Cloud Computing

Defining Cloud Computing Paradigm

Over the years different computing paradigms have been developed and used. In fact different computing paradigms have existed before the cloud computing paradigm. Let us take a look at all the computing paradigms below.

Distributed Computing :

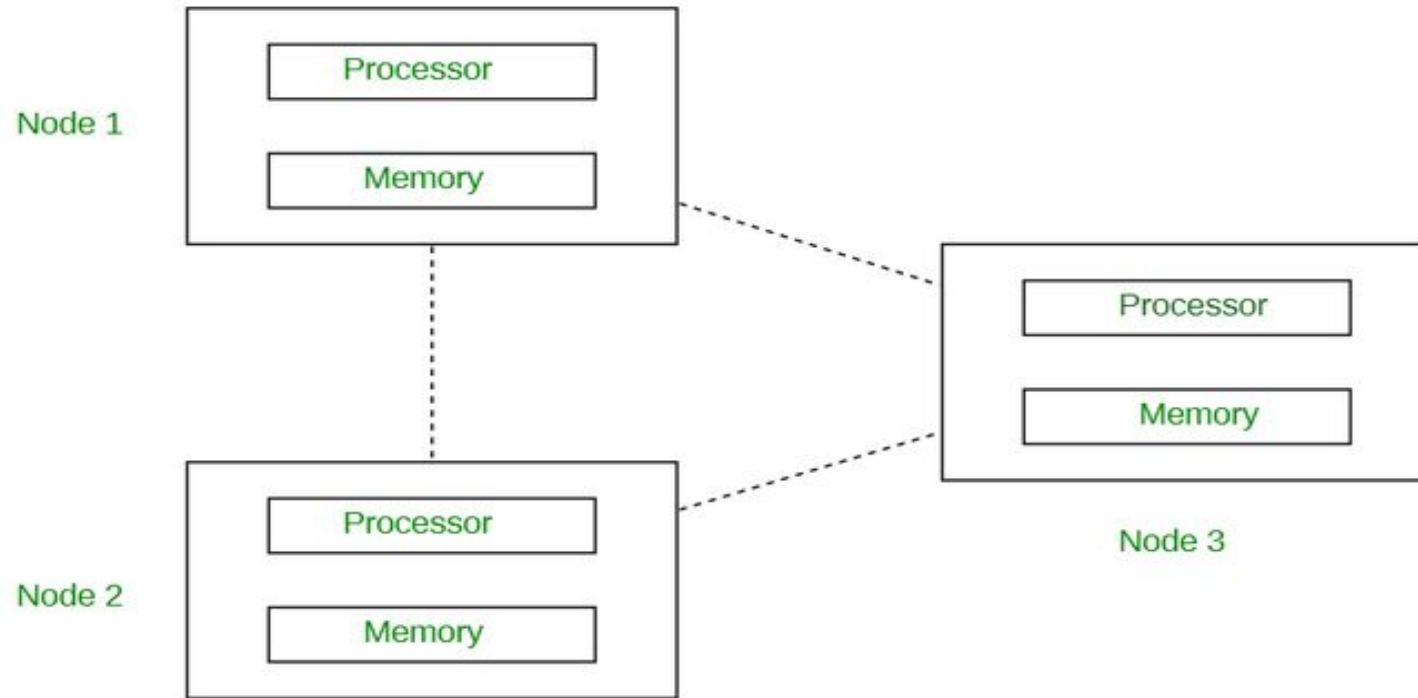Distributed computing is defined as a type of computing where multiple computer systems work on a single problem.
Here all the computer systems are linked together and the problem is divided into sub-problems where each part is solved by different computer systems.

The goal of distributed computing is to increase the performance and efficiency of the system and ensure fault tolerance.

In the below diagram, each processor has its own local memory and all the processors communicate with each other over a network.

