

Cloud Computing :- It is the use of remote servers on the internet to store, manage and process the data rather than local servers. By the help of cloud computing we can easily scale up and scale down as per our requirement.

⇒ Benefits of cloud computing :-

- Reduces investment
- Increased scalability
- Increased availability and reliability

⇒ Features/characteristics of cloud computing

- O :- On demand self service
- B :- Broad network access
- R :- Resource pool
- E :- Rapid Elasticity
- M :- Measured service (Pay per use)

* These characteristics are given by National Institute of Science & Technology (NIST)

⇒ Applications of cloud computing :-

- Online storage
- Photo & video editing sw
- Presentation sw (ex: slide rocket)
- finding way on Map
- word processing application (ex:- white board)

Cloud Computing Service models:-

↳ Infrastructure As A Service (IaaS) or Hardware As A Service (HAAS):-

In the IaaS model, the cloud provider manages IT infrastructures such as storage, server and networking resources and delivers them to the subscribers organization via virtual machines accessible through the internet. IaaS can have many benefits for organization, such as potentially making workloads faster, easier, more flexible and more cost efficient.

Here the whole control is in the hands of the user how he/she wants to use that cloud services.

⇒ The choices that we can make are as follows.

- Operating system
 - IP address
 - VM and storage
 - Flexible
 - Provider Infrastructure
 - Enhanced scalability
- * It is mainly used by the system administrators.

↳ Platform As A Service (PaaS):-

PaaS is a complete development

and deployment environment in the cloud with resources that enable you to deliver everything from simple cloud based apps to sophisticated, cloud enabled enterprise applications.

It is used by developers because we have provided with a platform, some tool, run time environment and some programming languages etc. And by the help of these tools, we can build and deploy our applications.

⇒ The areas available in this model are as follows:-

- OS, the areas of OS virtual storage, physical storage are not available here
 - your application
 - Run time environment
 - offers development and deployment tools
- * Used by developers
- * No need to purchase expensive hardware and software.

↳ Software As A Service (SaaS):-

Software As A Service allows users to connect to and use cloud based apps over the internet. Common examples are

email, calendaring, and office tools such as Microsoft office 365). SaaS provides a complete software solution that you purchase on a pay as you go basis from a cloud service provider. SaaS means accessing software through the internet without downloads. ~~However~~ ~~the~~ ~~software~~ ~~without~~ Users subscribe to applications hosted on remote servers, accessing them via web browsers. No maintenance or updates are required, making it a convenient and cost effective way to use the software.

⇒ features of SaaS are as follows:-

- On demand Accessed by the end users/clients. No need install on PC servers/resources managed by vendor. Platform independent.

→ XAAS (Anything and anything as a Service) :-

As from the name we can understand that this model provides everything and anything as a resource with

remote access rather the services are related to Blu, SaaS, desktop, infra-structure etc. It will provide the service for anything with the remote access.

⇒ features of XaaS model:-

- we use the model to save our cost and time
- It is faster and scalable
- It is cheaper and safe

Cloud Computing Deployment Models

→ Public cloud :-

- It is publicly available to all where everyone can access the same resource
- It is deployed globally
- Due to the global deployment, there is less security and privacy as compared to the private cloud.
- It is less expensive that why it is cost efficient
- There is less customization available in this model

It provide multi tenent model. Here SLA (Service level agreement) is formal.

Multi-tenant model means there is one server which provides many virtual machines. It is cheaper than private.

→ Private cloud :-

- It is not publicly available to all
- It is deployed locally
- It is more secure than public cloud
- It is more expensive as compared to public cloud
- It provides more customization as compared to public cloud.

It is a cloud computing environment dedicated to a single organization. Any cloud infrastructures had underlying compute resources like CPU and storage that you provision on demand through a self-service portal. In a private cloud, all resources are isolated and in the control of one organization.

⇒ Type of private cloud :-

1. On-Premise :- An on-premise private cloud is one that you can deploy on your own resources in an internal data center. You must purchase the resources

, maintain and upgrade them, and ensure security. Its management is expensive and requires heavy initial investment and ongoing expenses.

2. Off-Premise :- Off-premise software is a type of software that is not installed on a company's own servers. Instead, the company leases or rents the software from a third-party provider. Off-premise software can exist within cloud technology or as a SaaS model.

