

CLOUD

- ① - Servers that are accessed over Internet,
 - ② Softwares
 - ③ Databases } running on these servers.
- Cloud servers located in Datacentres all over the world.
- Users & companies do not have to manage physical servers themselves or run s/w's or applications on their own machines.

> Cloud
- enables users to access same files & applications from almost any device.
as storage + computing takes place on servers in a Datacenter instead of locally on their device.

(Eg) Instagram Login
— can be logged in on new device & still get all their data.

(Eg) Gmail or Microsoft Office 364 — cloud service providers (Dropbox or Drive)

UNIT - 1

Definition of Cloud

- huge space
- collection of datacenters & controlling them through network.
- lets you rent only services you need!

> When something's stored on cloud, it means — it is stored on servers over the Internet, and you can access it anytime you are connected to the Internet.

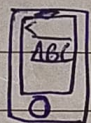
> you can access these files from anywhere using the cloud-based apps.

(Eg.) Google Docs

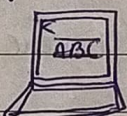
= free

= view, edit, or, create any documents

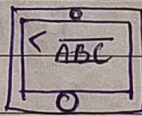
You can access Google docs from any device.



Phone



Laptop



Tab

> The document can be accessed from any remote place as well and can be shared with anyone.
 same document can be accessed from any device.

> Storing files on cloud is best way to save your data from accidents, viruses, etc.

- Can backup your data using cloud based services.

> "Cloud" refers to servers that can be accessed over Internet and the databases that run on those servers.

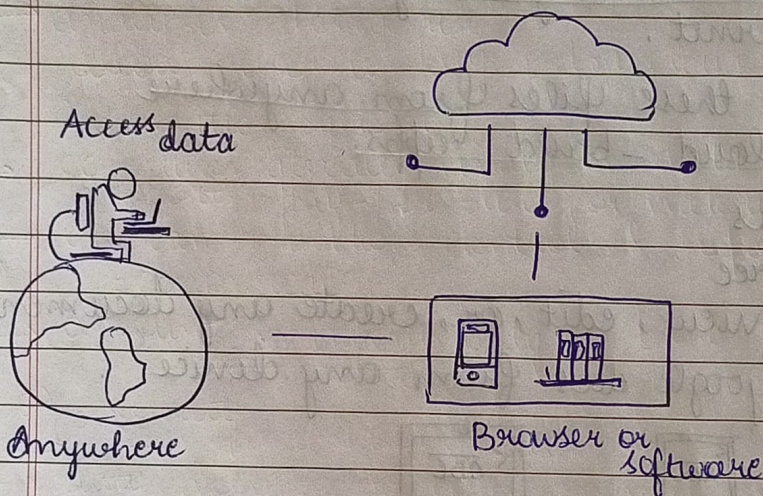
located at DC's worldwide.

> All computing & storage done on a DC, & not at a specific local device.

Cloud Computing

"Practice of using a n/w of remote servers hosted on the Internet to store, manage, & process data, rather than a local server or a personal computer".

- > place where you can store, process, and, access your data/applications through servers via Internet.



- > convenient, on-demand access from anywhere to shared pool of resources,
- > making available different services over Internet.

"On-demand delivery of IT resources over Internet with pay-as-you-go pricing".

Why?

(a) On-demand

- can access service anywhere, anytime
- Isn't limited by space or size.
Eg. Netflix.
- resources are available on "as needed" basis.

(b) Cheaper

- you don't have to purchase computers, rent office space or hire staff.
- various models offer one or all of those options
- means huge savings as you only pay for what you want.

(c) Flexible

- Since you only pay for what you want, & what you want is accessible anywhere, you can ↑ or ↓ scope of your project
 - Scalability : scales on demand to support fluctuating workloads.
 - Storage options : users can choose public, private, or, hybrid storage offerings
 - Control choices :
Org's determine their level of control with as-a-service options
- SAAS, PAAS or, IAAS.
 - Tool selection :
Users can select from menu of prebuilt tools & features
 - Security Features - encryption, API keys, Virtual private cloud } keeps data secure.

(d) Strategic value

- Streamlined : CSP's manage underlying infrastructure work enabling org's to focus on applⁿ. development
- Regular updates : SP's & other priorities, ment regularly update to give users most up-to-date technology.
- Collaboration : worldwide access means teams can collaborate from widespread locations.

