

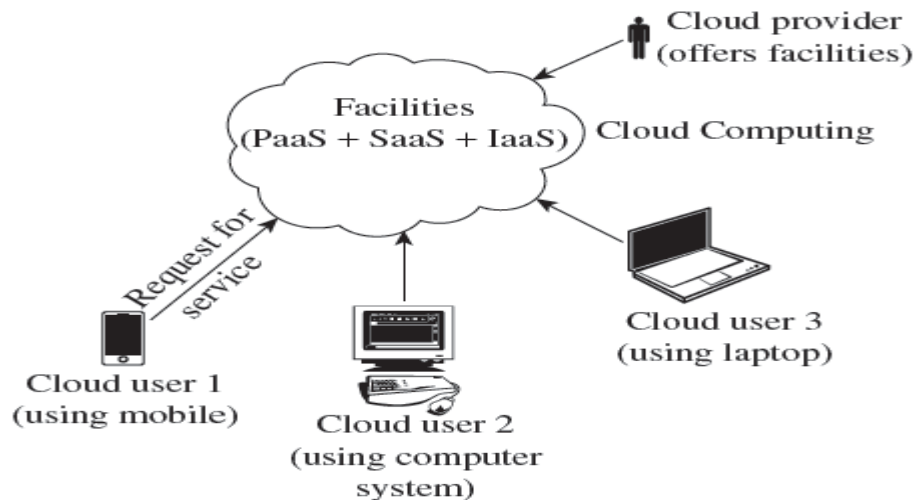
## 1. ESSENTIALS OF CLOUD COMPUTING

Cloud computing is a technology which utilizes the Internet and central isolated servers in order to sustain applications and data. This technology permits much more proficient computing by consolidating bandwidth, processing, and storage memory. Cloud offers robust memory administration, thus there is no necessity to sustain memory on a personal system.

The term ‘cloud’ is defined by NIST [10] as follows:

*“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. This cloud model is composed of five essential characteristics, three service models, and four deployment models.”*

Cloud computing performs tasks at a faster rate to meet the demands of users. It permits the data center to allow enterprises to acquire applications and work on data quickly, and needs only simple administration and less upholding



**Fig. 1.1 Basic structure of cloud computing**

The basic structure of cloud computing is shown in Fig. 1.1. As given in the figure, facilities and services are offered by cloud providers in a cloud computing environment and different users from various locations and devices can request for specific services that are offered



**Some of the benefits of cloud computing is given here:**

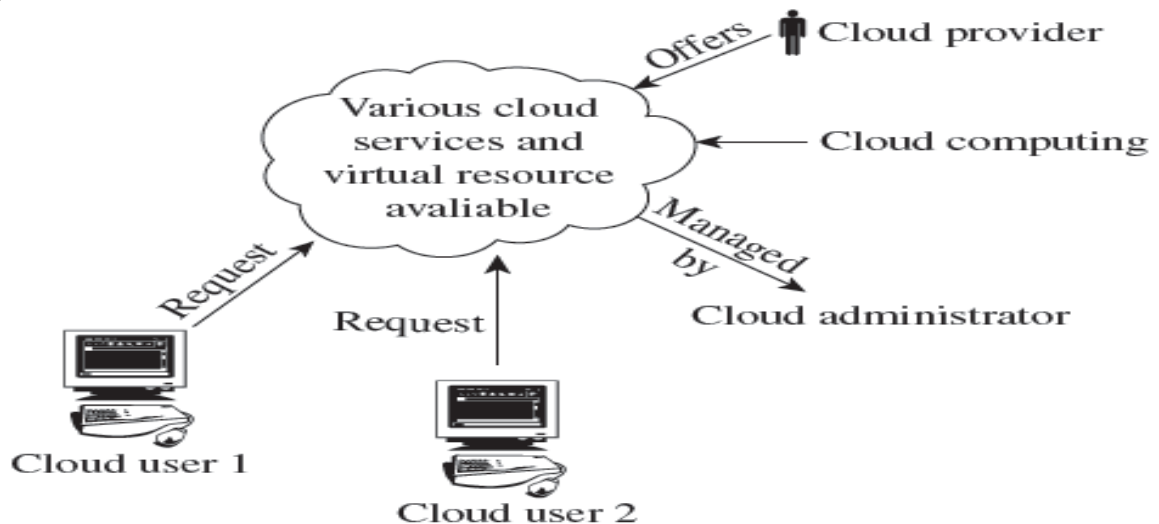
- It improves parallelism and allocation of resources for fast accessing.
- One may acquire software services, networked storage space, computer resources, and various other services at a single place.
- An additional company hosts a set of applications, get software renewals (with no charge), and so on.
- It improves monetary burden such as operational expenses, renewing charge, and capital expenses.

