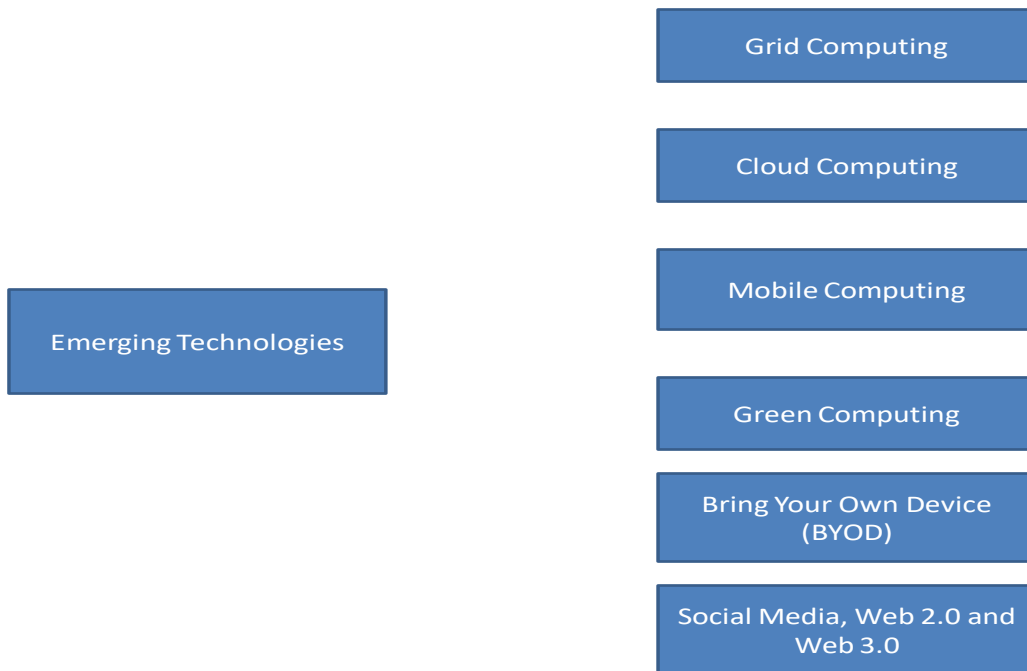
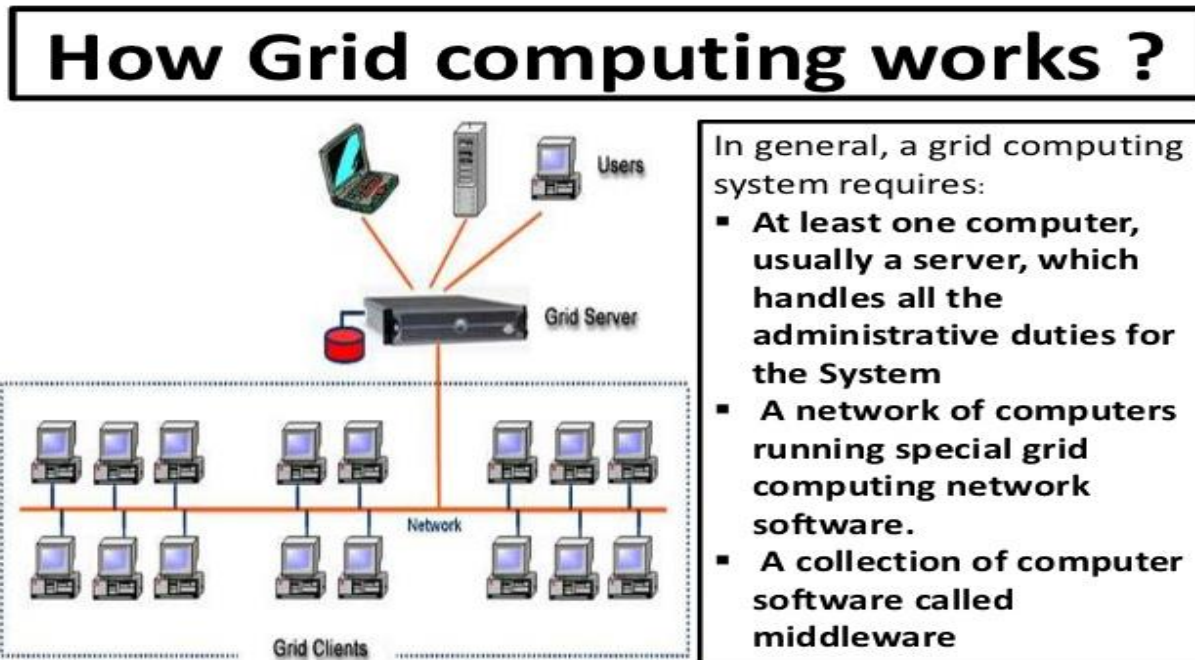