Characteristics of Cloud Computing

1.) Resource Pooling =

- different physical & virtual resources assigned & reassigned that depends on customer demand.
- user can 2.) On-demand self service continuously monitor server uptime, capabilities, & allotted n/w storage.

28/01/22

3) Easy Maintenance

- servers : easily maintained.
- less downtime or no downtime in some cases.
- frequent updates — compatible with devices & perform faster.

4) Large N/w Access

- user can access data of cloud or upload data to cloud from anywhere.
- These capabilities are available all over network & accessed with help of Internet.

5) Availability

- capabilities of cloud : can be modified as per use, can be extended too.
- analyzes storage use, allows user to buy extra cloud storage.

6) Automatic System

- cc automatically analyzes data needed & supports pay-per-use (or metering) capability.
- you can monitor, control, & report the usage.

7) Economical

- amount is spent only on basic maintenance

8) Security

- creates snapshot of data stored
- data doesn't get lost, even if one of servers gets damaged
- data stored within storage devices, cannot be hacked & utilized by other person.
- Storage service is quick & reliable.

9) Pay As you go

- user has to pay only for service or space they've utilized.
- no hidden or extra charge to be paid

10) Measured Service

- Cloud Computing resources used to monitor & company uses it for recording.
- resource utilization is analyzed by supporting charge-per-use capabilities.

11) Resilience

- ability to recover from any interruption.
- CSP's needs to be prepared against any disaster
- In case one server goes down — emergency servers can manage load till main gets down.

History of Cloud Computing

- (a) 1961: John MacCarthy at MIT said "Computing can be sold as a Utility, like water & Electricity"
- (b) 1999: Salesforce.com
↳ started delivering enterprise application over Internet
- (c) 2002:- Amazon started Amazon Web Services (AWS)
- It will provide storage, computation over Internet
- (d) 2006: Elastic Compute Cloud Commercial Service EC2
(Open for everybody to use)
- (e) 2009: - Google Play also started to provide CC ~~app's~~ ^{enterprise app's}.
- Microsoft launched → Oracle & HP
Windows Azure cloud ~~for~~ Cloud

Challenges

- (a) Security & Privacy
 - * Insecure Access control pts. (what if interfaces & APIs are not safe)
 - * DDOS (Distributed Denial of Service) = ^{overwhelm website server} so it can no longer respond
 - * Data breaches & Data Loss (accidental deletion or human error, malicious tampering)
- (b) Portability * Lack of portability leads to client being locked into a single cloud provider.
↳ applications should easily be migrated from one cloud provider to another.
↳ not yet made possible, because each cloud provider uses diff. languages for their platforms.
- (c) Interoperability
↳ applⁿ. on one platform should be able to incorporate services from other platform.
- (d) Computing Performance
↳ Data Intensive applⁿ require high n/w bandwidth → high cost.
- (e) Reliability & Availability

Vision of Cloud Computing

- IT services traded as utilities in open market without technological and legal barriers.
- It is possible to find solⁿ. that matches with requirements by simply entering our request in global digital mkt. that trades with CC services.
- enable automation of discovery process, and its integration into existing s/w systems.
- Will potentially ↑ their revenue.
- a cloud provider can also become a consumer of a competition service to fulfil its promises to customers.
- Presence of this mkt will enable acquisition process to automatically integrate with its integration into its existing s/w appⁿs.
- A cloud provider can also be a buyer of a competitive service to fulfill its promises to customers.

GRID COMPUTING

* Network of computers working together → to perform a task that would be difficult for a single m/c.

- * all m/c's on that n/w work under same protocol (act as a virtual supercomputer)
- * Computers on the network contribute resources like processing power & storage capacity to n/w.

Working

Three types of machines :

- A) Control Node } - computer
 - usually, a server or grp. of servers
 - administers whole n/w
 - keeps account of resources in n/w pool.
- B) Provider } - computer
 - contributes its resources to n/w resource pool
- C) User } - computer
 - uses resources on the n/w.

Computer → makes a request for resources to control node → gives user access to available resources

Normal computer
can be a user or a provider based on requirement.

when not in use, control node should contribute resources to n/w.