Hotmail, Gmail, Yahoo email, etc., are all simple illustrations of cloud computing. In cloud architecture, there are generally five main components of cloud infrastructure.

- Front-end interface for users for simple access and for using cloud resources
- Management for handling networking resources
- Storage for virtual machine
- Constant storage tool that may be organized within working virtual machines
- Monitoring tools for initiating virtual machines on the cloud

There are two types of a cloud environment:

1. The end user who has no idea about cloud complexity
2. The cloud service provider who has the liability of controlling the complete cloud environment and offer services to the consumer. One of the jobs of the supplier is safety, and it assures the consumers the degree to which their data is protected. The cloud service supplier is also accountable for IT resources, uploading, and other services offered to the user. Various services and resources are provided to users by the cloud provider, as suggested and managed by the cloud administrator, in the cloud environment, as shown in Fig. 1.2.



**Fig. 1.2 Cloud resource management**



Cloud computing involves a cloud consumer, cloud provider, cloud auditor, cloud broker, and cloud carrier, as shown in Table 1.1.

Cloud consumer	An individual person or organization that sustains a business relationship with cloud providers and avails the services offered by the provider
Cloud provider	An individual person or organization who offers a service and is liable for the services of cloud computing to the parties that demand it
Cloud auditor	A party that conducts evaluation of cloud services, such as performance, operation on various systems, and security, among others
Cloud broker	The management between cloud providers and cloud consumers, like presentation and delivery of various services
Cloud carrier	The mediator responsible for connectivity and transport of cloud services from service providers to cloud consumers

## 2. HISTORY OF CLOUD COMPUTING

### Client-Server Technology

Client-Server is the technology behind cloud computing. Client-Server technology is shown in Fig. 1.4. In this; multiple computers perform collectively to augment computing power. The client may request to be associated to the server, to which the server replies appropriately. This is known as dumb terminal as it does not have high processing power, storage space, or memory

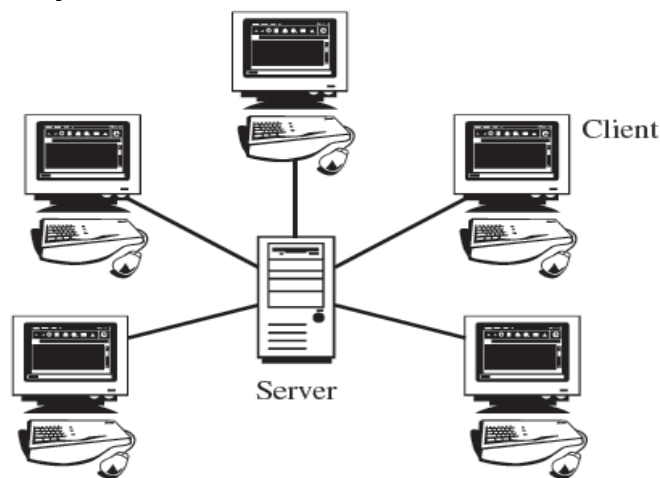


Fig. 1.4 Client-Server technology

Fat clients make periodic connections with the server, for performing large functions. Without synchronous connections, it easily performs computations, when compared to thin clients.

A thin client is a computer that is used to create a virtual environment. It depends on the server for performing computation. It shares a desktop, data, and file storage. The

**Arise, Awake and do not stop until the goal is reached.**



advantage of using thin clients for hardware optimal utilization is to reduce software maintenance cost and maintain security of data.

### *Advantages of Client–Server Networks*

**Centralized control:** There is a centralized power used in the client-server model. Servers assist in controlling the complete system. Access acceptance of distinct users and resource allotment is made by servers.

**Administration managed:** File administration turns out to be trouble-free since every file is saved at a single place.

**Replication for backup:** Since complete data is saved on the server, it is easy to create a back-up of it. During the time of recovering the missing data, it performs a vital role.

**Easy updating possible:** Variations may be made simply by mere advancement of the server.

**Remote service** Access of distant server is possible to accomplish the needs of consumers and support distinct network.

**Secure and safe:** For any computing, safety is a vital feature. Safety convention and access privileges may be termed at the time of association of server.

### *Disadvantages of Client–Server Networks*

1. If the server is unable to tackle countless requests from the consumers, it might lead to congestion with data getting missed.
2. In case you are downloading a file from the server and if, because of some fault, it gets discarded, download too discontinues.
3. Administration and deployment is extremely costly for such computing.
4. Expert IT populaces are forever required for maintaining servers and other technological particulars of the network. It needs unique guidance for the upholding of server.