EMERGING TECHNOLOGIES

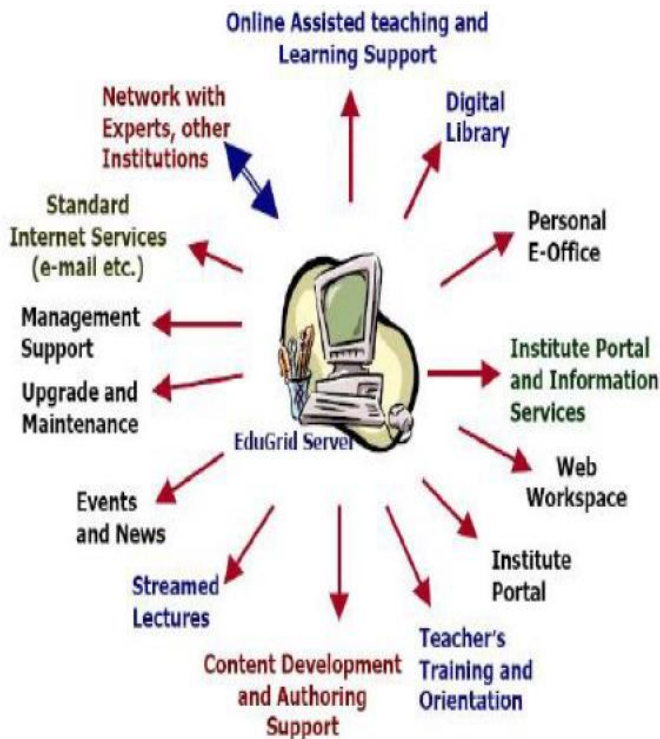


Grid Computing



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- Grid Computing is a network of computing or processor machines managed with a kind of software such as middleware to access and use the resources remotely
- Middleware is software that will connect the components of software with applications, allowing them to communicate
- Managing Activity of Grid Resources through middleware is called Grid Services
- Grid Services Provide access control, security, access to data including digital libraries and databases and access to large scale interactive and long-term storage facilities



- E.g.- All students of Kerala, are given high quality education by the Kerala Education Grid Project, which is an initiative undertaken by the Government of Kerala
- Kerala Education Grid Provides Web Based Course Content as well as various collaboration tools such as message board, discussion boards, shared web space, chats, asynchronous interaction between students or between students and teachers

Grid Computing is common due to the following reasons

- Ability to make use of the unused computing power
- Enables heterogenous resources of computers to work co-operatively

Cloud Computing

- Means the use of Computing resources as a service through networks, typically the internet
- Using Cloud Computing, users can access the database resources via the internet from anywhere, as long as they need without worrying about the maintenance and management of actual resources



- Cloud Computing provides the facility to access shared resources and common infrastructure offering services on demand over the network to perform the operations that meet changing business needs
- With Cloud Computing, Companies can scale up to massive capacities in an instant without having to invest in new infrastructure, train new personnel or license new software

Grid Vs Cloud Computing

Similarities

- **Scalability** is the capability of a system, network, or process to handle a growing amount of work, or its potential to be enlarged to accommodate that growth. Both Cloud and Grid Computing are scalable-accomplished through the load balancing of application instances running separately on a variety of operating systems and connected through Web Services
- Both Computing involve **Multi-tenancy and Multi-tasking**-meaning many customers can perform different tasks, accessing a single or multiple application instances

Dissimilarities

- Storage in Grid is well suited for data intensive storage, not economical for storing small objects as small as 1Byte. Amount of distributed data to be large here for maximum benefit. In Cloud we can store an object as low as 1byte to as high as 5GB or even several terabytes
- Computational Grid focusses on computationally intensive operations, while cloud computing offers two types of instances- standard and high CPU

