Semester – VI

17ITU602B **CLOUD COMPUTING** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Int : **40** Ext : **60** Total: **100**

SCOPE

The main objective of the course is to portray the recent trends in the field of cloud computing and providing exposures to some open source and commercial clouds.

OBJECTIVES

- Provide a good understanding of the concepts, standards and protocols in Cloud computing
-

UNIT-I

Overview of Computing Paradigm: Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. **Introduction to Cloud Computing:** Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Benefits and limitations of Cloud Computing.

UNIT-II

Cloud Computing Architecture: Comparison with traditional computing architecture (client/server), Services provided at various levels, Service Models- Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), How Cloud Computing Works, Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud, Case study of NIST architecture.

UNIT-III

Case Studies: Case study of Service model using Google App Engine, Microsoft Azure, Amazon EC2 , Eucalyptus.

UNIT-IV

Service Management in Cloud Computing: Service Level Agreements (SLAs), Billing & AITUounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling.

UNIT-V

Cloud Security: Infrastructure Security- Network level security, Host level security, Application level security, Data security and Storage- Data privacy and security Issues, Jurisdictional issues raised by Data location, Authentication in cloud computing.

Suggested Readings

1. Barrie Sosinsky. (2010). Cloud Computing Bible. New Delhi: Wiley-India,
2. Rajkumar Buyya., James Broberg., & Andrzej, M. Goscinski Wile. Cloud Computing: Principles and Paradigms.
3. Nikos Antonopoulos., & Lee Gillam. (2012). Cloud Computing: Principles, Systems and Applications. Springer.
4. Ronald, L. Krutz., & Russell Dean Vines. (2010). Cloud Security: A Comprehensive Guide to Secure Cloud Computing.New Delhi: Wiley-India.
5. Gautam Shroff. (2010). Enterprise Cloud Computing Technology Architecture Applications. Adobe Reader ebooks available from eBooks.com.
6. Toby Velte., Anthony Velte., & Robert Elsenpeter.(2010). Cloud Computing, A Practical Approach. McGraw Hills.
7. Dimitris, N. Chorafas. (2010). Cloud Computing Strategies. CRC Press.

WEB SITES

1. en.wikipedia.org/wiki/Cloud_computing
2. www.ibm.com/cloud-computing/in/en/
3. www.oracle.com/CloudComputing
4. www.microsoft.com/en-us/cloud/default.aspx

ESE Patterns	
Part – A(Online)	20x1=20
Part – B	5x2=10
Part – C(Either or)	5x6=30
Total	60 Marks

CIA Patterns	
Part – A	20x1=20
Part – B	3x2=06
Part – C(Either or)	3x8=24
Total	50 Marks

Faculty **HOD**

KARPAGAM ACADEMY OF HIGHER EDUCATION

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Established Under Section 3 of UGC Act 1956

Coimbatore – 641 021.

LECTURE PLAN

DEPARTMENT OF CS,CA & IT

STAFF NAME: Dr.N.THANGARASU

SUBJECT NAME: Cloud Computing **SUB.CODE:17ITU602B**

SEMESTER: VI **CLASS: III B.Sc (IT)**

S.No	Lecture Duration Period	Topics to be Covered	Support Material/Page Nos
		UNIT-I	
1.	1	Recent trends in computing: Grid Computing, cluster computing	w1
2.	1	Distributed Computing,	w1
3.	1	Utility Computing	w1
4.	1	Cloud Computing	w1
5.	1	**Introduction to Cloud Computing:** History of cloud Computing	T1 :4-5
6.	1	Cloud service providers	T1:5-10
7.	1	Benefits and limitations of Cloud Computing.	T1:10-19
8.	1	Recapitulation and Discussion of Important Questions	
Total No Of Periods Planned For Unit 1 :8			
		UNIT-II	
1.	1	Comparison with traditional computing architecture (client/server),	T1 :65,w2
2.	1	Service Models – IaaS,	T1:66 -69
3.	1	Service Models - PaaS, SaaS	T1:70 -75
4.	1	Cloud Computing Works	w2
5.	1	Deployment Models - Public& Private cloud	T2:24-27
6.	1	Hybrid cloud, Community Cloud	T2:28-29
7.	1	Case Study of NIST architecture.	T2:121,167