### **Peer-to-Peer Approach**

Peer-to-Peer (P2P) is a decentralized approach and it encompasses no principal server. It is a design in which every computer has equal responsibilities and facilities. In a P2P setting, there is no master (boss) and slave. P2P facilitates straight swap of services and resources.

### *Disadvantages of Peer-to-Peer Networks*

1. It is not easy to administer this type of network.
2. Safety matters are forever on this network and it cannot be tackled appropriately.
3. Backup or data revival is not simple. Every computer must have its personal imitation system.

### **Distributed Computing**

A system is not completely busy all the time; several systems remain idle many times, so if the idle time of various systems is integrated and used for computation, which functions for the highest consumption, it is known as distributed computing. Distributed



computing utilizes those idle resources that are not utilized for some reason or the other. Figure 1.5 shows distributed computing.

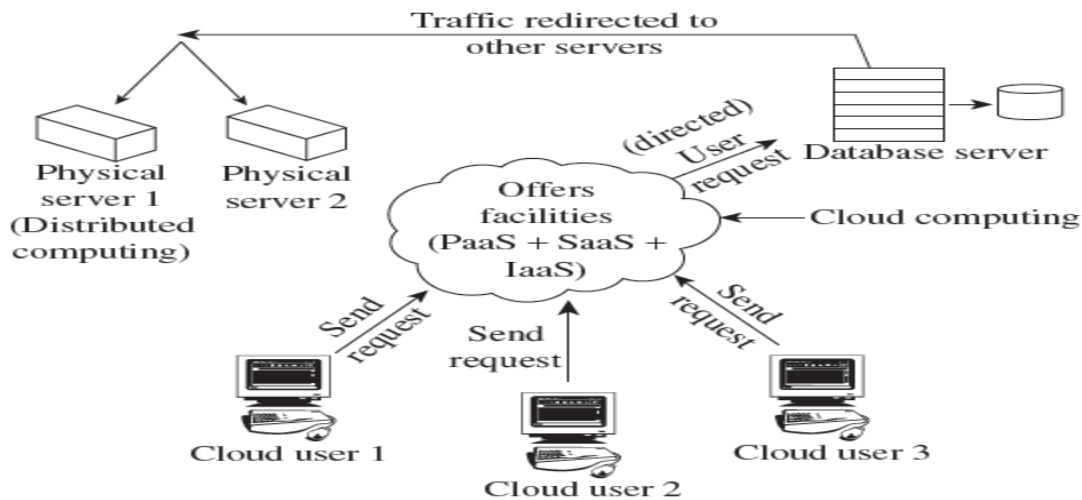


Fig. 1.5 Distributed computing

### Disadvantages of Distributed Computing

There are several problems regarding transfer and allocation of IT resources. They are as follows:

1. Growing computing power at every data center
2. Growing storage facility
3. Under-consumption of the resources in various scattered data centers
4. Rise in maintenance expenses of data centers

### Evolution of Cloud Computing from Grid Computing

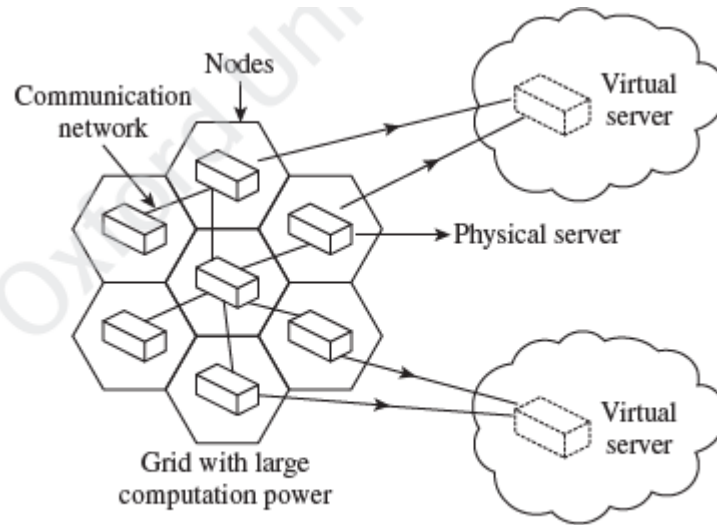
Grid computing utilizes a network or group of computers for making computing resources like super computers, and performs large or complex operations and tasks over it. Unused computing powers of many computers are used to perform complex scientific problems using grid computing.

Grid computing is attractive for several reasons:

1. Computer resources are not appropriately utilized; as a result it is profitable to employ a known sum of computer resources.
2. It accomplishes the need of high computing power.
3. The resources of various computers can be shared with an understanding, not requiring a single computer to have to organize it further.