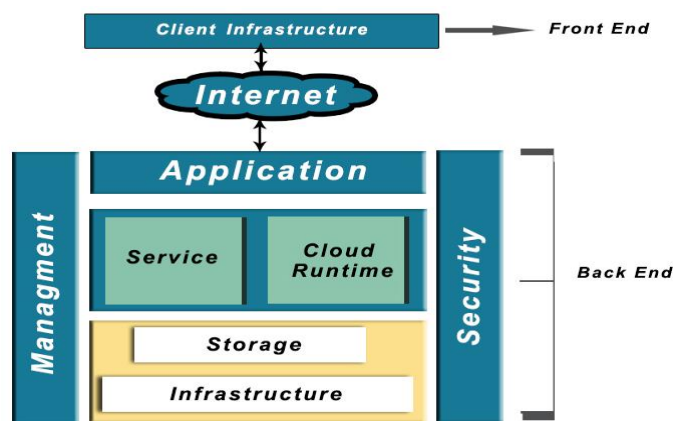
Goals of Cloud Computing

- Goals in using the Cloud Computing Platform are as follows
 - Create a highly efficient ecosystem , where resources are pooled together and costs are aligned with resources used

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- Access services and data from anywhere at any time
- Scale the IT ecosystem quickly, easily and cost effectively based on the evolving business needs
- Consolidate IT infrastructure into a more integrated and manageable environment
- Reduce costs related to the IT energy/power consumption
- Enable or improve Access Anywhere(AA) for ever increasing users
- Enable rapidly provision resources as needed

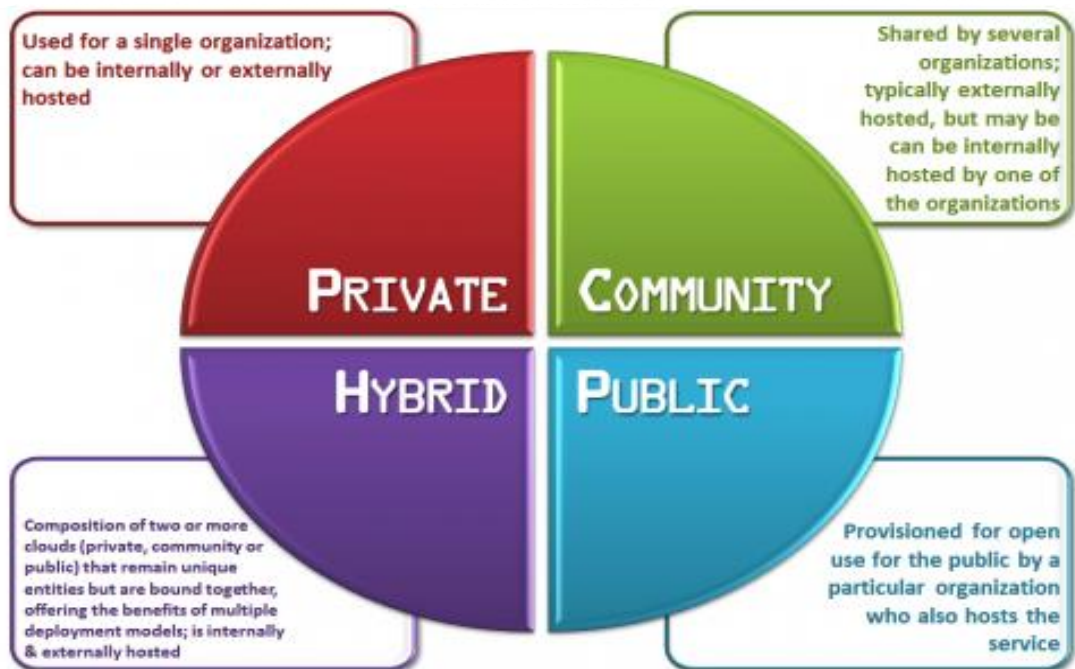
Cloud Computing Architecture



Front end Architecture:-Consists of the Client's devices or computer network and some applications required for accessing the cloud computing system