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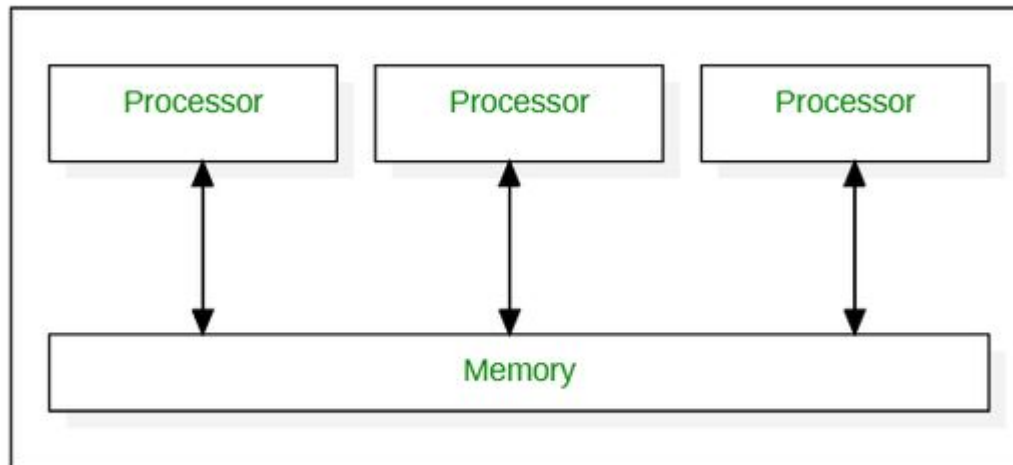# Defining Cloud Computing Paradigm

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Parallel Computing :

Parallel computing is defined as a type of computing where multiple computer systems are used simultaneously.
Here a problem is broken into sub-problems and then further broken down into instructions.
These instructions from each sub-problem are executed concurrently on different processors.

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Parallel Computing :

Cluster Computing :

A cluster is a group of independent computers that work together to perform the tasks given.
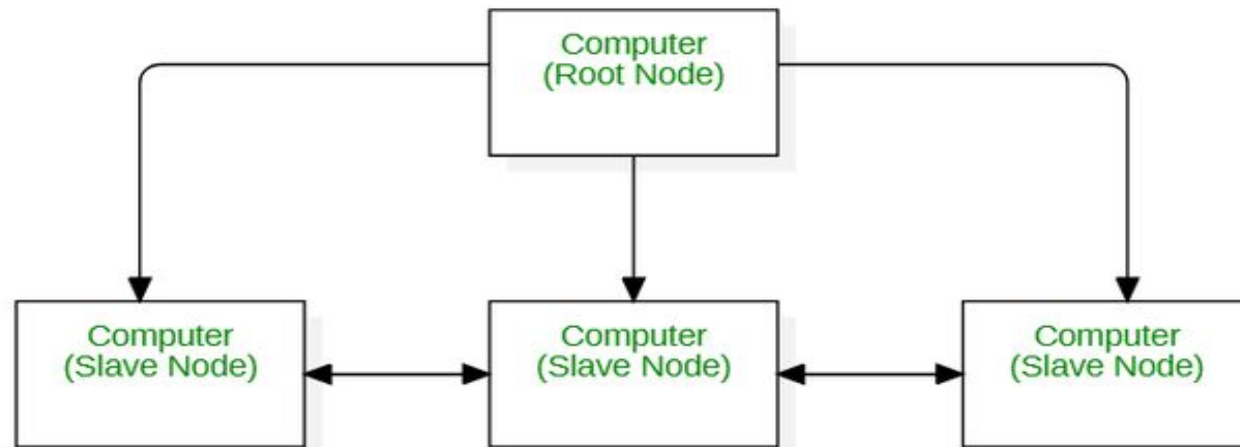
Cluster computing is defined as a type of computing that consists of two or more independent computers, referred to as nodes, that work together to execute tasks as a single machine.

The goal of cluster computing is to increase the performance, scalability and simplicity of the system.

As you can see in the below diagram, all the nodes, (irrespective of whether they are a parent node or child node), act as a single entity to perform the tasks.

Defining Cloud Computing Paradigm

Cluster Computing :

Defining Cloud Computing Paradigm

Cloud Computing :

Cloud is defined as the usage of someone else's server to host, process or store data.

Cloud computing is defined as the type of computing where it is the delivery of on-demand computing services over the internet on a pay-as-you-go basis.

It is widely distributed, network-based and used for storage.