8.	1	Recapitulation and Discussion of Important Questions	
Total No Of Periods Planned For Unit II :8			
		UNIT-III	
1.	1	Case Study-Service model	W3
2.	1	Exploring Google application	T1:151-161
3.	1	Google App Engine	T1:162-173
4.	1	Microsoft Azure	T1:206-228
5.	1	Amazon EC2	T1:180-190
6.	1	Amazon EC2 – Other IaaS	T1:190-202
7.	1	Eucalyptus	T2:115-116
8.	1	Recapitulation and Discussion of Important Questions	
Total No Of Periods Planned For Unit III :8			
		UNIT-IV	
1.	1	Service Management in Cloud computing	T1:232-237 , w4
2.	1	Service Level Agreements	T2:11, 23
3.	1	Billing & Accounting	T3:237-238
4.	1	Billing & Accounting – Economic Model	T3: 248-250
5.	1	Comparing Scaling Hardware	T3:49-50
6.	1	Traditional vs Cloud	T3:50-52
7.	1	Traditional vs Economics of scaling	T3:52-56
8.	1	Recapitulation and Discussion of Important Questions	
Total No Of Periods Planned For Unit IV:8			
		UNIT-V	
1.	1	Cloud security - Network level security	T1: 250-252
2.	1	Host & Application level security,	T1:252-255
3.	1	Data Security and Storage	T2:85-90
4.	1	Authentication in Cloud computing	T1:78, w4
5.	1	Recapitulation and Discussion of important Questions	

6.	1	Discussion of Previous ESE Question Papers.	
7.	1	Discussion of Previous ESE Question Papers.	
8.	1	Discussion of Previous ESE Question Papers.	
Total No of Periods planned for Unit V: 8			
Total Planned Hours:-40			

Suggested Readings

1. Barrie Sosinsky. (2010). Cloud Computing Bible. New Delhi: Wiley-India,
2. Dr.Kumar Saurabh (2014), Cloud Computing, 2ed edition, Wiley Pvt.Ltd.New Delhi
3. Judith Hurwitz, Robin Bloor, Marcia karfman, Fern Halper. (2015), Cloud Computing for Dummies,Wiley Publication, New Delhi.
4. Rajkumar Buyya., James Broberg., & Andrzej, M. Goscinski Wile. Cloud Computing: Principles and Paradigms.
5. Nikos Antonopoulos., & Lee Gillam. (2012). Cloud Computing: Principles, Systems and Applications. Springer.
6. Ronald, L. Krutz., & Russell Dean Vines. (2010). Cloud Security: A Comprehensive Guide to Secure Cloud Computing.New Delhi: Wiley-India.
7. Gautam Shroff. (2010). Enterprise Cloud Computing Technology Architecture Applications. Adobe Reader ebooks available from eBooks.com.
8. Toby Velte., Anthony Velte., & Robert Elsenpeter.(2010). Cloud Computing, A Practical Approach. McGraw Hills.
9. Dimitris, N. Chorafas. (2010). Cloud Computing Strategies. CRC Press.

WEB SITES

1. www.wikipedia.org/wiki/Cloud_computing
2. www.ibm.com/cloud-computing/in/en/
3. www.oracle.com/CloudComputing
4. www.microsoft.com/en-us/cloud/default.aspx

UNIT-I

Overview of Computing Paradigm: Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. **Introduction to Cloud Computing:** Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Benefits and limitations of Cloud Computing.

Introduction

Cloud computing is an emerging technology and has many challenges in various aspects of information handling. Cloud Computing provides us means by which we can access the applications as utilities over the internet. It allows us to create, configure, and customize the business applications online. The term Cloud refers to a Network or Internet. In other words, we can say that Cloud is something, which is present at remote location. Cloud can provide services over public and private networks, i.e., WAN, LAN or VPN.