Back end architecture:- Service facilitating peripherals, back end is cloud itself, encompassing various computer machines, data storage systems and servers

Cloud Computing Environment



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- Private Cloud
- Public Cloud
- Hybrid Cloud
- Community Cloud

Private Cloud



- **Private cloud** (internal **cloud** or corporate **cloud**)
- Unlike public clouds, which deliver services to multiple organizations, a **private cloud** is dedicated to the needs and goals of a single organisation
- A Private Cloud can either be private to the organisation and managed by the single organisation (On Premise Private Cloud) or can be managed by third party (Outsourced Party Cloud)
- Certain Characteristics of Private Cloud are as follows
 - **Secure:-** as it is deployed and managed by the organisation itself and hence there is least chance of data being leaked out
 - **Central Control:-** Private Cloud is managed by the organisation itself, there is no need for the organisation to rely on anybody
 - **Weak Service Level Agreements:-** SLA plays a very important role in any cloud service deployment model as they are defined as agreements between the user and service provider in private cloud
- The Advantages of Private Cloud Include
 - **Improves Average Server Utilisation,** allow utilisation of low cost servers and hardware while providing higher efficiencies
 - **Provides a high level of security and privacy** to the user
 - **It is small in size and** controlled and maintained by the organisation
- The **Limitations** of Private Cloud are
 - Organisation may have to **Invest in buying, building and managing** the clouds independently
 - **Budget is a constraint** in Private Clouds
 - **Loose SLA's**

Differences between On-Premise and Outsourced Private Cloud

	On Premise Private Cloud	Outsourced Private Cloud
Management	Managed by the Organisation itself	Managed by the third party

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Service Level Agreements(SLA)	SLA's are defined between the Organisation and its users . Users have broad access rights than the general public cloud users and service providers are able to provide the service efficiently because of small user base and mostly efficient network	These are followed strictly as it is a third party organisation
Network	Network Management and Network issue resolving are easier . Networks usually have high bandwidth and low latency	The Cloud is fully deployed at the third party site and organisations connect to the third party by means of either a dedicated connection or through internet
Security and Data Privacy	Comparatively, it is more resistant to attacks than any other clouds and the security attacks are possible from an internal user only	Cloud is relatively less secure and the security threat is from the third party and the internal employees
Location	The data is usually stored in the same geographical location where the cloud users are present . In case of several physical locations, the cloud is distributed over several places and is accessed over the internet	The Cloud is located off site and when there is change of location, the data need to be transmitted through long distances
Performance	Performance depends on the network and resources and can be controlled by the network management team	Performance of the cloud depends on the third party that is outsourcing the cloud

Public Cloud



- Cloud Infrastructure that's provisioned for open use by the general public
- It consists of users from all over the world wherein a user can simply purchase resources on a hourly basis and work with the resources which are available in the cloud

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- Examples of public clouds include Amazon Elastic Compute Cloud (EC2), IBM's Blue Cloud, Sun Cloud, Google AppEngine and Windows Azure Services Platform.

Characteristics of Public Cloud

Highly Scalable	• Resources within are large in number and the service providers make sure all the requests are granted. • Public Clouds are considered to be scalable
Affordable	• Offered to Public on Pay-as you go basis, user has to pay only for what he or she is using
Less Secure	• Offered by third party and so they have full control over the cloud • Public cloud is less secure out of all the deployment models
Highly Available	• Anybody from any part of the world can access the public cloud with proper permission
Stringent SLA's	• Service Providers reputation and customer strength are dependent on the cloud services • They follow SLA's strictly and violations are avoided

