Flexible scaling of resources

4. CLOUD CARRIER

- ↳ acts as an intermediary that provides connectivity & transport of cloud services b/w consumers & providers.
- ↳ They provide access to consumers through network, telecommunication & other access devices.
- ↳ The distribution of cloud services is normally provided by network or a "Transport Agent". It refers to a business organisation that provides physical transport of storage media.

5. CLOUD PROVIDER

- ↳ a person, an organisation who is entirely responsible for making a service available to interested parties
- ↳ a provider acquires & manages the computing infrastructure required for providing the service, runs the software that provides the services & makes arrangement to deliver the cloud services to cloud consumers through network access

MAJOR ACTIVITIES

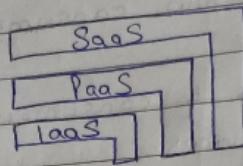
1. Service Deployment
2. Service Orchestration
3. Cloud Service Management
4. Security
5. Privacy

Public
Private
community
Hybrid] done before

2. SERVICE ORCHESTRATION

↳ Layers:

- ↳ Service layer
 - ↳ SaaS
 - ↳ PaaS
 - ↳ IaaS



Here, the cloud provider define interfaces for cloud consumers to access the computing services.

From the diagram, it can be seen that it is possible to build SaaS component on top of IaaS & IaaS components as well as stand alone.

For ex: SaaS application can be implemented & hosted on VMs from an IaaS cloud or it can be implemented directly on top of cloud resources.

Likewise, PaaS component can be build on IaaS component.

↳ Resource Abstraction

- This layer controls the usage of resources.

Ex: Hypervisor

Resource Abstraction
usage of the resources

- Control aspects responsible monitoring

- This is the physical dynamic

↳ Physical Layer

- It includes
- hardware
- storage

- It also

↳ Resource Abstraction and Control layer

- This layer contains the system components that cloud providers use to provide and manage access to the physical computing resources through software abstraction

Ex: Hypervisors, VMs, Virtual data storage

Resource Abstraction needs to ensure efficient, secure & reliable usage of the underlying physical resources

- Control aspect refers to the software components that are responsible for resource allocation, access control, and usage monitoring
- This is the software fabric that ties together the numerous underlying physical resources & their software abstractions to enable pooling, dynamic allocation & measured service

↳ Physical layer

- It includes all the physical computing resources. It includes hardware such as CPUs, memory, network (routers, switches, hubs), storage component & other elements
- It also includes HVAC, power, communication & other aspects



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The layer in the model represents dependency relationships - the upper layer components are dependent on the adjacent lower layer to function

3. Cloud Service Management

↳ It includes all of the service-related functions that are necessary for the management and operation of the services required by consumers

3 perspectives

↳ Service delivery, business support

↳ Business support

- Details the set of business related services dealing with clients and supporting processes

• Customer management

• Contract management

• Inventory management

• Accounting & Billing

• Reporting & Auditing

• Training & Learning

↳ Services

↳ PR

↳ I

↳ Provisioning / Configuration

- Rapid provisioning: automatically deploying cloud systems based on the requested services
 - Resource changing: Adjusting resources for specific requirements
 - Monitoring & reporting: generating performance report
 - Metering: metering capability
 - SLA management

↳ PORTABILITY / INTEROPERABILITY

- Portability: customers can move their data or apps across multiple cloud environment at low cost & minimal disruption

- Interoperability: communication between multiple clouds
 - encrypted data portability, service interoperability
 - System portability

- 4. SECURITY: maintains control of data and information
 - Privacy: protect the assured, proper & consistent collection, processing, communication use & disposition of PI and PII in cloud

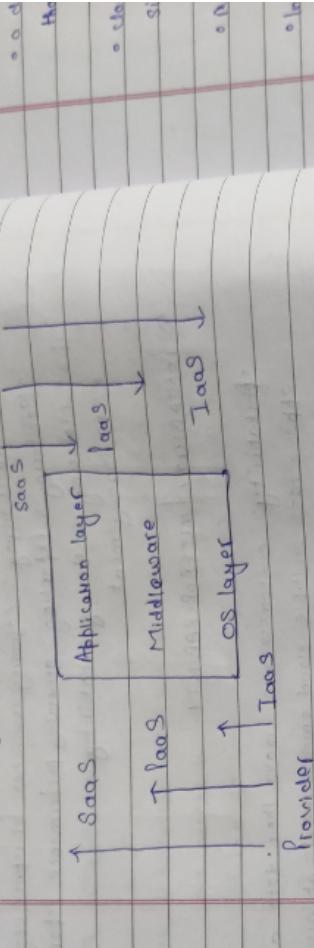
PI: personal info
PII: personal identifiable info



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Scope of control b/w Provider & Consumer

↳ both of them share the control of resources
in a cloud system



↳ 1. Application layer : includes software apps targeted at end users or programs

↳ 2. Applications are used by SaaS consumer,
installed/managed by PaaS consumers,
TaaS consumers & SaaS providers.

e.g. using of
IaaS consumer: I use google app engine to
build & deploy an app. The
user is using it.

TaaS : I use EC2 to set up VM, use OS,
build & deploy the app

SaaS : Such as google docs, gmail

HISTORICAL DEVELOPMENTS

1) DISTRIBUTED SYSTEMS

- o distributed system is a collection of independent computers that to its users as a single system
- o cloud hide the complex architecture they rely on a provide a single interface
- o main purpose is to share resources & utilize them better
- o in cloud, it can be seen when users rent resources

Properties

Homogeneity; Openness; Scalability; Transparency;
Concurrency; Continuous Availability; Independence; Failures

3 milestones:

- ↳ Mainframes