

# Cloud computing

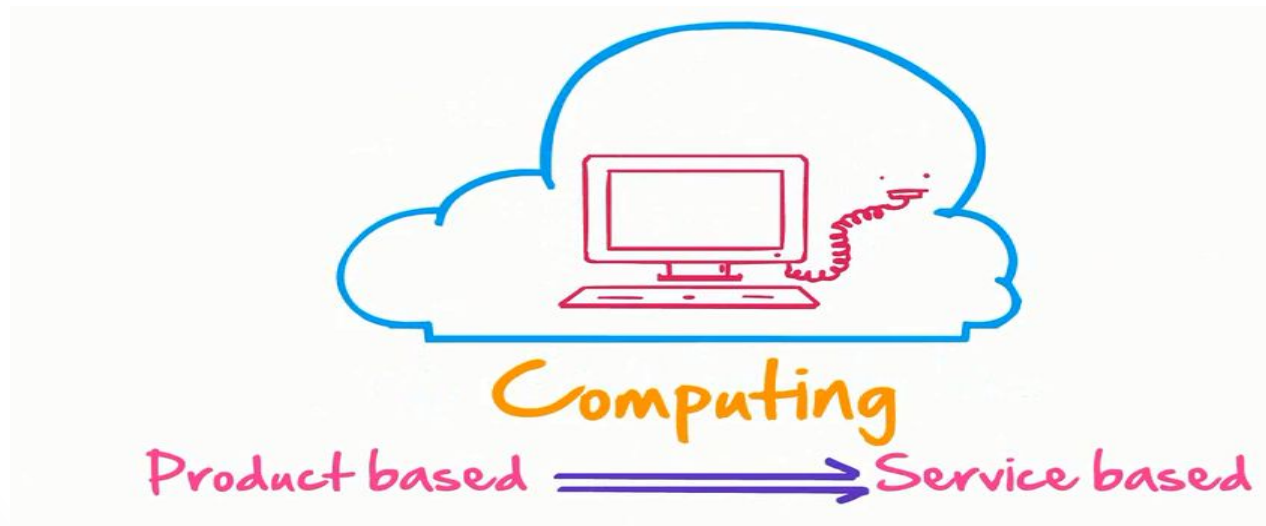
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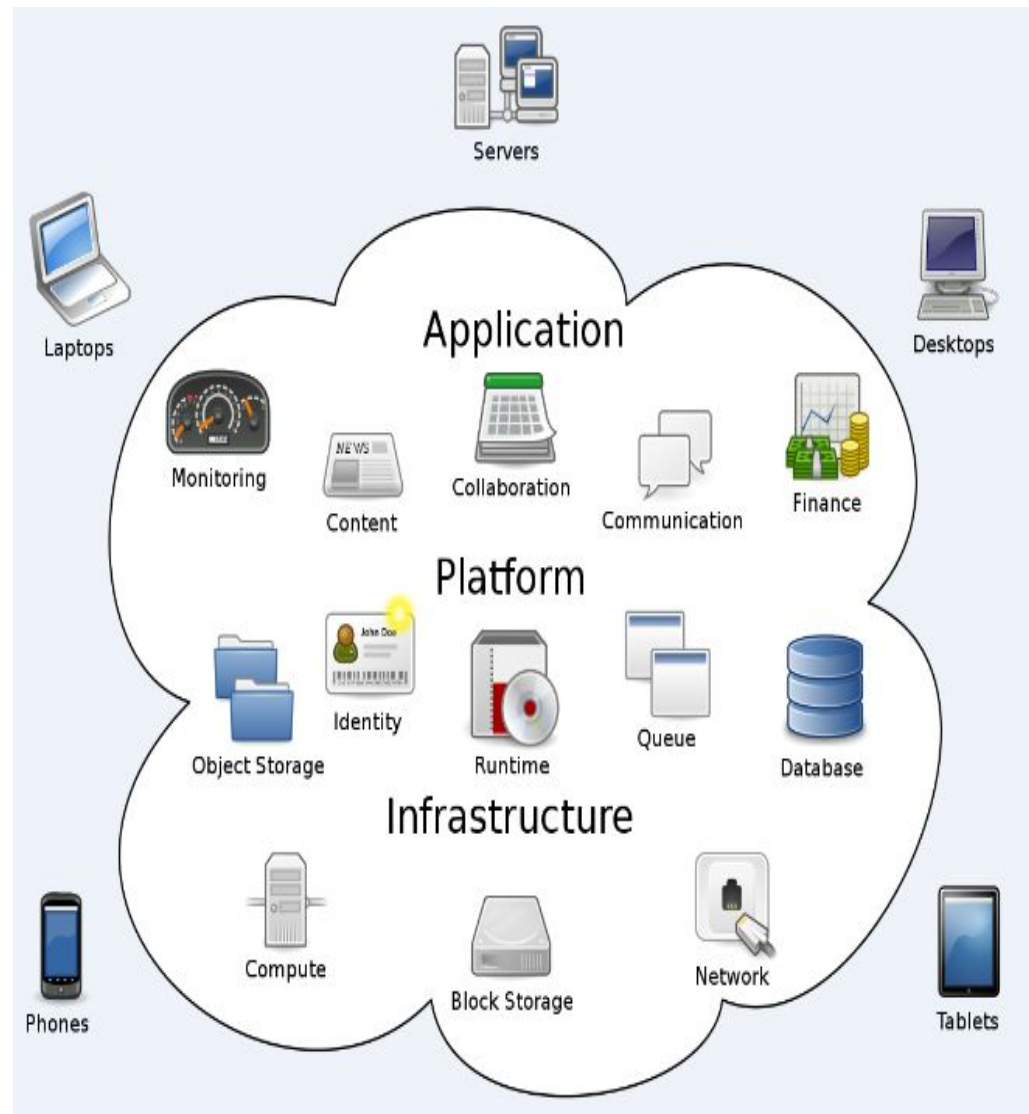
# Introduction