* Middleware

- spw or networking protocol used
- responsible for administering n/w
- job of control node : to check that any provider is not overloaded with tasks.
- authorizes any process that is being executed on the network.
(no unwanted task being executed on n/w)

Advantages

- not centralized
- multiple heterogeneous m/c's (m/c's with different OS's use a single grid computing n/w)
- tasks can be performed parallelly across various physical locations, users don't've to pay for them.

" Main goal : Virtualize resources to simply solve problems or issues and apply resources of several computers in n/w to single problem at same time to solve technical or scientific problem.

Utility Computing

- > provide services & resources to customers.
- > facility provided to users on their demand & charge them for specific usage.
- > Similar to cloud computing
- > ∴ requires cloud-like infrastructure
- > Eg. consumer pays his electricity bill as per no. of units consumed, nothing more & nothing less.
- > Similarly, cloud computing works on same concept.

- > Provides processing power
 - when you need it
 - where you need it
 - cost of how much you use it

(Eq.) | Travel Reservation Services

- > Travel & hotel industry
- > Surge in demand for tickets to exotic destinations.
- > Travel reservation applications → will deploy additional infrastructural support, virtual servers to manage travellers wanting to make their reservations.
- > In this way, travel app's get extra resources onboard when they require & pay only based on consumption.

GRID Computing

- > process architecture, combines different computing resources, from multiple locations to achieve common goal.
- > distributes workload across multiple systems, allows computers to contribute individual resources to common goal.
- > makes better use of existing resources, address rapid fluctuations in customer demands, improve computational capabilities, etc.
- > focuses on sharing computing resources.
- > Three Types:
 - ① Computational
 - ② data
 - ③ collaborative
- > Characteristics:
 - ① resource coordination
 - ② transparent access
 - ③ dependable access

Utility Computing

- > process architecture, provides on-demand computing resources & infrastructure on basis of pay per use method.
- > allows orgⁿ to allocate & segregate computing resources & infrastructure to various users on basis of their requirements.
- > reduces IT costs, easier to manage, provide greater flexibility, compatibility, etc.
- > focuses on acquiring computing resources.
- > Two types:
 - ① Internal
 - ② External
- > Characteristics:
 - ① scalability
 - ② demand pricing
 - ③ automation

> In Grid computing, broken each computing task $\rightarrow$ small fragments, distributed across computing nodes for efficient execution.
Each fragment is processed in parallel, complex task is accomplished in less time.

Eg. $X = (4 \times 7) + (3 \times 9) + (2 \times 5)$

Desktop computer

- Step ①. $X = 28 + (3 \times 9) + (2 \times 5)$
 ②. $X = 28 + 27 + (2 \times 5)$
 ③. $X = 28 + 27 + 10$
 ④. $X = 65$

Grid computing step

Three processors or computers calculate diff. pieces of equation separately & combine them later.

- Step ①. $X = 28 + 27 + 10$
 ②. $X = 65$

Fewer steps, shorter timeframes.

Key components of Grid Computing

(a) User Interface

- $\rightarrow$ grid portal offers an interface, enables users to launch applications with resources provided by grid.
- $\rightarrow$ grid user views a single, large virtual computer offering computing resources.

(b) Security

- $\rightarrow$ GSI (Grid Security Infrastructure)
- $\rightarrow$ outlines specifications that establish secret & tamper-proof comm. b/w s/w entities operating in a grid n/w.
- $\rightarrow$ provides security by employing authentication & authorization mechanisms.

(c) Scheduler

- $\rightarrow$ To run specific tasks concurrently, require inter-process communication.
- Job scheduler coordinates the execution of different subtasks.

(d) Data Mgt.