For a specific assignment, an initial evaluation, to ascertain if it can be broken into assignments of a smaller range, is conducted. If it is feasible, distributed computing performs similar tasks and transfers the pieces of job into an additional computer for completion of the assignment. It is also beneficial for appropriate consumption of resources which remain unused. Figure 1.6 shows the typical forms of cluster grids where servers are connected with each other in an organization network; there is one

administrator to control the servers and so, services are accessed by the clients on the network.



**Fig. 1.6** Typical forms of cluster grids

**Table 1.2** Evolution of cloud computing from grid computing

Grid computing	Utility computing	Software as a Service	Cloud computing
Big crisis could be resolved with equivalent computing	Provided computing resources as metered services (disburses as per usage)	Beneficial in usage based payments to applications.	An Internet based computing offering services such as IaaS, PaaS, and SaaS.

### **Authentication Infrastructure**

The generally used authentication infrastructure is public key infrastructure, which is based on public key cryptography. A third-party mediator is involved for this authentication process, that issues certificate to users as grid identity that allows users to use shared resource in the grid infrastructure.

Another user authentication is done through Kerberos. Session key is issued to the users by the authentication servers.

Athenas, is also used, which maintains separate user account for each resource they want to access and users' accounts are managed centrally by an account server. One level authentication technique is used, which is based on user name and password.

### **Authorization Infrastructure**

User mechanisms of security in grid computing are authentication and authorization and these are termed as hard security, whereas other method, trust management based system, is called as soft security.

Trust between two parties is a bidirectional relationship, which decides extent up to which one party depends or relies on the other. Trust management consists of a trustor and a trustee. Mutual trust relationship is of the following types:



1. Provision trust—It describes a user's trust on a service provider or service.
2. Access trust—It describes service provider trust in the user access on provided resource.
3. Identity trust—It describes trust on identity claimed by the user.
4. Delegation trust—It describes trust on someone which acts and makes decision on behalf of some other.

Trust values are calculated for prediction of future possibilities. Depending upon application trust value, trust model is of three types:

1. Fuzzy logic model
2. Probability theory model
3. Mathematical method model

Fuzzy logic uses linguistic terms for calculating trust value that explains its believe on the other entity.

In probability based model, trust is calculated on the basis of previous experience that determines future actions. In mathematical method, calculated index value determines the level of belief on the other entity.

### **Autonomic Computing**

The aim of autonomic computing is to have the computer carry out versatile and critical functions without any interference by a user. Each task may be programmed, with orders given according to necessity, and evading user interference as per the need.

### **Platform Virtualization**

Virtualization makes physical resources look like virtual resources in front of users. Virtualization is founded on the perception of a virtual machine working on a physical computing platform. Virtualization is managed by a Virtual Machine Monitor (VMM), called a hypervisor. An open-source hypervisor, Xen, is broadly utilized for cloud computing

### **Service Oriented Architecture—SOA**

In cloud computing, service level agreements (SLAs) are mandatory to manage the usage of resources. In the negotiation process, a joint decision is made between the parties, service provider, and service consumer in the context of cloud computing. Quality of service (QoS) is the ability to offer various priorities to dependents based on applications and consumers, and guarantees a certain level of performance. The general service arrangement is as follows:

1. Loss—Chance that a flow's data is missing
2. Delay—Time it acquires a package's flow in order to find it from source to target
3. Bandwidth—Greatest speed at which the source may transmit data

SLA considers its responsibility, service charge, and fine in case of violations of the agreement.



Utility computing is the procedure of offering computing services via an on-demand, pay-per-use invoicing system. It is a computing enterprise module where the supplier possesses, works, and controls the computing resources and infrastructure, and is accessed by subscribers as and when needed on a metered and leasing basis.

The customer has access to a virtually infinite delivery of computing resolutions over the virtual private network or the Internet that may be sourced; supply is managed by the service providers. Utility computing may offer virtual software, virtual storage, virtual servers, and other IT resolutions. Managed IT services, grid computing, and cloud computing are based on the idea of utility computing.

### **Web 2.0**

Web 2.0 represents a change in technology in the world of the World Wide Web. It is usually designed to increase data security and customization of application. In Web 2.0, the World Wide Web (WWW) puts stress to generate content by the user, and easy access and other operations on the content.