- Cloud computing is the delivery of computing as service rather than a product.
- Cloud computing means storing and accessing data and programs over the internet instead of your computer's hard drive.



# Cont..

It is the use of remote servers on the internet to store, manage and process data rather than a local server or your personal computer



# Needs for Cloud Computing

- Companies is probably already using several cloud computing services. For instance, all hosted email providers including Gmail and Outlook are SaaS cloud computing services.
- Additional examples of cloud computing services include:
  1. Virtual Machines
  2. Data Storage
  3. Backup & Disaster Recovery
  4. App Development Platforms
  5. Cloud-Based Servers
  6. Infrastructure Monitoring & Management
  7. Build, Host, & Deploy SaaS Services

# high-performance computing

- in high-performance computing systems, a pool of processors are connected with other resources like memory, storage, and input and output devices, and the deployed software is enabled to run in the entire system of connected components.

# Parallel Computing

Parallel computing is also one of the facets of hpc.

in parallel computing, since there is simultaneous use of multiple processor machines, the following apply:

1. It is run using multiple processors (multiple cpus).
2. A problem is broken down into discrete parts that can be solved concurrently.
3. Each part is further broken down into a series of instructions.

# Distributed Computing

- Distributed computing is also a computing system that consists of multiple computers or processor machines connected through a network, which can be homogeneous or heterogeneous, but run as a single system.
- the cpus in a distributed system can be physically close together and connected by a local network, or they can be geographically distant and connected by a wide area network.



# Advantageous of Distributed computing systems

1. **scalability**: it is the ability of the system to be easily expanded by adding more machines as needed, and vice versa, without affecting the existing setup.
2. **redundancy or replication**: here, several machines can provide the same services, so if one is failed, other similar computing supports will be available.