- $\rightarrow$ secure & reliable mechanism to move or make any ~~mechanism~~ data or application module accessible to various nodes within the grid.
- $\rightarrow$ Globus Toolkit
 - open-source
 - offers data mgt. component called Grid access secondary storage (GASS)
 - uses standard FTP protocol
 - utilizes GSI for authentication

Types

① Computational GC

- When a task taking longer than expected
- main task is split into multiple subtasks
- each subtask → executed parallelly on separate node

② Data GC

- refers to grids that split

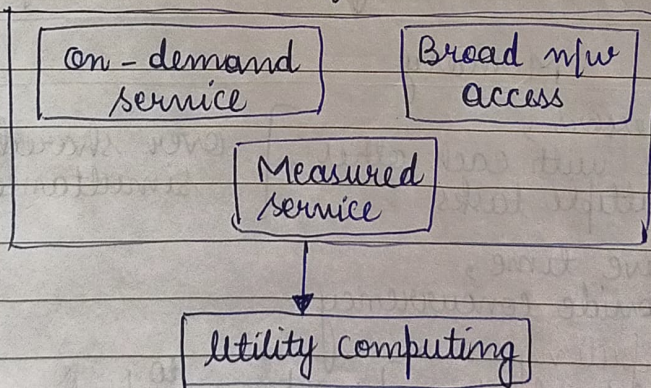
- goal : to ↑ performance, (as a single m/c)
scalability,
simplicity

4. Grid Computing

- Type of computing,
constitutes n/w of computers — work together to perform tasks, maybe difficult for a single machine to handle.
- all computers on that network work under same protocol, virtual super computer.
 - Tasks → high computing power, large data sets.
 - communication done in GC is done on "Data grid".
 - goal = solve high computational problems in less time,
↑ productivity.

5. Utility Computing

- Service provider, provides needed resources & services to customer.
- charges them depending on usage, not on a fixed rate.
 - involves resource renting depending on requirement.
 - goal = ↑ resource usage, be more cost efficient.



6. Edge Computing

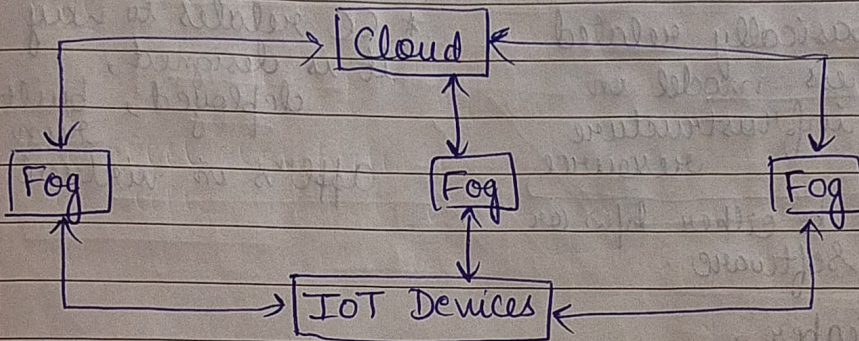
- focused on decreasing long distance commⁿ b/w client & server.
- by running few processes in cloud & moving these onto a user's computer, IOT device, etc.

- goal → bring computation to network's edge, builds less gap & results

7. Fog Computing

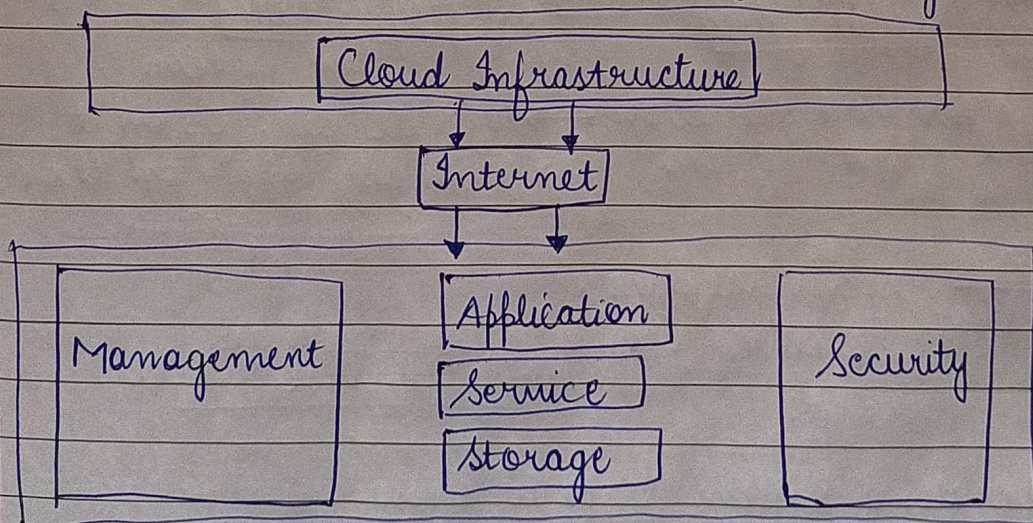
→ computational structure b/w cloud & data producing devices.