The important features of Web 2.0 are as follows:

1. Easy to access
2. User interaction and participation
3. Rich customization features
4. Easy communication through video chatting, instant messaging facilities, etc.
5. User-friendly writing tools and applications
6. Data management and analysis
7. Multimedia supporting tools
8. Web application and hosting

### **Parallel Computing**

Parallel computing supports a type of computation which is helpful for carrying out computation of a program simultaneously. It is based on the principle that a single large problem is divided into small parts and parallelly runs different parts on different machines.

Distributed or grid computing is also a special type of parallel computing in which computers are connected on a network. Different parts of the same problem run in parallel for faster and easy processing. Parallel computing simultaneously uses various computing resources for solving a computational problem:

1. Discrete parts of a broken problem can be solved in parallel
2. Further, every part is broken down into a series of instructions
3. Different processors are used to execute the instructions in parallel
4. Coordination method works behind parallel computing

Parallel computing supports applications that require processing of a large problem in a sophisticated way. Some of the examples are:

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- Data mining
- Search engines

- Medical diagnosis
- Virtual reality
- Multimedia

### **3. BUSINESS AND INFORMATION TECHNOLOGY PERSPECTIVE**

Cloud service providers propose a number of advantages over and above those provided by remote hosting:

1. Accessibility of data all over
2. Physical servers or virtual servers
3. Servers' interaction within similar clouds
4. Allocation or imitation of resources at numerous physical regions
5. Strength offered by different cloud storage capacities

Other services provided by cloud computing are discussed in the following sections.

**Electronic Faxing:** Secure faxes are transmitted to specific telephone number and are directed to an e-mail address as PDF attachments. Outgoing messages are transmitted through e-mail and conveyed to fax machines all around the world.

**Voice on Clouds:** Cloud-founded Google Voice can deal with calls, in case the call is made by an user on a published phone number. The call can be acknowledged from any telephone number associated to Google voice.

**Commerce on Clouds:** Businesses can be tackled via clouds, for example, the sale and purchase of items. A few books are accessible for sale as downloadable e-books on websites.

**Distributed Hosting on Clouds:** Godaddy.com is faultlessly hosted and provides services in this context. You might have utilized Rack space, Amazon, and many other websites for availing services.

**Accounting and Online Banking:** The online banking system offers convenient banking, encompassing numerous characteristics such as amount transfer and balance enquiry, among others. The cloud provides complete safety of data in the bank. The complete SaaS application is accessible to banks for invoice imbursement and similar services. Similarly, in many organizations, salaries are is also accepted electronically as direct deposit payments. Cloud computing may be used not only for business-to-personal communication, but also for business-to-business communication.

### **4. BENEFITS OF CLOUD COMPUTING**

Cloud computing technology offers various benefits to both cloud service consumers and cloud service providers. The main advantage of cloud computing systems and technologies is increased economical return due to reduced maintenance costs related to infrastructure and IT software. Cloud computing offers the following benefits:

**Pay as per use:** On demand access to pay-as-you-go computing resources on a short-term basis and ability to release these computing resources when they are no longer needed.



**Reduced investment and proportional costs:**

The investment in cloud-based IT resources is in the reduction or outright elimination of up-front IT investments, namely hardware and software purchases, and ownership costs. The cloud measures operational expenditures (directly related to business performance) to replace anticipated capital expenditures. This is also referred to as proportional costs. The same rationale applies to operating systems, middleware or platform software, and application software.

**Accessibility from anywhere:** Resources can be accessed from anywhere, irrespective of location and device. This feature facilitates business continuity around the clock.

**Increased scalability:** The business load can be handled with scalability of the respective resources without much effort, time, and cost.

**Increased availability and reliability:** Resources provided as services are available all the time. Even if there is a failure in any of the components of a service, the provider immediately identifies, isolates, and replaces the failed components without any performance degradations.

**Dynamic provisioning:** It is the perception of having unlimited computing resources that are available on demand, thereby reducing the need to prepare for provisioning.

## **5. LIMITATIONS OF CLOUD COMPUTING**

1. By whom the applications and data will be accessed and how will that be scrutinized?
2. What security methods are used for storage and transmission of data?
3. How data and applications from diverse consumers are reserved separately?
4. Where will the data be stored in terms of geographical sites? Will the selection of the site influence us?
5. Can these details and channels be specified in a service-level contract?

Each of these consumer worries are the chief obstacles to the implementation and development of cloud computing. Some of the limitations of cloud computing are discussed

**Availability of Services:** As services are a primary concern of consumers, they sometimes need to discard all the data from the cloud environment provided to them, while sometimes they may want to recover all the data. There is an augmented risk of disaster in this when compared to conventional services, as there are more ways to access the application or information over cloud computing.