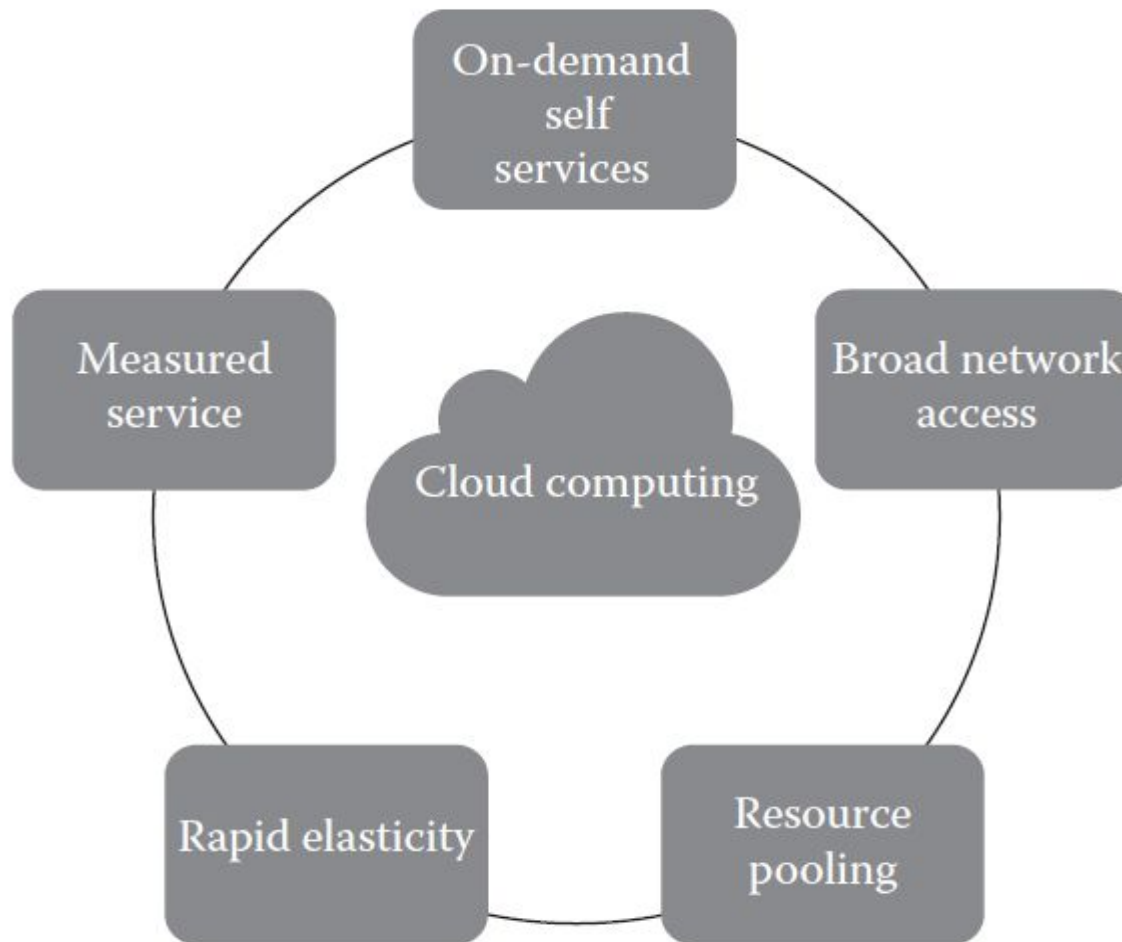
# Cluster Computing

- a cluster computing system consists of a set of the **same or similar** type of processor machines connected using a dedicated network infrastructure.
- all processor machines share resources such as a common home directory and have a software such as a message passing interface (mpi) implementation installed to allow programs to be run across all nodes simultaneously. this is also a kind of hpc category.

# Cloud Computing

- in the simplest terms, cloud computing means storing and accessing data and programs over the **internet** from a remote location or computer instead of our computer's hard drive.
- this type of computing has several properties such as scalability, elasticity etc.