Advantages of Public Cloud

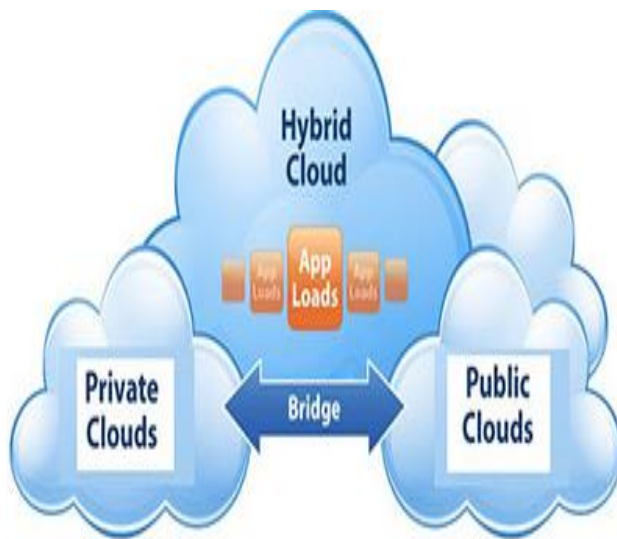
- Widely used in the development, deployment and management of the enterprise applications, at affordable costs
- Allows the organisations to deliver highly scalable and reliable applications rapidly at more affordable costs
- No need for establishing infrastructure for setting up and maintaining the cloud
- No limit for the number of users

Limitations of Public Cloud

- Security Assurance –building trust among clients is far from desired
- Privacy and organisational autonomy- are not possible

Hybrid Cloud

- Hybrid cloud is a cloud computing environment which uses a mix of on-premises, private cloud and third-party, public cloud services with orchestration between the two platforms



- Usual method of using a Hybrid Cloud is to have a private cloud initially and then for additional resources, the Public cloud is used
- Hybrid cloud can be regarded as a private cloud extended to public cloud and aims at utilizing the power of the public cloud by retaining the properties of the private cloud

- A vendor has a private cloud and forms a partnership with a public cloud provider

Characteristics of Hybrid Cloud

Scalable	Hybrid Cloud has the property of public cloud with private cloud environment and as the public cloud is scalable , the hybrid cloud with the help of its public counterpart is also scalable
Partially Secure	Private Cloud is considered as secured and public cloud has high risk of security breach. The hybrid cloud thus cannot be fully termed as secure but partially secure
Stringent SLA's	Overall the SLA's are more stringent than the Private Cloud and might be as per the public cloud service providers
Complex Cloud Management	Cloud Management is complex as it involves more than one type of deployment model and also number of users is high

Advantages of Hybrid Computing

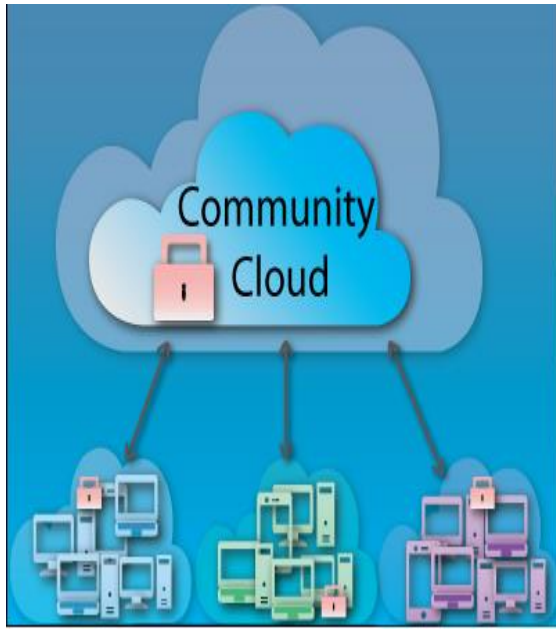
- Highly Scalable and gives the power of both private and public clouds
- Provides better security than the public cloud

Limitations of Hybrid Computing

- Security Features are not as good as private cloud

- Not easy to manage

Community Cloud



- A community cloud in computing is a collaborative effort in which infrastructure is shared between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally.
- This is controlled and used by a group of organizations that have shared interest.

- This model is suitable for organisations which cannot afford a private cloud and also cannot rely on the private cloud either

Characteristics of Community Cloud

Collaborative and Distributive Maintenance	• No single company has full control over the Whole cloud. • Usually distributive and hence better cooperation provides better results
Partially Secure	• Property of the Community Cloud where few organisations share the cloud, so that there is possibility data can be leaked from one organisation to another , though safe from external world
Cost Effective	• As the Complete cloud is shared by several organisations or community, not only the responsibility gets shared, the community cloud becomes cost effective too