- enables users to "Fogging" allocate resources, data, applications in locations at close range within each other.
- goal: improve n/w efficiency & performance.



8. Cloud Computing

- - usage of someone else's server to host, process, or store data.
- delivery of on-demand computing services over Internet on pay-as-you-go.
- widely distributed, network-based, used for storage.



Cloud Computing v/s Utility Computing

- * CC does everything that UC does, offers much more.
- * CC not restricted to any specific network, accessible through Internet.
- * Resource virtualization, scalability, reliability } more in CC.
- * UC is basically related to business model in applⁿ. infrastructure resource.
 - ↳ could be either h/w or software.
- * CC relates to way it is designed, deployed, built, & run. applⁿs in virtual envt.
- * CC is cheaper.
- * UC : user wants to be in control of location of services & infrast.
 - good for less resource demanding
- * CC : provider is in complete control of CC services.
 - good for high resource demanding

WORKLOAD

> an applⁿ or service deployed on cloud.

Can be • massive one comprising of microservices
• modest individual service

> Resource running on cloud

Consuming resources such as computing power.

> When a service is called a Workload

it means

= can be moved around b/w different platforms
= without any dependencies or hassle.

> Various versions

— everytime a workload is deployed,

— new version of it is created.

• Having diff. versions of same workload helps in A/B testing.

• can switch b/w different versions,
shut down instances of one, etc.

Types of Workloads

A) Based on Resource Requirements

- web appⁿs, web servers, etc.
- do not have any specific computational requirements
- easily run using default abilities of cloud

General Compute

CPU Intensive

• These workloads have specifically high computational requirements.

• deep learning applications,
highly scalable multiplayer gaming apps,
3D modeling, etc.

• need CPU memory to execute tasks.

• distributed databases, caches,
real-time streaming

memory Intensive

B) Classified by User Traffic Patterns

- resource utilization is known,
no surprises,
no traffic spikes.
 - can be a utility deployed on cloud used by a limited no. of users in private network.
- eg. — organization: tax-calculation utility.

Static workloads.

Periodic

workloads.

- utilization at specific times
(few days in a month like electricity bill payment app).
- no need to pay for idle instances, just pay for compute utilized.

- Include popular apps like social networks, online multiplayer games, video, etc.
- Traffic can spike by any amount exponentially.

Unpredictable workloads.

Hybrid workload.

- Hybrid of above - static workloads

What is IT?

- use of computers to
 - create
 - process
 - retrieve
 - store
 - exchange
- } all kinds of electronic data & information.
- IT is now expected to operate as a
 - business unit that assists the orgⁿ & its users.

ITaaS

- similar as CC services, IT expertise & services] can be consumed "as a service".
- Operational model
 - allows line of business or users to consume IT] as a managed service
- This model can be adopted by Internal IT dept. or external vendors.
 - cataloged
 - consumers pay only for services they require.

Approach

- > variety of services, configuration settings, framework guidelines, technologies] made available, to address unique demands of each user & line of business.
- > consumers → variety of choices
→ employ IT solⁿ's to meet specific demands
- > Focused addressing unique requirements of internal consumers
- > Allowing options to choose best available resources & solutions.

Benefits

With ITaaS model, organizations employ same services without operating an individual IT dept. in-house.

ITaaS vendors

- responsible for maintaining vast library of IT solⁿ's & services reqd. by end users
- take role of managed service providers & brokers.

From IT Service Lifecycle

- Identifying user reqt. $\xrightarrow{\text{to}}$ final outcome of effectively delivered service.
- Tasks: - helping users make decisions
- Finding available solutions, etc

Key Components of ITaaS

- (a) Business Focus
- (b) IT mgt. framework } ^{should} focus on business & end user req's
- (c) Financing } justify promised cost savings & value
- (d) Cross Functional Expertise } require expertise with business & sales knowledge to connect right user with right external provider
- (e) User Experience } should offer improved user experience, managed services should ensure end-user requirements effectively across service lifecycle

CLOUD COMPUTING APPLICATIONS

A.) Art appl^{n's} $\rightarrow$ design attractive cards, booklets & images.