# Five Essential Characteristics



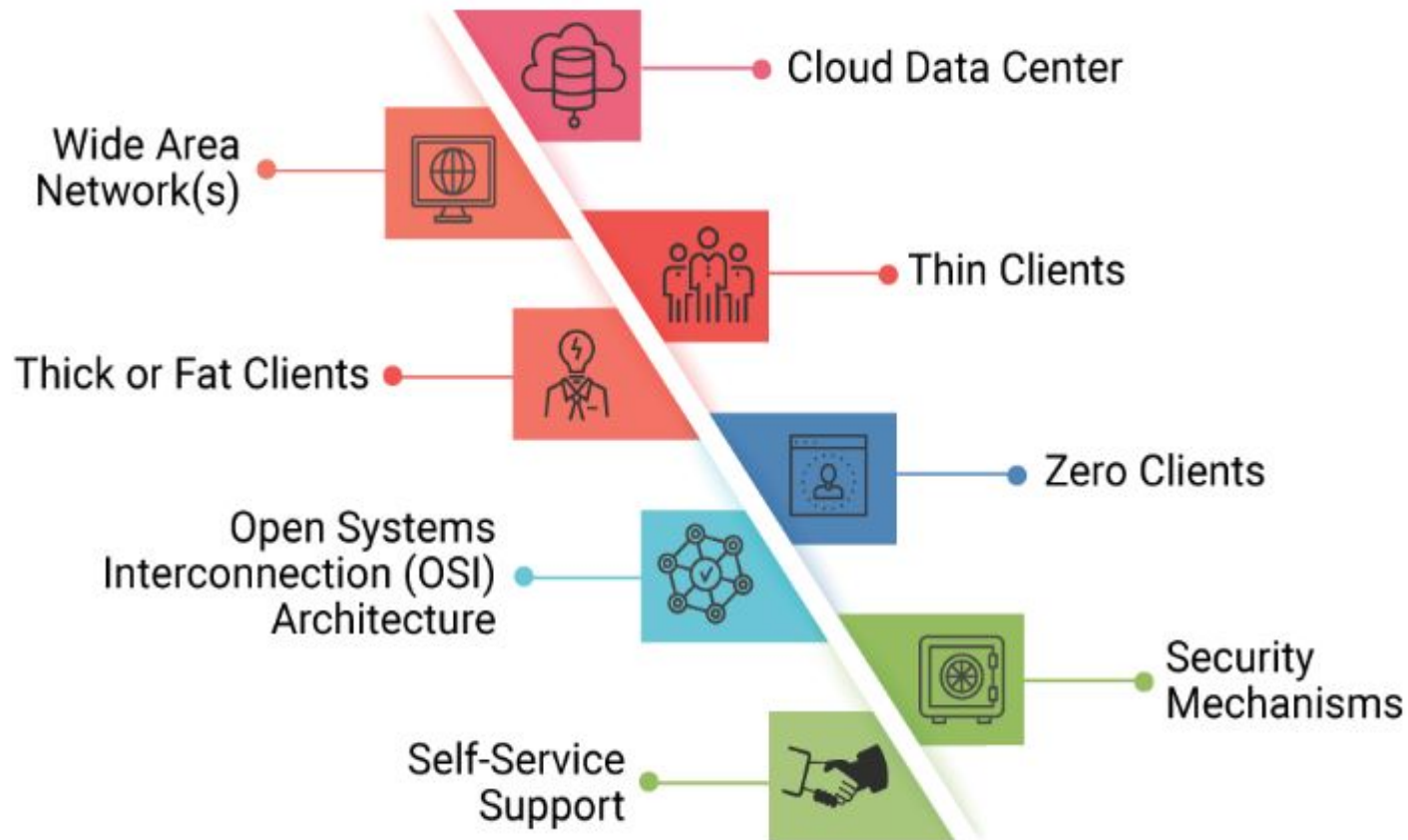
# 1. *On-demand self-service*

- A consumer can individually delivery computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.

## 2. *broad network access*

- Broad network access is the ability of network infrastructure to connect with a wide variety of devices, including thin and thick clients, such as mobile phones, laptops, workstations, and tablets, to enable seamless access to computing resources across these diverse platforms. It is a key characteristic of cloud technology.

## KEY COMPONENTS OF BROAD NETWORK ACCESS



### 3. *Elastic resource pooling*

- The provider's computing resources are pooled to serve multiple consumers using a multitenant 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 the location at a higher level of abstraction (e.g., country, state, or data center).

## 4. *Rapid elasticity*

- Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in.
- to the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.



## 5. *Measured service*

- Cloud systems automatically control and optimize resource use by powering 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.

# The Need for Cloud Computing

- the main reasons for the need and use of cloud computing are convenience and reliability.
- in the past, if we wanted to bring a file, we would have to save it to a universal serial bus (usb) flash drive, external hard drive, or compact disc (cd) and bring that device to a different place.

# The Need for Cloud Computing

- instead, saving a file to the cloud (e.g., use of cloud application dropbox) ensures that we will be able to access it with any computer that has an internet connection.
- the cloud also makes it much easier to share a file with friends, making it possible to collaborate over the web.

# Four Cloud Deployment Models

- deployment models describe the ways with which the cloud services can be deployed or made available to its customers, depending on the organizational structure and the provisioning location.
- four deployment models are usually distinguished, namely:
  1. public
  2. private
  3. community
  4. hybrid cloud service

# 1. Private cloud

- the cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). it may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

## 2. 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.

# 3. Community cloud

- the cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations).
- it may be managed by the organizations or a third party.

# 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 (e.g., cloud bursting for load balancing between clouds).



# Three Service Offering Models



## Software as a Service (SaaS)

- End user application is delivered as a service.



## Platform as a Service (PaaS)

- Application platform onto which custom applications and services can be deployed.