Advantages of Community Cloud

- Allows establishing a low cost-private cloud

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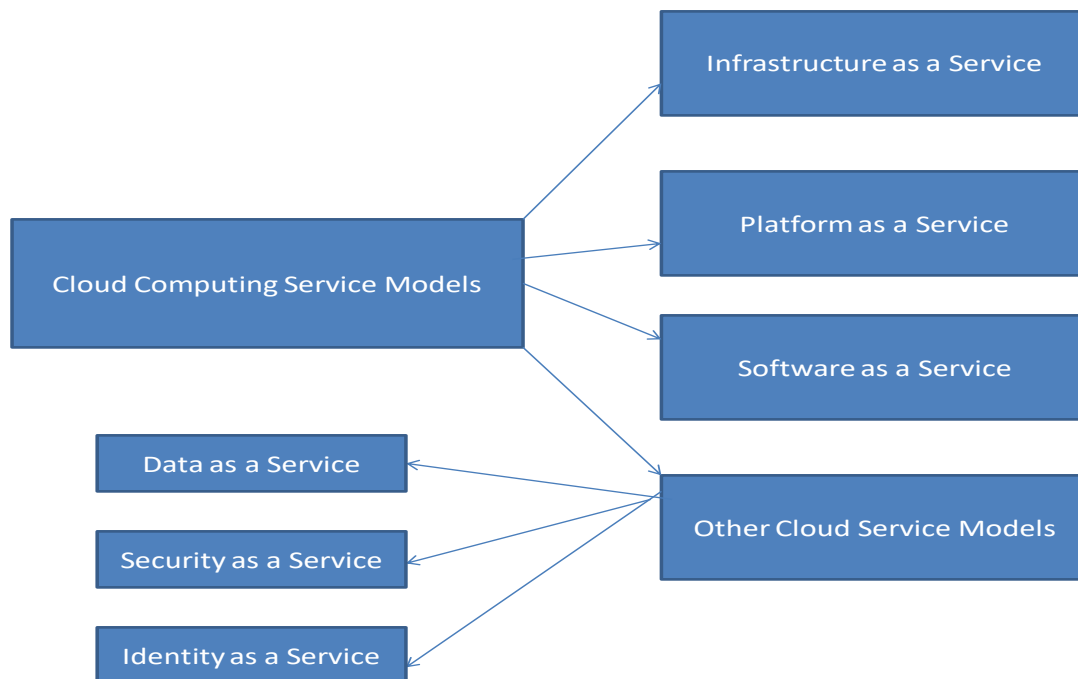
- Allows collaborative work on the cloud
- Allows sharing of responsibilities among the organisations
- Has better security than the public cloud

Limitations of Community Cloud

- Autonomy of the organisation is lost
- Some Security features are not so good as the private cloud
- Not suitable in cases when there is no collaboration

Cloud Computing Service Models

- Cloud Computing is a model that enables the end users to access the shared pool of resources such as compute, network, storage, database and application as an on-demand service without the need to buy or own it



Infrastructure as a Service(IaaS)

- With IaaS, pre-configured hardware resources are provided to users through a virtual interface.

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- Unlike PaaS and SaaS, IaaS doesn't include applications or even an operating system (implementing all of that is left up to the customer), it simply enables access to the infrastructure needed to power or support that software.
- Examples of IaaS providers include Amazon Web Services(AWS), Google Compute Engine, OpenStack and Eucalyptus

Typical IaaS provider may provide the following services

- Compute:-Computing as service includes the virtual central processing Inputs(CPUs) and virtual main memory for the Virtual machines(VMs) that are provisional to end users
- Storage:-Back end storage for the Virtual Machine images
- Network:- Network as a service (NaaS) provides virtual networking components such as virtual router, switch and bridge for the VM's
- Load Balancers:-Load Balancing as a Service may provide load balancing capability at the infrastructure layer

Characteristics of IaaS are as follows:-

Web Access to the resources	• The IaaS Model enables the IT users to access infrastructure resources over the internet
Centralised Management	The resources distributed across different paths are controlled from any management console
Elasticity and Dynamic Scaling	Depending on the load, IaaS services can provide the resources and elastic services where the usage of resources can be increased or decreased according to the requirements
Shared Infrastructure	One to many model and allows multiple IT users to share the same physical infrastructure and thus ensure high resource utilization
Metered Services	IaaS allows the IT users to rent the computing resources instead of buying it Services consumed will be measured and user will be charged based on usage