- Moo: for designing & printing business postcards, cards, & mini cards.
- Vistaprint: design printed mktng. products
- cards, postcards, wedding invitⁿ cards, etc.
- Adobe Creative cloud:
- for designers, artists, filmmakers, etc
- Photoshop, InDesign, Dreamweaver, etc.

B.) Business appl^{n's} $\rightarrow$

- MailChimp: email publishing platform
- send, save, & design templates
- Salesforce: provides tools for sales, service, marketing, e-commerce, etc.
- Chatter: share imp. info. about orgⁿ. in real time
- Bitrix 24: Collaboration platform
- provides commⁿ., mgt., social coll. tools
- Slack: Searchable Log of all commⁿ & knowledge
- user-friendly interface
- to create public & private channels for commⁿ.
- Quickbooks: "Run Enterprise anytime, anywhere, on any device"
- provides online accounting solutions for business.

c) Data Storage & Backup Applications →

- Box.com : for secure content mgt., workflow & collaboratⁿ
 - allows to store different files = Excel, Word, Pdf, & images on cloud
 - provides drag & drop.
- Mozy : online backup solutions
 - for personal & business data.
 - backup scheduled for each day at specific time
- Toukoo : to share & track cloud-based backup files. automati^{cally}
- Google G Suite : one of best cloud storage & backup application.
 - Google calendar, Docs, Forms, Google+, Hangouts., Gmail.

d) Google Apps for Education →

- Chromebook for Education
- Tablets with Google Play : quickly implement latest technology solⁿ's into classroom
- AWS in Education : education - friendly envt. to universities, colleges & schools

e) Entertainment Applications →

- cloud gaming
- video conferencing

f) Management applications →

resource deployment, data integration, disaster recovery } to manage

- Toggi : track allocated time period for particular proj.
- Evernote : sync & save recorded, typed notes
- Outright : mgt. users use for accounts, track income, expenses, profits.

g) Social Applⁿ's →

- Facebook • LinkedIn : team collaboratⁿ tool,
- Twitter • Yammer : to chat, share images, docs, & videos.

For testing applications on different platforms of OS.

3. Server Virtualization

When VM s/w or VMM → directly installed on server system.

Usage.

done bcoz single physical server
↓ divided
multiple servers on demand for load balancing.

4. Storage Virtualization

grouping physical storage from multiple n/w storage devices. looks like → single storage device.

Usage.

mainly done for backup & recovery purposes.

<u>Hardware</u>	<u>Operating System</u>	<u>Server</u>	<u>Storage</u>
• physical parts of computer • physical component, memory, storage, power supply, etc. • Input devices, processing devices, output devices, etc.	• Translator b/w user & h/w. • resource allocation, handles I/O op'n's, program execution, etc.	• Computer prog. that provides service to another computer prog. & its user. (client) • role: share data & resources, distribute work.	• process through which digital data is saved within a storage device ↓ - by means of computing technology. • enables to retain data, either temporarily or permanently.

Virtualization In Cloud Computing

- Normally, In CC, users → share data → app'n's, etc.
- With virtualization, CC → can share Infrastructure.

Main Usage.

- provide applications with standard versions to cloud users
 - If new version is released, cloud provider → provide latest version to cloud users.
- Pay on monthly or annual basis.

Characteristics of Virtualization

1. Increased Security

- Controlling ability on guest program → secure, controlled execution envt.
- VMM → controls & filters activity of guest programs.

2. Managed Execution

Sharing

Aggregation

Emulation → imitation of function or action] different computer

Isolation

3. Sharing

- allows creation of separate envt. within same host.
- reduces active servers
- limits power consumption.

4. Aggregation

- group of separate hosts tied together → represented to guests as single virtual host.

5. Emulation

- Guest prog's executed within envt., controlled by virtualizatⁿ layer.
- Completely different envt. w.r.t host can be emulated.

6. Isolation

- provide guests : OS, appⁿ's, or, other entities completely separate envt.

7. Portability

- guest is packaged → virtual Image
- safely moved, executed on different VM's.