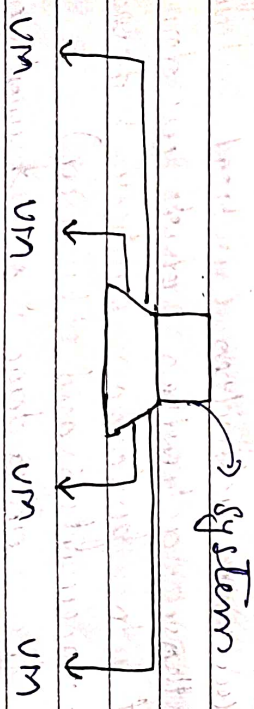
→ Hybrid cloud :- It is the combination of both public and private cloud that is why it is known as hybrid cloud.

- It is used when we need to perform the critical activities (critical activities are those activities which we don't want to perform publicly but want full security and privacy)
- All the advantage of private and public cloud comes under this

→ Community :- A community cloud is a computing in a collaborative effort in which infrastructure is shared between

several organizations from a specific community with common concerns (Security compliance, jurisdiction, etc.). whether managed by internally or by a third party and hosted externally or external. These share requirements are some user community cloud.

Virtualization :- Virtualization is a technology that you can use to create virtual representation of servers and other physical machines. Virtual software mimic the function of physical hardware to run multiple virtual machines simultaneously on a single physical machine.



⇒ Hypervisor :- A Hypervisor is a software that you can use to run multiple virtual machines on a single physical machine. Every virtual machine has

its own operating system and applications. The Hypervisor allocates the underlying physical computing resources such as CPU and memory to individual VM as required.

* If your hypervisor is compromised then it is called buffer packing.
* open stack, VM escape etc are the tools for virtualization.

* VM hopping :- It is a common attack made up of virtualization security attack. It means that an attacker attempts to gain access to other virtual device on the same Hypervisor based on one virtual machine, and then attacks it.

29/01/2024

* MITM attack :- MITM stands for Man in the middle attack. It is a general term for when a perpetrator positions himself in a communication between a user and an application - either to eavesdrop or to impersonate one of the following parties, making it appear as if a normal exchange of information is underway.
* Virtualization is a technique to convert hardware to software.

* Denial of service attack (DoS attack):-

It is an attack meant to shut down a machine or network, making it inaccessible to its intended user. DoS attack attempts this by flooding the target with traffic, or sending it information that triggers a crash. In both instances, the DoS attack deprives legitimate users (i.e. employees, members, or accounts holders) of the service or resource they expected. It is an attack when the attacker increases the no. of request for a particular website or application due to which the site get down.

Roles in cloud computing :-

- Cloud Service Provider (CSP)
 - Cloud Service Consumer (CSC)
 - Cloud Service Auditor (CSA)
- * There are two types of CSP
- Internal
 - External
- Cloud broker :- It decides which services to whom and many more things
- Cloud carrier :- It provides the networking resources by the help of which CSC

meet with broker

Historical Development :-

- 1950s, when large scale mainframes were made available to school and corporations.
- 1970s, IBM released an OS called VM that allowed technicians on their system/370 mainframe system to have multiple virtual systems, or VM on a single physical node
- 1990s, telecommunication companies started offering virtualized private network (VPN) cloud computing is realized through the advent of internet
- 1960s, John McCarthy noted:
 - computation may someday be organized as a public utility.
 - McCarthy's prediction forecasts the advent of grid computing in the early 1990s
- One of the first companies to embrace the cloud was Salesforce.com
- CRM services via the Internet
- Amazon Web Services (2002), Google Docs (2006), and Amazon's Elastic Compute Cloud (EC2)
- In 2007 Google and IBM partnered

with higher education to introduce cloud computing to academia,
 Microsoft entered the arena with the introduction of Windows Azure in Nov. 2009

Two core technologies that played an important role in the realization of Cloud computing :-

- Distributed system
 - Virtualization
 - web 2.0
 - Service-oriented computing
 - Utility computing
- These major milestones have led to cloud computing :-
- mainframe computing
 - cluster computing
 - grid computing

31/01/2024

Advantages of Public cloud services

| Disadvantages | Public cloud | Private cloud |
|---------------|---|---|
| Cost | generally cost-effective we with pay-as-you-go model | can be more expensive due to infrastructure ownership |

Scalability Highly scalable, on demand resources

Flexibility Offer a wide range of services & resources

Ease of Implementation Quick setup and minimal hardware management

Global reach Accessible from anywhere with an Internet connection

Resource Management Outsourced maintenance & updates

Redundancy & Reliability Built in redundancy & multiple data centers

Security updates Automatic updates managed by the cloud provider

Scalability might be limited by on premise hardware

Limited flexibility especially in resource types

Requires more time and management for implementation

Limited by the physical location of private data centers

Full control over resource management & configuration

Relies on the infrastructure set up by the org.