Different Instances of IaaS are as follows:-

Network as a Service	• Provides users with the needed communication capacity to accommodate bursts in data traffic during data intensive activities such as video-conferencing or large file downloads
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Storage as a Service	Provides storage infrastructure on a subscription basis to users who want a low cost and convenient way to store data
Database as a Service	Provides users with seamless mechanisms to create, store and access the databases at a host site on demand
Backend as a Service	Provides the Web and mobile app developers a way to connect their applications to backend cloud storage with added services
Desktop as a Service	Ability to the end users to use desktop virtualization without buying and managing their own Infrastructure

Platform as a Service

- Platform as a Service (PaaS) or platform base service is a category of cloud computing services that provides a platform allowing customers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app

Typical PaaS service provider may provide the following services

- Programming Languages:- PaaS providers provide a wide variety of programming languages like Java, for the developers to develop applications
- Application Frameworks:-Application development framework like Wordpress, Sinatra
- Database:-PaaS provides some of the databases like ClearDB, Cloudant, Redis etc.so that application can communicate with databases
- Other Tools:- PaaS providers provide all tools that are required to develop, test and deploy an application

Characteristics of PaaS are as follows

All in One	Most PaaS providers offer services like programming languages to develop, test, deploy , host and maintain applications in the same Integrated Development Environment(IDE)
Web Access to Development Platform	PaaS provides web access to the development platform that helps the developers to create, modify, test and deploy different platforms on the same data
Offline Access	To enable the offline development, some of the PaaS providers allow the developer to synchronise their local IDE with the PaaS software

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Built in Scalability	PaaS services provides a built in scalability to application that is developed using PaaS
Collaborative Platform	Enable Collaboration among developers, most of the PaaS providers provide tools for project planning and communication
Diverse Client Tools	Provides a wide variety of the client tools like Web User Interface(UI), Application Programming Interfaces, etc. to help the developers choose the tool of their choice

Software as a Service (SaaS)

- Software as a service (SaaS) is a software distribution model in which a third-party provider hosts applications and makes them available to customers over the Internet.

The Services provided by the SaaS are as follows

- Business Services:-Variety of business services to startup companies including ERP, CRM, billing, sales and human resources
- Social Networks:- Number of users in the social networking sites are on the rise, it is the best match for handling the variable load
- Document Management:- Creating Managing and tracking electronic records
- Mail Services:- Handle unpredictable number of users and the load on e-mail services, most of the email providers offer their service as SaaS services

Characteristics of SaaS

One to Many	Single instance of the application can be shared by multiple customers
Web Access	SaaS services allow the end users to access the application from any location
Centralised Management	Since these services are hosted and managed from central location, automatic updates are performed to ensure that each customer is accessing the most recent version
Multi-Device Support	SaaS services can be accessed from any end user devices such as desktops, laptops , tablets, smartphones
Better Scalability	Leverage PaaS and IaaS for its development and deployment and ensure better scalability than traditional software
High Availability	Ensure 99.99% availability of user data

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API integration	SaaS services have the capability of integrating with other software or service through standard APIs (Application programming interface)
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Different instances of SaaS

- Testing as a Service(TaaS):- Provide users with software testing capabilities
- API as a Service(APIaaS):- Allows user to explore functionality of Web services such as Google Maps, Payroll Processing, and Credit Card Processing facilities etc.
- E-Mail as a Service(EaaS):- Integrated system of emailing, office automation, records management, migration and integration services

Other Cloud Service Models

- Communication as a Service (CaaS):- Allows businesses to selectively deploy the communication devices and modes on a pay-as-you –go-as needed basis
- Data as a Service(DaaS):-provides data on demand to a diverse set of users, systems or application. The data may include text, images, sounds, and videos
- Security as a Service(SEaaS):- Ability given to the end user to access the security service provided by the service provider on a pay per use basis
- Identity as a Service(IDaaS):- Ability given to end user to access the authentication infrastructure that is built, hosted, managed and provided by the third party service provider