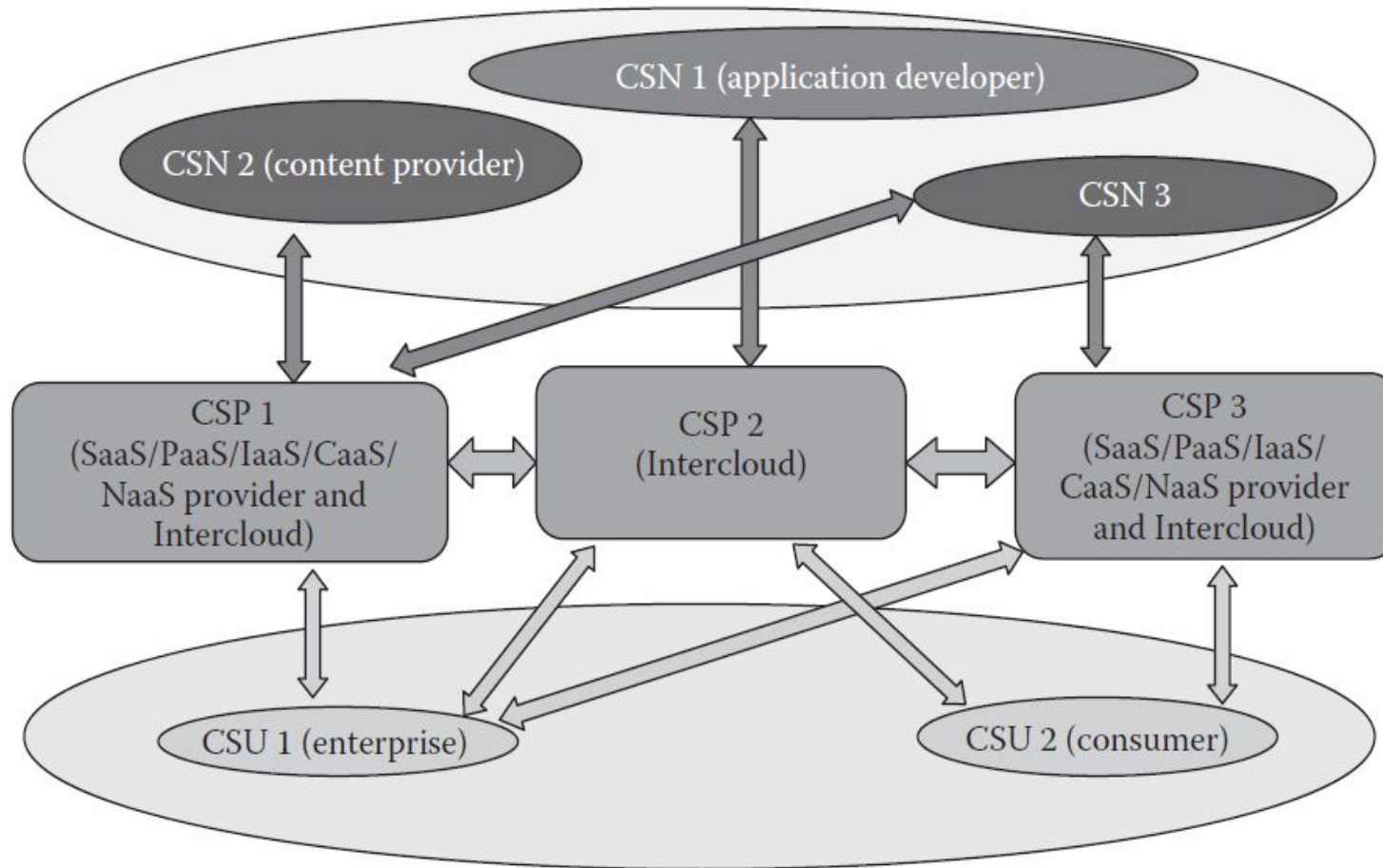
## Infrastructure as a Service (IaaS)

- Physical infrastructure is abstracted to provide computing, storage, and networking as a service.

# Cloud Ecosystem

- Cloud ecosystem is a term used to describe the complete environment or system of interdependent components or entities that work together to enable and support the cloud services.
- to be more precise, the cloud computing's ecosystem is a complex environment that includes the description of every item or entity along with their interaction

# Cont..



# Cloud Ecosystem Cont..

- the complex entities include the traditional elements of cloud computing such as (saas), (paas and/or iaas), other infrastructure (e.g., network, storage), and also stakeholders like consultants, integrators, partners, third parties, and anything in their environments that has a bearing on the other components of the cloud which is categorized in the following manner:

# 1. *Cloud service users (CSUs)*

a consumer (an individual/person), enterprise (including enterprise administrator), and/or government/public institution or organization that consumes delivered cloud services; a csu can include intermediate users that will deliver cloud services provided by a cloud service provider (csp) to actual users of the cloud service, that is, end users. end users can be persons, machines, or applications.