Applications such as e-mail, web conferencing, customer relationship management (CRM) execute on cloud.

Fig 1: Cloud Computing

Cloud computing offers platform independency, as the software is not required to be installed locally on the PC. Hence, the Cloud Computing is making our business applications mobile and collaborative.

OVERVIEW OF COMPUTING PARADIGM:

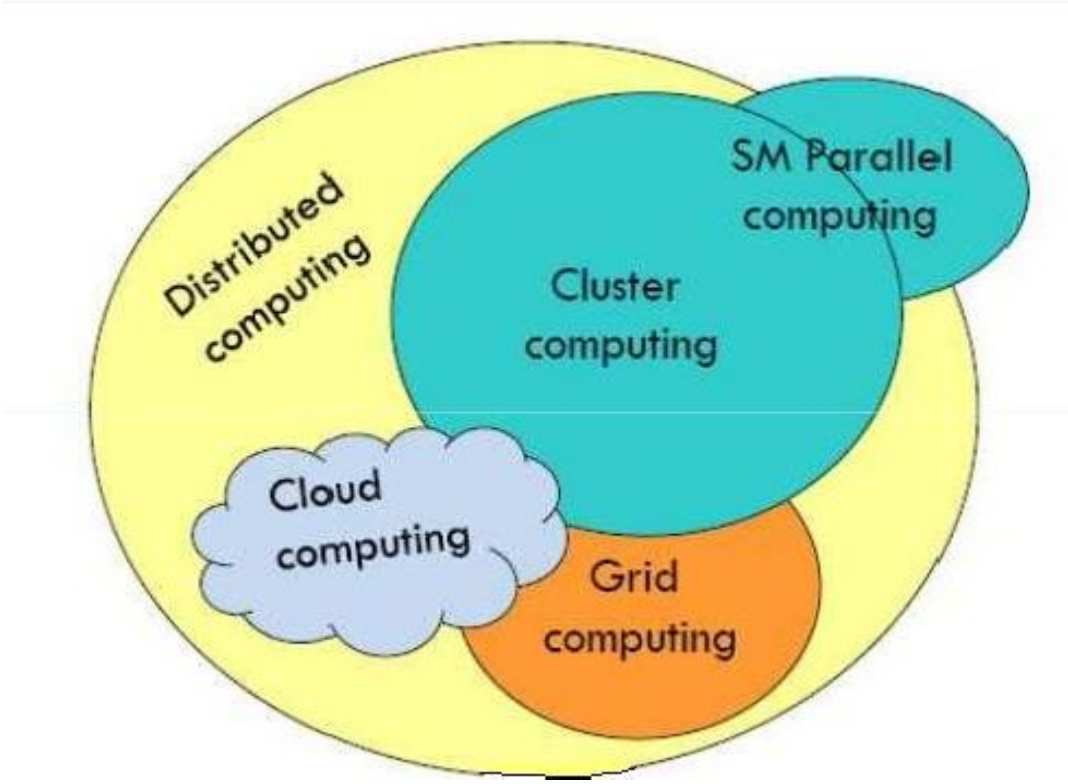

Fig 2: Overview of computing paradigm

What is computing?

- The process of utilizing computer technology to complete a task. Computing may involve computer hardware and/or software, but must involve some form of a computer system.

• **Computing includes -**

- designing,
- developing and building hardware and software systems;
- processing,
- structuring, and managing various kinds of information;
- doing scientific research on and with computers;
- Entertainment media.

1. Grid computing - Grid computing involves connecting geographically remote computers into a single network to create a virtual supercomputer by combining the computational power of all computers on grid.