Characteristics of Cloud Computing

High Scalability	Cloud Environments enable servicing of business requirements for larger audiences , through high scalability
Agility	Cloud works in distributed mode environment . Shares resources among users and tasks , while improving efficiency and agility(responsiveness)
High Availability and Reliability	Availability of servers is supposed to be high and more reliable as chances of the infrastructure failure are minimal
Multi-Sharing	Cloud working in a distributed and shared mode , multiple users and applications can work more efficiently with cost reductions by sharing common infrastructure
Services in Pay-per-use mode	SLA between provider and user must be defined when offering services in pay per use mode This may be based on complexity of services offered

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Virtualisation	Technology allows servers and storage devices to increasingly share and utilise applications , by easy migration from one physical server to another
Performance	It is monitored and consistent and loosely coupled architectures are constructed using web services as the system interface
Maintenance	Cloud Computing applications are easier, because they are not be installed on each user computer and can be accessed from different places

Advantages of Cloud Computing

- **Cost Effective:-** Traditional desktop software costs companies a lot in terms of finance. Adding up the license fees for multiple users can prove to be much expensive
- **Almost Unlimited Storage:-** Storing Information in the cloud almost gives unlimited storage capacity. No need to worry about running out of space
- **Backup and Recovery:-** All data is stored in the cloud, therefore backing up and restoring the same is relatively much easier than on a physical device
- **Automatic Software Integration:-** Software integration happens automatically in cloud, we need not take additional efforts to customise and integrate the applications as per our preferences
- **Easy access to information:-** Once registered in cloud, information can be accessed from anywhere
- **Quick Deployment:-** Once Cloud Technology is opted for, the entire system can be fully functional in a matter of few minutes

Issues relating to Cloud Computing

Can be classified into

- Security Issues
- Implementation/Adaptation Issues

Security Issues

Confidentiality	• Cloud works on public networks, there is a requirement to keep the data confidential to unauthorised entities
Integrity	• Prevention of unauthorised modification of data • Owners hope that the data and application is secure after it is

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	• moved to cloud • Ensured that the data is not changed after moved to the cloud
Availability	• Prevention of unauthorised withholding of data • Data backup through Business Continuity Planning(BCP) and Disaster Recovery Planning(DRP) • Availability also ensures – they meet organisation’s continuity and contingency planning requirements
Governance	• Lack of control over employees and services could cause the problems relating to design, implementation, testing and deployment • Need for Governance Model which controls the standards, procedures and policies of the organisation
Trust	• Trust ensures that the various service arrangements have sufficient means to allow visibility into security and privacy controls
Legal issues and Compliance	• Vary from place to place • Users have no assurance where the data is located physically • Need to understand the laws that impose security and privacy duties on an organisation
Privacy	• Embedded in each phase of the cloud design • Should include both the legal compliance and trusting maturity
Audit	• It is checking what happens in auditing environment • Time Consuming audits detains a key gain of cloud agility
Data Stealing	• Data stored anywhere is accessible in public form and private form by anyone at any time • Some of the Cloud Providers use servers from external providers • Backup policies to be implemented in order to avoid issues with data recovery after the attack
Architecture	• Control over the privacy and security of the system
Identity Management and Access Control	• Organisation Identification and authentication framework may not may not naturally extent to a public cloud
Incident Response	• Ensures to meet the requirements of the organisation during an incident

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	• Ensure mechanisms are available with the Cloud Provider to share information during and after the incident
Software Isolation	• To understand the virtualization and other logical isolation techniques that cloud provider employs
Application Security	• Security issues apply when applications move to a cloud platform

Implementation/Adaptation Issues

Threshold Policy	• Checking how the policy enables to detect the sudden increases in demand and results in creation of additional instances to fill in the demand • To determine how the unused resources are to be de-allocated
Interoperability	• Company outsourcing or creating applications with one cloud vendor may find it difficult to change to another computing vendor
Hidden Costs	• Companies incur high network charges from storage and database applications containing terabytes of data in the cloud • Service providers do not reveal “what the hidden costs are”
Unexpected Behavior	• It is important to test the application of the cloud with a pilot study to check for unexpected behavior
Software Development in Cloud	• To develop software using high end databases, most likely is cloud server pools the internal data corporate center and extend resources temporarily for testing purposes
Environment Friendly Cloud Computing	• May be environment friendly • This may be achieved by reducing the number of hardware components needed to run applications on the company’s internal data and replacing them with cloud computing systems