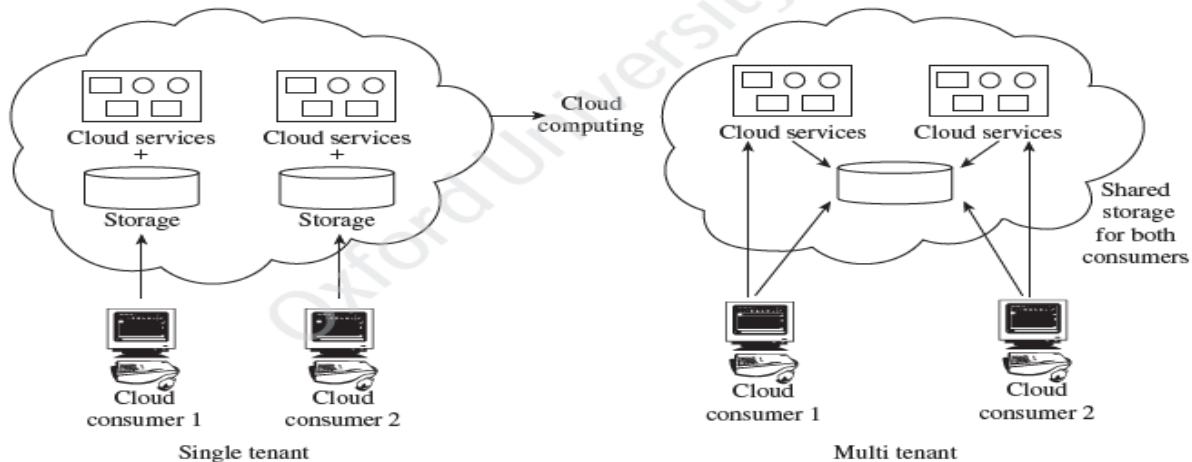
**Data Lock-in:** shifting of data and applications from one platform to another is a challenge to the cloud provider for a big organization handling high volumes of data. Google is the single cloud supplier to attain a more typical environment and they also have a scheme, known as Data Liberation Front, to support user shifting applications and data in and out of their platform.



**Data Segregation:** Amazon EC2 service measured real threat and rectified the attack by effectively overcoming the following:

1. Finding out where a particular virtual machine command is positioned in the cloud infrastructure
2. To determine whether two instances are resident in a similar physical machine
3. The secrecy of the data should be guaranteed, whether or not it is in transit. It should be required to offer a closed box implementation environment where the secrecy and reliability of the data must be confirmed by its possessor.
4. In a majority of circumstances, data should be encrypted at a certain time when it is within the cloud. Several procedures are unfeasible to perform with encoded data, and moreover performing computation with the encoded data must utilize more computing resources.
5. The user encodes the data earlier to upload it to the cloud. When specific data is needed, the token creator is used by the user to produce a token as well as decryption key. The token is transmitted to the cloud, the chosen encoded file(s) are downloaded, and after that these files are confirmed locally and decrypted using the key. Sharing is facilitated by transmitting the decryption key and token to the other user with whom you wish to cooperate

**Privilege Neglect:** Companies sometimes take advantage of the liberty given to them. They disclose sensitive data of their company to others for some benefits. The threat of a malicious insider with access to confidential data is a concern for any outsourced computation model. Miscreants might affect and harm the consumer's fame and brand or openly harm the consumer.



**Fig. 1.8** Multi-tenancy in cloud computing

**Scaling Resources:** The capability of scaling resources up and down to meet workload is one of the chief benefits of cloud computing. Separate storage devices are provided to every client on the cloud network, called a single tenant; and in a multi-tenant environment, a single storage device is shared by more than one cloud user as shown in



Fig. 1.8. In the figure, there are two consumers 1 and 2, who are sharing a single shared storage for storing data, so there is the risk of interchanging or risk related to mismatch of data if proper arrangement is not carried out.

**Data Location:** At present, there are cloud suppliers who leave the alternative of the data center site to the user. For example, Amazon proposes one site in Europe and two in other countries. It is expected that other suppliers will follow Amazon's region option proposal as the site of data is a rising and significant requirement of promising consumers.

**Deletion of Data:** Public cloud users might need their data to be removed, that is, totally erased from the cloud. Sometimes, one company migrates its data to another cloud provider. In that case, they want complete deletion of the data or complete migration of data; if this is not done, the benefit of the data might be used by the malicious user later.

**Recovery and Backup:** For safety purpose, keeping the data of a consumer safe at different locations, for easy recovery and backup, if there is any failure, is a big challenge. A proposal of data backup must be proposed to cloud suppliers in of the event of a disaster.