Requires proactive management of security updates

| | | |
|----------------------------|---|--|
| Disaster recovery | Typically has robust disaster recovery options | Relies on the organization's own disaster recovery plans |
| Focus on core competencies | Allows organization to focus on their core business | Requires more resources for IT infrastructure management |

Advantages of Private cloud over Public

| | | |
|------------------------------|--|---|
| Advantages | Private cloud | Public cloud |
| Control and Customization | Full control over infrastructure and configuration | Limited customization due to shared infrastructure |
| Security and Compliance | Enhanced security and compliance adherence | Shared environment may raise security and compliance concerns |
| Performance & Predictability | Dedicated resources for consistent performance | Performance may be influenced by shared resources |
| Data residency | Secures control | Data may reside |

| | | |
|---------------------------|--|---|
| and privacy | Users data location and privacy | in diff. regions affecting privacy |
| System Application | suited for organization with unique application needs | standardized service may not fit specialized requirement |
| Cost Predictability | Predictable cost without unexpected charges | Variable costs based on usage potentially less predictable. |
| Network Performance | Dedicated network resources for improved performance | Network performance may be influenced by shared infrastructure |
| Legacy system integration | Easier integration with existing legacy systems | May require additional effort for integration with legacy systems |
| Resource allocation | More control over resource allocation and optimization | Limited control over underlying infrastructure |

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* SETI :- Search for extra terrestrial intelligence

* Term cloud computing in 2000

* Load sharing (load distribution in servers)

* Cloud computing :- The main difference

is that there is no need of money in grid computing

grid computing

* Open stack (NASA and Rosetta) in 2008

* rapid growth in 2010

* Servers less computing in 2015, FaaS (function as a service)

* Edge computing in 2020 (portion of computing on user end)

02/02/2024

3rd layer - Cloud computing

2nd layer - fog computing

1st layer - edge computing / smart computing

* No. of devices are more in layer 1 and it decreases as layers increases

Parallel computing :- Parallel computing

refers to the process of breaking down

larger problems into smaller, independent

often smaller parts that can be executed

simultaneously by multiple processors

communicating via shared memory, the

results of which are combined upon completion as part of an overall algorithm. In other words we can say that in server and in client is parallel computing.

Concurrent computing :- Concurrent computing

refers to the simultaneous execution of

multiple tasks or process, allowing them

to make progress independently and

potentially interact with each other.

It's a key concept in computer science,

enabling efficient utilization of resources

and supporting parallelism in system

designs. Concurrent computing involves handling

multiple tasks or process concurrently

often through the use of threads or

processes, enabling efficient resources

utilization and potentially improving

system performance by allowing tasks

to execute simultaneously. It's a

fundamental concept in modern

computing system, essential for handling

tasks in real time distributed environ-

ment, and parallel processing.

* 1 server and n clients

Cluster computing - Cluster computing refers to the use of multiple interconnected computers, often referred to as nodes or servers, working together as a single system to perform computational tasks. These nodes are typically linked via a high speed network and may share resources such as storage, memory, and processing power. Cluster computing enables distributed processing, allowing large scale tasks to be divided among multiple nodes for parallel execution, thereby increasing computation speed and capacity. It's commonly used in scientific research, data analysis and high-performance computing applications.

Automatic computing :- Automatic computing refers to the process of performing computation or tasks without direct human intervention. It involves the use of compiler systems and software programs designed to execute predefined instructions or algorithms without requiring constant manual inputs or oversight. Automatic

computing systems are capable of processing data, performing calculations and executing tasks automatically, based on predetermined rules or instructions. This concept underlies much of modern computing where tasks are automated to streamline processes, improve efficiency and reduce the need for human intervention. Suppose you have 4 computers or 4 cores in a computer (it can be more than 4) and if any of these computer stops then those 3 remaining computers will try to fix that computer which is not working. until it get fixed those 3 computers will behave the load.