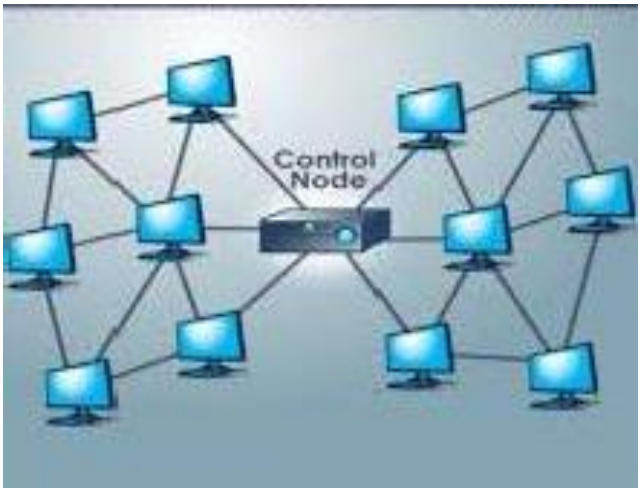

Fig 3: How Grid Computing works

- "the Grid" links together computing resources (PCs, workstations, servers, storage elements) and provides the mechanism needed to access them.
- By implementing our proposed Intranet Grid it is very easy to download multiple files very fast.
- No need to worry about the security as we are authenticating each and every step taking place in our Grid.
- In particular user to access the database. Further implementations could be carried out in the nearest future.

WHY GRID COMPUTING?

- 40% Mainframes are idle
- 90% Unix servers are idle
- 95% PC servers are idle
- 0-15% Mainframes are idle in peak-hour
- 70% PC servers are idle in peak-hour

Advantages

- Can solve larger, more complex problems in a shorter time
- Easier to collaborate with other organizations
- Make better use of existing hardware

Disadvantages

- Grid software and standards are still evolving
- Learning curve to get started
- Non-interactive job submission

Examples:

1. A Scientists studying scientific concepts has the ability to use an entire network of computers in order to analyze data
2. A Business man has the ability to access an entire network of computers in order to forecast the growth of particular stock.

2. Cluster computing

- It is a form of computing in which a group of computers are linked together so they can act like a single entity.
- It is the technique of linking two or more computers into a network (Usually through a local area network) in order to take advantage of the parallel processing power of those computers.

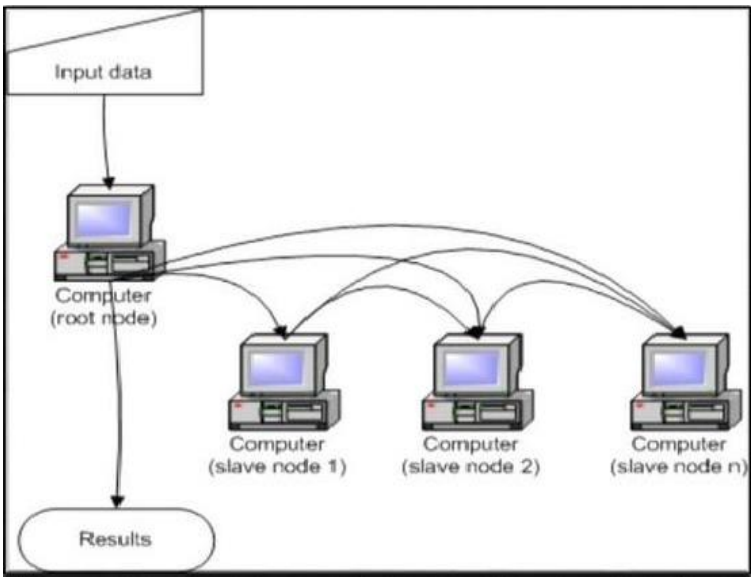

Fig 4: A Simple Cluster Layout

Cluster Application

- Google Search Engine
- Earthquake Simulation Software
- Image Rendering
- Weather Forecasting

Benefits

- High processing power
- Cost Efficient
- High Availability
- Fault Tolerance

Advantages

A computer cluster provides much faster processing speed, larger storage capacity, better data integrity, superior reliability and wider availability of resources.