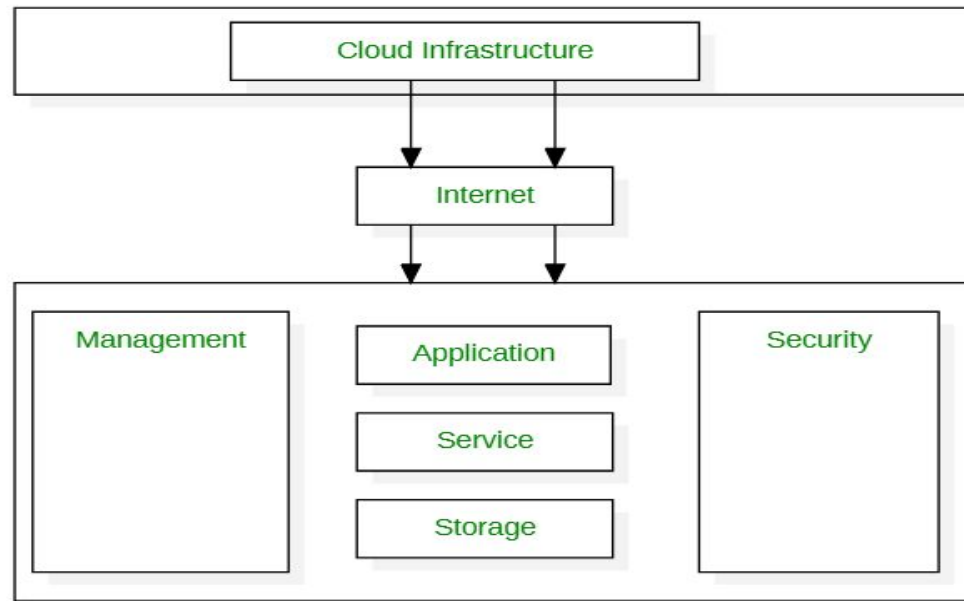There type of cloud are public, private, hybrid and community and some cloud providers are Google cloud, AWS, Microsoft Azure and IBM cloud.

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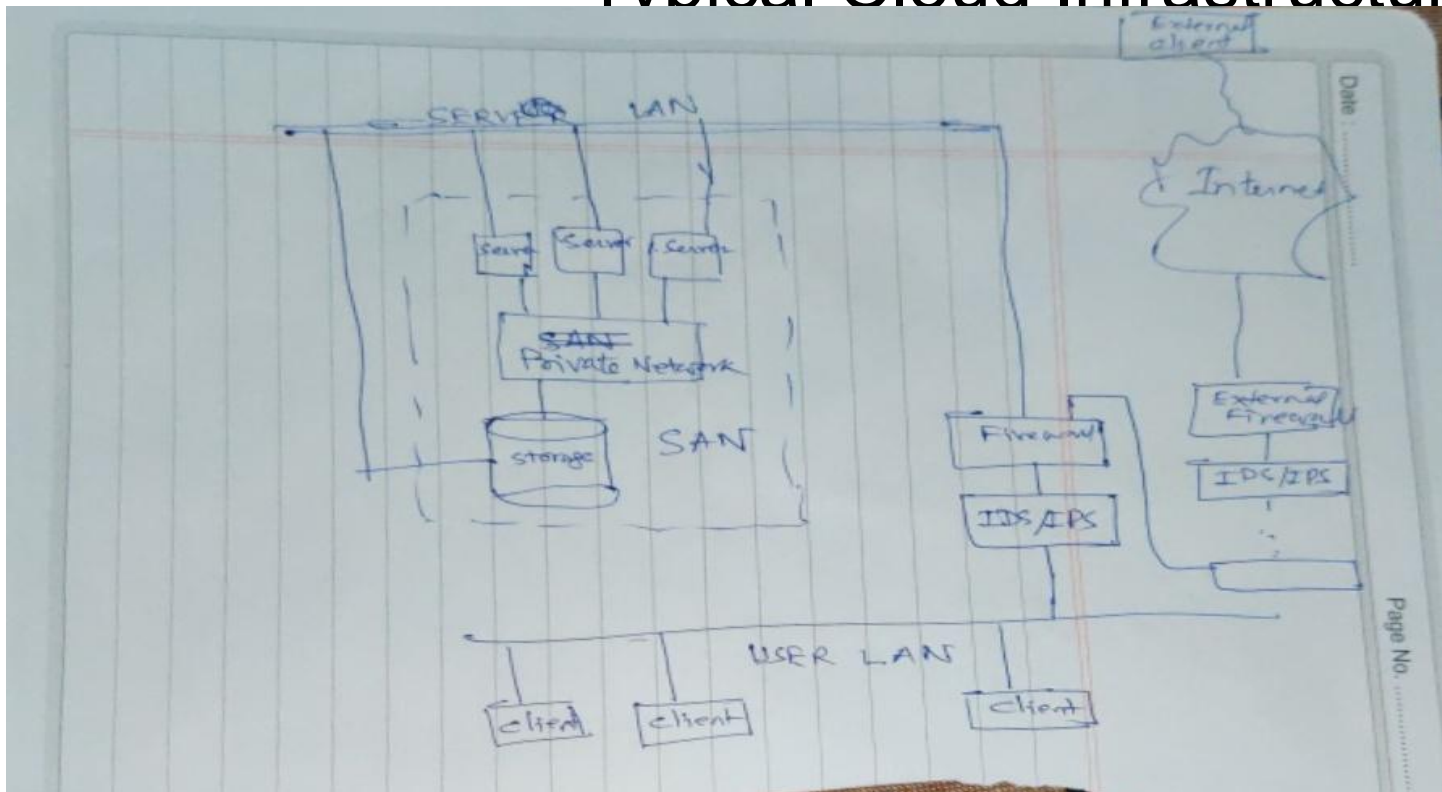
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Cloud Computing :