03/02/2024

Client server architecture :- A network architecture where client request services from centralized server. It is a network model where client devices or applications request services or resources from servers, which provides those services or resources in response to the clients requests. In this model, client initiates communication & make request, while servers

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wait for and respond to those request
 This architecture enables distributed
 computing, allowing clients to access
 resources or services hosted on
 remote servers, and it's commonly
 used in various application including
 web browsing, email, file sharing and
 database management system.

⇒ Client - Server architecture v/s cloud
 computing architecture

| | | | | |
|----------------|--|---|--|---|
| Aspect | Client - Server architecture | Cloud Computing architecture | Resource sharing | adding more server by provisioning hardware often resulting in more resources as cost and complexity needed |
| Definition | A network archi- tecture where client request service from centralized servers | A distributed model providing on demand re- sources and service over the internet | limited resource sharing between clients connected to the same server org. & application | latency varies based on the proximity of the cloud data center and network condition. |
| Resource owner | server resources are owned and managed by the organization | cloud resource are owned and managed by a cloud service provider | latency depends on the distance b/w the client and the server | latency varies based on the proximity of the cloud data center and network condition. |
| Scalability | Scaling requires | readily available | Infrastructure Management | Organization manage their own infrastructure & server maintenance |
| | | | cost model | Organization incur costs for server maintenance, h/w and s/c |
| | | | | pay-as-you-go model with costs based on resource consumption and usage. |

| | | |
|------------------------|---|---|
| Accessibility | Accessibility depend on network connectivity to the specific server | Accessible from anywhere with internet connectivity, providing high availability |
| Data storage | Data is primarily stored on the server, potentially leading to data concentration | Data storage is distributed across multiple data centers, improving redundancy and resilience |
| Security | Organizations are responsible for server security and data protection | Cloud providers implement security measures, but data security is a shared responsibility |
| Application Deployment | Application deployment and updates are managed individually on each server | Application can be easily deployed, updated and managed centrally through the cloud platform |

| | | |
|-----------|--|---|
| use cases | Common in traditional application with a centralized data or service structure | scalable, suitable for a wide range of application, from simple web apps to complex analytics |
|-----------|--|---|

Distributed system :-

- * collection of independent computers
- * Appears to its users as a single coherent system
- * clouds are essentially large distributed computing facilities that make available their servers to third parties on demand

* Purpose of distributed system

- to share resource
- to utilize them better
- to run in the case of cloud computing

* Properties :- heterogeneity, openness, scalability, transparency, consistency, continuous availability and independent failures.

Computer cluster :-

- * is a group of linked computers
- * Working together thru in many

many servers forming a single computer.
 * The components of a cluster are connected to each other through fast local area network.

- Types of cluster
- High availability cluster
 - Load Balancing cluster
 - HPC cluster

Comparison b/w Cluster, Grid & cloud.

| | Cluster | Grid | cloud |
|------------------------|---------|------|-------|
| On demand self service | X | X | ✓ |
| Broad N/w access | ✓ | ✓ | ✓ |
| Resource Pooling | ✓ | ✓ | ✓ |
| Rapid elasticity | X | X | ✓ |
| Measured service | X | ✓ | ✓ |

Grid Computing :-

- Grid computing is a term referring to the combination of computer resources from multiple administrative domains to reach a common goal.
- Coordinates resources that are not subject to centralized control.
- Uses standard, open, general purpose protocol and interfaces.
- Servers maintain (important) qualities of service.

Vision of Cloud Computing

- Cloud computing provides the facility to provision virtual hardware, software having money.
- There all thing can be used as long as they are needed by the user, there is no requirement for the upfront commitment.

→ The whole collection of computing system is transformed into a collection of utilities, which can be provisioned and composed together to deploy system in hours.

rather than days with no maintenance costs.

→ The long term vision of cloud computing is that IT services are traded on a utility in an open market without technological and legal barriers.

→ In the near future we can imagine that it will be possible to find the solution that matches with our requirement by simply entering our request in a global digital market that trades with cloud computing services.

→ The existence of such market will enable the automation of the discovery process and its integration into its existing software systems.

→ Due to the existence of a global platform for trading cloud services will also help service providers to potentially increase their revenue.

→ A cloud can also become a consuming provider.

of a competitor service in order to fulfill its promises to customers.