Disadvantages

Cost is high..... Since clustering needs more servers and hardware to establish one, monitoring and maintenance is hard.

3. Distributed Computing

Distributed computing is the method of processing in which different parts of a program are run simultaneously on two or more computers that are communicating with each other over a network.

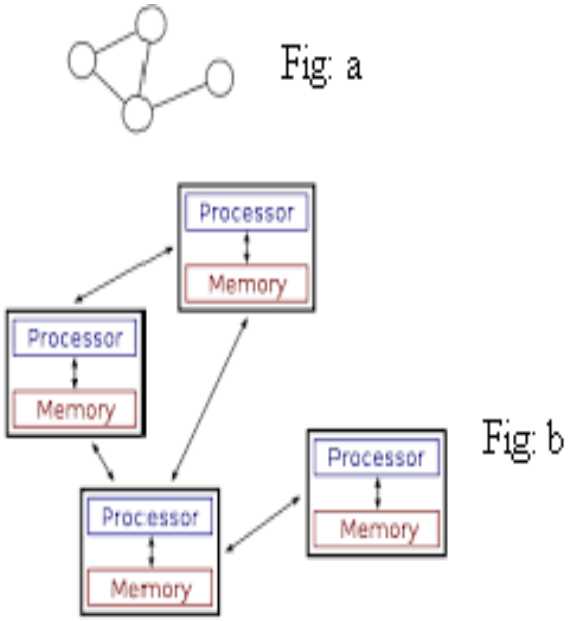

Fig 5: Distributed computing

The figure illustrates the distributed computing systems. Figure (a) is a schematic view of a typical distributed system; the system is represented as a network topology in which each node is a computer and each line connecting the nodes is a communication link. Figure (b) shows the same distributed system in more detail: each computer has its own local memory, and information can be exchanged only by passing messages from one node to another by using the available communication links.

Advantages

- **Inherently Distributed applications**: several applications are inherently distributed in nature and require distributed computing system for their realization

- **Information Sharing among Distributed Users:** In a distributed computing system, information generated by one of the users can be easily and efficiently shared by the users working at other nodes of the system .The use of distributed computing systems by a group of users to work cooperatively is known as computer-supported cooperative working (CSCW), or groupware .
- **Resource Sharing:** Information is not the only thing that can be shared in a distributed computing system. Sharing of software resources such as software libraries and databases as well as hardware resources such as printers, hard disks, and plotters can also be done in a very effective way among all the computers and the users of a single distributed computing system

Disadvantages

- **Complex**: Additional programming required to set up distributed systems
- **Security**: Information passed around the network may be tracked and used for illegal purposes
- **Network dependency**: In case of network failure, the entire system becomes unstable.

4. Utility computing

It is a service provisioning model in which a service provider makes computing resources and infrastructure management available to the customer as needed, and charges them for specific usage rather than a flat rate.

Like other types of on-demand computing (such as grid computing), the utility model seeks to maximize the efficient use of resources and/or minimize associated costs.