## 2. *CSPs*

an organization that provides or delivers and maintains or manages cloud services, that is, provider of saas, paas, iaas, or any allied computing infrastructure.

### 3. *Cloud service partners* (*CSNs*)

- A person or organization (e.g., application developer; content, software, hardware, and/or equipment provider; system integrator; and/or auditor) that provides support to the building of a service offered by a csp (e.g., service integration).

# Requirements for Cloud Services

- from the concepts illustrated in the earlier sections, one can understand that the cloud services or service offering models require certain features to be exhibited in order to be considered as *services*. the following are the basic requirements for anything that can be considered as a service by the actors of the cloud computing ecosystem, which can be offered or provisioned through the cloud:

# Requirements for Cloud Services

## ***1. Multi tenancy***

Multi tenancy is an essential characteristic of cloud systems aiming to provide isolation of the different users of the cloud system (tenants) while maximizing resource sharing. it is expected that multi tenancy be supported at various levels of a cloud infrastructure.

## ***2. Service life cycle management***

Cloud services are paid as per usage and can be started and ended at any time. therefore, it is required that a cloud service support automatic service provisioning.



# *Cont.*

## **3. Security**

The security of each individual service needs to be protected in the multitenant cloud environment.

## **4. Responsiveness**

The cloud ecosystem is expected to enable early detection, diagnosis, and fixing of service-related problems in order to help the customers use the services faithfully.

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## **5. *Intelligent service deployment***

It is expected that the cloud enables efficient use of resources in service deployment, that is, maximizing the number of deployed services while minimizing the usage of resources and still respecting the slas.

## **6. *Portability***

it is expected that a cloud service supports the portability of its features over various underlying resources and that csps should be able to accommodate cloud workload portability (e.g., vm portability) with limited service disruption.

# Cont.

## ***7. Interoperability***

It is expected to have available well-documented and well-tested specifications that allow heterogeneous systems in cloud environments to work together.

## ***8. Regulatory aspects***

All applicable regulations shall be respected, including privacy protection.

# Cont.

## ***9. Environmental sustainability***

A key characteristic of cloud computing is the capability to access, through a broad network and thin clients, on-demand shared pools of configurable resources that can be rapidly provisioned and released.

## ***10. Service reliability, service availability, and quality assurance:***

CSUS demand for their services end-to-end quality of service (qos) assurance, high levels of reliability, and continued availability to their CSPS.

# Cont.

## **11. *Service access***

A cloud infrastructure is expected to provide csus with access to cloud services from any user device. it is expected that csus have a consistent experience when accessing cloud services.

## **12. *Flexibility***

it is expected that the cloud service be capable of supporting multiple cloud deployment models and cloud service categories.

# Cont.

- 13. *Accounting and charging*
- It is expected that a cloud service be capable to support various accounting and charging models and policies.
- **14. *Massive data processing***
- It is expected that a cloud supports mechanisms for massive data processing (e.g., extracting, transforming, and loading data).

# Cont.

## **Cloud Application**

A cloud application is an application program that functions or executes in the cloud; the application can exhibit some characteristics of a pure desktop application and some characteristics of a pure web-based application. A desktop application resides entirely on a single device at the user's location (it does not necessarily have to be a desktop computer), and on the other hand, a web application is stored entirely on a remote server and is delivered over the internet through a browser interface.

# Cont...

- An example of cloud application is a web-based e-mail (e.g., gmail, yahoo mail); in this application, the user of the e-mail uses the cloud—all of the emails in their inbox are stored on servers at remote locations at the e-mail service provider.
- dropbox is a cloud storage service that lets us easily store and share files with other people and access files from a mobile device as well.



# Summary

- for a clear understanding of cloud computing, there are certain fundamental concepts to be known, as discussed in this chapter. this chapter starts with the motivation for cloud computing and discusses in brief the reason for which cloud was introduced, the need for cloud computing, and the basic definition of cloud.
- nist provides a standard definition for cloud computing. cloud is based on the 5-4-3 principle. cloud has different environments. and so, the cloud ecosystem is discussed, which briefly points out different roles involved in cloud computing. further several essential features of cloud computing are elaborated. applications in cloud are also briefly discussed. the chapter ends with a detailed note on the benefits and drawbacks of cloud.