**Offline Clouds:** Google launched Gears, a free-of-cost add-on for the browser, which allows data to be saved locally in a complete searchable database while surfing the Internet. Gears resolved the 'offline problem' permitting web applications to resume their working while offline and subsequently coordinating when the link was accessible again. The latest edition of the HTML protocol tackles the offline matters with a pair of constituents—database and AppCache.

1. Canvas—Offers an influential and clear-cut meaning to depict arbitrary graphics on a web page using Javascript
2. Video—Aims to assemble a simple video on a web page as it is to establish images nowadays
3. Web workers—A novel method to take on gear jobs which should hold up the web browser

**Unpredictable Performance:** The cloud-end consumer would not even know the number of physical machines on which their application was functioning. The single source of information which the user has regarding these servers is the hardware specification offered by the cloud supplier for every kind of service.

## **6. CHARACTERISTICS OF CLOUD COMPUTING**

The features are as follows:

**On-demand self-service:** This implies that the customers, comprising non-IT persons, may unilaterally provision the service and scale it up or down by them.

**Broad network access:** This implies the service is uninterruptedly accessible by using the standard selection of tools comprising conventional mobile tools, PCs, and portable computers.

**Resource pooling:** This implies customers share a universal multi-occupant situation where virtual and physical resources can be dynamically allotted.



**Quick elasticity:** This implies the service may be swiftly scaled and frequently mechanically, such that to the customer, the facility seems infinite.

**Calculated service:** This implies the service and its required resources are metered for the consumer

Apart from the vital features précised by NIST, other features which should also be considered are discussed in the sections below.

**On-demand self-service:** Computer services such as applications, email, server, or network service may be without the requirement of any human interface. Cloud service suppliers offering on-demand self-services comprise Salesforce.com, Microsoft, Amazon Web services (AWS), IBM, and Google. A customer's requirements can alter from time to time due to which it is known as on demand.

**Broad network access:** Thick customers are users who download files of big size to their workplace before using the characteristics. Thin customers, who download a file of small size and may access all the accessible aspects and resources.

**Resource pooling:** The resources include memory, storage, processing, network bandwidth, various mail services, and virtual machines. Resource grouping is regarding forcefully conveying computing resources to numerous consumers.

**Rapid elasticity:** Imagine that you are hosting a website and you get 1000 hits per day on an average. All of a sudden, you are deploying a project and for a specific day, lots of users will be logging in online at the similar time. At that particular instant, there may be 10,000 hits in a day. For such a situation, during a usual day, the cloud will allocate you one server but in peak time, it will go up to seven servers and back to one server in usual hour. The finest feature is that you simply pay as per the usage.

**Measured service:** Usage of cloud computing resource may be controlled and reported while providing transparency to both the customer and provider of the used service. Cloud computing services use a metering facility, which allows optimizing and managing resource use. IT services are also charged for each usage metrics, that is, pay for every use. The more you consume, the more the bill. Customers pay for simply the resources used by them and are thus charged on a utilization-based module.

**Multi-persistence:** It refers to the desire for strategy-focused segmentation, enforcement, control, separation, invoicing modules, and service levels for distinct customer areas. Customers could consume public cloud service offerings of supplier or in fact be from the similar company, like discrete business entities instead of different managerial units, but would yet share infrastructure.

### **Self-managed Platform:**

Clouds facilitate self-administration through software automation, influencing the following capabilities:

1. Reserving and planning resource capability
2. Abilities for managing, configuring, and reporting to make sure resources may be assigned and re-assigned to various users





3. Devices for managing access to resources and strategies for how resources could be used or functions could be carried out

Each of these abilities allows businesses to grow. This reduces the IT administrative effort level and lowers functioning costs, releasing up resources to concentrate on higher value undertaking.

### **Elasticity and Scalability**

The cloud is flexible, signifying that resource distribution may meet smaller or bigger based on the need. Suppleness facilitates scalability, which implies that the cloud may scale upward for peak requirement and downward for lighter needs. Scalability too implies that an application may scale while adding up users or when some other modification occurs.

### **Standardized Interfaces**

Cloud services must have consistent APIs that offer directives on how two data sources or applications can function with one another. A consistent interface allows the consumer to connect to cloud services together.

Cloud computing services can be used by the customer on order without any human interference or long executions. These services are accessed commonly and scaled up or down according to requirement, providing a factual efficiency method for utilization.

## **7. HOW TO DEVELOP CLOUD INFRASTRUCTURE**

Infrastructure should meet the following vital features for assisting users to access data proficiently and efficiently at any occasion:

**Accessibility** It is the major responsibility of every central origin that data is accessible, on order, to users.

**Functioning** Optimal service and functioning should be offered by the data center.

**Supple** High-priority business needs may be under the control of the prevailing infrastructure, without any disruption of accessibility and with the least charge and least variation.