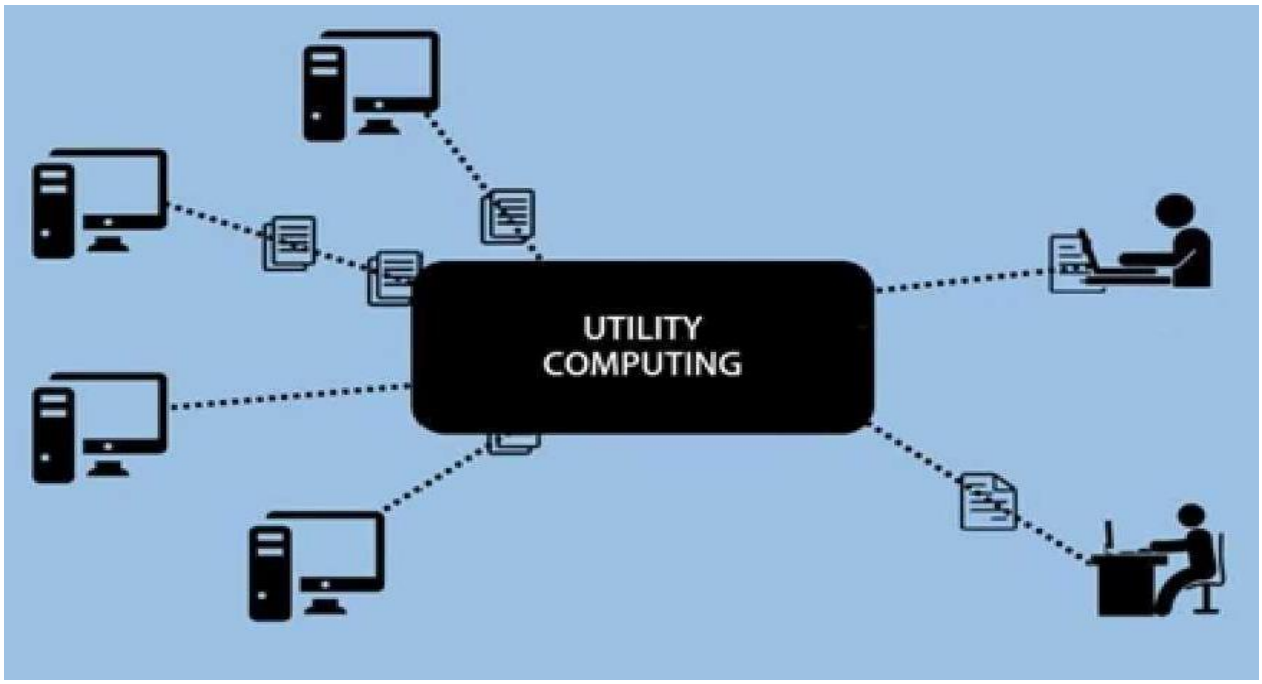

Fig 6: Utility Computing

The Evolution of cloud computing:

With Software as a Service (SaaS) becoming widely accepted, Cloud Computing is becoming increasingly important for small businesses because of its low cost (pay as you go and just for what you need) and agility (rapid ramp up and down).