Defining Cloud Computing Paradigm

Cloud Computing :   Typical Cloud Infrastructures

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Cloud Computing :

Definitions of Cloud Computing

"A cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and the consumers."

"Cloud computing refers to both the applications delivered as services over the Internet, and the hardware and system software in the datacenters that provide those services."

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Cloud Computing :

<u>Features of Cloud Computing</u>

✔ It is massively scalable,

✔ It can be encapsulated as an abstract entity that delivers different levels of services to customers outside the Cloud,

✔ It is driven by economies of scale,

✔ The services can be dynamically configured through virtualization

✔ Delivered on demand.

There are three main factors contributing to the surge of interest in Cloud Computing:

✔ Rapid decrease in hardware cost and increase in computing power and storage capacity,

✔ Advent of multi-core architectures and modern supercomputers consisting of hundreds of thousands of cores.

✔ The exponentially growing data size in scientific instrumentation/simulation and Internet publishing and archiving,

✔ The wide-spread adoption of Services Computing and Web 2.0 applications.

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Cloud Types – NIST Model

There was a special publication of National Institute of Standards and Technology (NIST) - 800-145 in September 2011 .

As per NIST definitions,

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

Cloud Types – NIST Model

As per this, cloud model is composed of

✔ Five essential characteristics,

✔ Three service models,

✔ Four deployment models.

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Cloud Types – NIST Model

A. Essential Characteristics

(1) On-demand self-service.
A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

(2) Broad network access.
Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Cloud Types – NIST Model

A. Essential Characteristics

(3) Resource pooling

The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter).

Examples of resources include storage, processing, memory, and network bandwidth.

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Cloud Types – NIST Model

A. Essential Characteristics
(4) Rapid elasticity.
Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

(5) Measured service.
 Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts).

Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

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Cloud Types – NIST Model

B. Service Models
(1) Software as a Service (SaaS).

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 either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. 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.

Cloud Types – NIST Model

B. Service Models

(2) Platform as a Service (PaaS)

The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, 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 configuration settings for the application-hosting environment

Cloud Types – NIST Model

B. Service Models

(3) Infrastructure as a Service (IaaS)

The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary 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, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

Cloud Types – NIST Model
C. Deployment Models

1) **Private cloud.**

The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units).

Can be owned, managed, and operated by the organization, a third party, or some combination of them

Can exist as on premises.

Cloud Types – NIST Model

C. Deployment Models

(2) Community cloud

The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations).

Owned, managed, and operated by one or more of the organizations in the community
a third party

Can exist as on or off premises.

Cloud Types – NIST Model

C. Deployment Models

(3) Public cloud

The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them.

It exists on the premises of the cloud provider.

Cloud Types – NIST Model

C. Deployment Models

(4) Hybrid cloud

The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability.

Examples - Cloud bursting for load balancing between clouds