**Safety** Data must be protected from illegal and malevolent users.

**Manageability** Corporations try to reduce IT expenses on the data center and increase the consumption of prevailing resources.

For the development of cloud infrastructure, the following are needed:

1. Understanding the prevailing conventional data center
2. Computing resources that will be virtualized
3. Installing service administration devices

Cloud infrastructure may be built in several stages:

1. The first starts with thoroughly recognizing the prevailing physical infrastructure with its procedures and constituents.
2. The next step is to concentrate on accumulating the prevailing infrastructure resources by using virtualization technologies. Therefore, the accessible resource allows centralized administration of resources and permits quicker resource provisioning.





3. Then comes the step to install service administration devices, which allow mechanization of procedures and administration to reduce human interference. Service administration devices comprise purposeful services as well as those that permit utilization-based metering so that customers have to pay for just what is utilized by them. Through service administration, on-order provisioning of IT resources turns out to be livelier and permits IT to be sent as a service.

#### *Core Components of Traditional Data Centers*

A conventional data center is the prevailing infrastructure which processes data using IT resources. The core components of a traditional data center are as follows:

**Application** Program employed to carry out numerous computing functions. It may be an operating system, DBMS, and many more.

**DBMS** It is an administration system which offers the ability to save or get data from rationally prepared tables.

**Compute** Resources which work numerous applications using various elements

**Storage** This is used to save data for often use

**Network** It is the ability to communicate among systems. It assists us to share data and resources.

All the core elements of a traditional data center work together, to complete a task.

## **8. VENDORS OF CLOUD COMPUTING**

### **Amazon Web Services—IaaS**

The cloud computing corporation of Amazon.com—Amazon Web Service (AWS)—offers Infrastructure as a Service (IaaS) on the cloud for associations needing computing storage, power, and further services.

**Elastic Compute Cloud** Elastic Compute Cloud (EC2) is a web service which permits resizable computing ability on the cloud. The consumers may generate virtual machines (VMs), that is, server cases known as Amazon Machine Image (AMI), on which the consumer may put in any software of his/her preference. A pay-by-the hour system is followed.

**Simple Storage Service (S3)** S3 offers a web service interface which may be used to regain and store an infinite quantity of data, from any place, at any time, via the Internet. Amazon SimpleDB is integrated for providing AWS services such as Amazon S3 and EC2, which provide the infrastructure for creating various web applications.

### **Google—SaaS, PaaS**

Google App Engine is Google's Platform as a Service (Paas) that provides hosting and produces web applications on the Google Infrastructure. Presently, Java and Python are the supported programming languages. Up to a specific level, the resource-used App Engine is without any charge. Payment is charged for further bandwidth, CPU cycles, and storage needed by the application. Software as a Service (SaaS) provides business agreements and email.

### **Microsoft Azure Service Platform—PaaS**

***Arise, Awake and do not stop until the goal is reached.***



Azure Service Platform is the proposal of Microsoft PaaS, an operating system known as Windows Azure, which performs as a runtime for the application and offers a set of services such as SQL Services, Live Services, and NET Services. Windows Azure is a Microsoft Cloud computing platform used to develop, launch, and control applications via a universal network of Microsoft-controlled data centers. Windows Azure offers both IaaS and PaaS services and is categorized as the 'public cloud' in cloud computing policy of Microsoft, with its SaaS offering, Microsoft Online Services.

The following new characteristics were released by Windows Azure:

1. Websites permit designers to develop sites using PHP, Node.js, or ASP.NET and may be installed using TFS, FTP, etc.
2. Virtual machines permit designers to drift infrastructure and applications without altering the existing code and may operate both Linux virtual machines and the Windows Server.
3. Cloud services is a platform of Microsoft as a Service environment which is used to generate scalable services and applications. Supports automated installations and multi-tier states.
4. Data management, an SQL database once recognized as SQL Azure Database, performs to generate, scale, and expand applications into the cloud by using Microsoft SQL Server techniques. It amalgamates with System Center and Active Directory.
5. Media service is a PaaS-based service that may be used for content security, encoding, analytics and/or streaming.

#### **Rackspace—Cloud Hosting**

Rackspace is the service head in Cloud Computing and an initiator of OpenStack, an open source cloud platform.

#### **Salesforce.com—SaaS, PaaS**

Salesforce is a supplier of SaaS-based goods, along with having a PaaS offering, Force.com. Salesforce is best identified for its consumer relationship management (CRM).