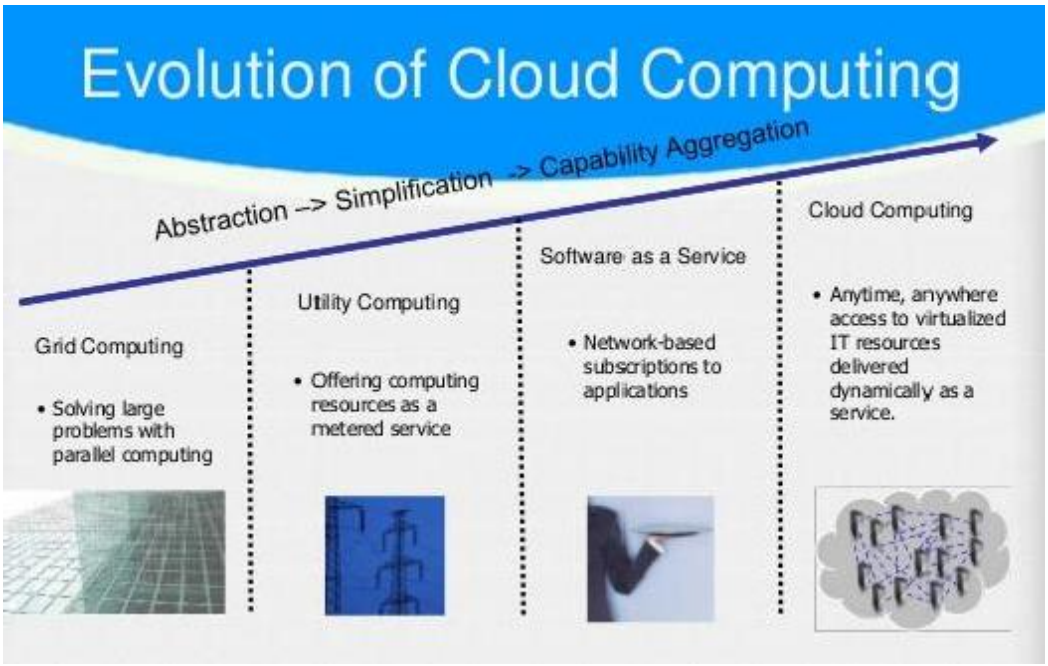

Fig 7: Evolution of Cloud Computing

Business Drivers for Cloud Business growth

1. **Business growth** - is one of the top benefits organisations realise as a result of cloud adoption, with 52% of enterprises reporting increased growth since going cloud (2015 Cloud Enterprise Report).

2. **Efficiency** - is an extremely common cloud driver, with 71% of organisations worldwide ranking it a top area they hope to approve through cloud technology (2015 Cloud Enterprise Report).

3. **Experience** - Next among the business drivers is improving the quality of the customer experience, which 45% of enterprises worldwide rank as a top cloud driver (although that number jumps to 61% looking at only organisations in the UK and Australia).

4. **Assurance** - Finally, there is assurance, which is the idea that data will be more secure in the cloud and the user will attain better uptime because its solutions are maintained by providers that have built their businesses around these competencies

Cloud Computing:

- **In the simplest terms**, cloud computing means storing and accessing data and programs over the Internet instead of your computer's hard drive. The cloud is just a metaphor for the Internet.
- **Definition** - Cloud Computing is the use of hardware and software to deliver a service over a network (typically the Internet). With cloud computing, users can access files and use applications from any device that can access the Internet. An example of a Cloud Computing provider is Google's Gmail. That is Gmail users can access files and applications hosted by Google via the internet from any device.

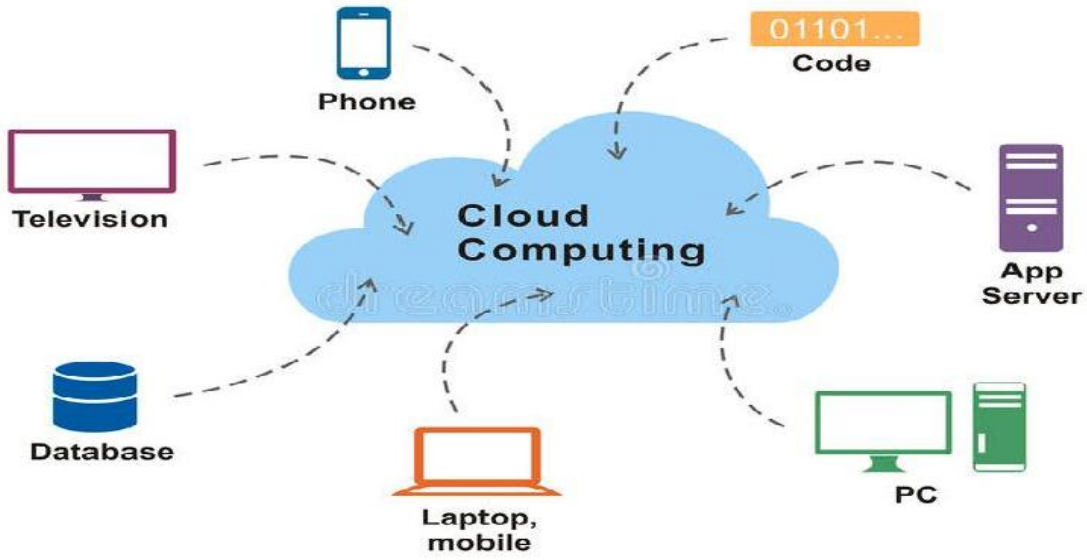

Fig 8: Cloud Computing - Devices

History of Cloud Computing

- **1950s -** In the 50s mainframe computers were huge, occupying entire rooms. Due to the cost of buying and maintaining mainframes, organisations couldn't afford to purchase

one for each user. The solution was "time sharing" in which multiple users shared access to data and CPU time. The term "time sharing" is the premise of cloud computing.

- **1969** - J.C.R. Licklider developed the ARPANET (Advanced Research Projects Agency Network) – the network that became the basis of the internet. His vision was for everyone on the globe to be interconnected and accessing programs and data at any site, from anywhere.
- **1970s** - IBM released an operating system called VM that allowed admins to have multiple virtual systems, or "Virtual Machines" (VMs) on a single physical node. The VM operating system took the 50s "time sharing" model to the next level and most of the basic functions of any virtualisation software that you see nowadays can be traced back to this early VM operating system.
- **1990s** - Telecommunications companies started offering virtualised private network connections, which meant it was possible to allow for more users through shared access to the same physical infrastructure. This change enabled traffic to be shifted as necessary to allow for better network balance and more control over bandwidth usage. Meanwhile, virtualisation for PC-based systems started in earnest, and as the Internet became more accessible, the next logical step was to take virtualisation online.
- **1997**- The term "cloud computing" is coined by University of Texas professor Ramnath Chellappa in a talk on a "new computing paradigm."
- **2002**- Amazon created Amazon Web Services (AWS), providing an advanced system of cloud services from storage to computation.
- **2006** - Amazon introduced the Elastic Compute Cloud (EC2) as a commercial web service. The EC2 let small companies rent computers on which they could run their own computer applications.
- **2009** - Google and Microsoft entered the playing field. The Google App Engine brought low-cost computing and storage services, and Microsoft followed suit with Windows Azure.
- **2010** - The Oneserve field service management software moves to the cloud

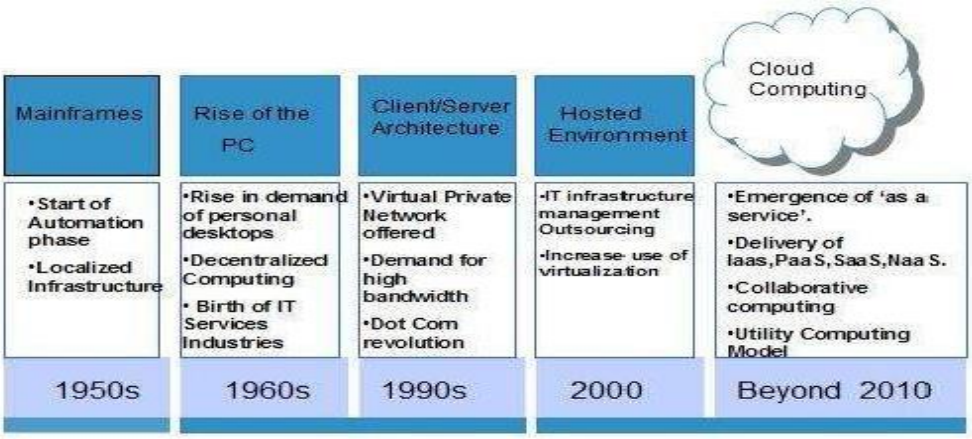

Fig 9: History of Cloud Computing

Challenges in Cloud Computing

Fig 10: Challenges in Cloud Computing

1. Security and Privacy

- Security and privacy are the main challenge in cloud computing.
- These challenges can reduce by using security applications, encrypted file systems, data loss software.

2. Interoperability

- The application on one platform should be able to incorporate services from the other platform. This is known as Interoperability.

- It is becoming possible through web services, but to develop such web services is complex.

3. Portability

- The applications running on one cloud platform can be moved to new cloud platform and it should operate correctly without making any changes in design, coding.
- The portability is not possible, because each of the cloud providers uses different standard languages for their platform.

4. Service Quality

- The Service-Level Agreements (SLAs) of the providers are not enough to guarantee the availability and scalability. The businesses disinclined to switch to cloud without a strong service quality guarantee.

5. Computing Performance

- High network bandwidth is needed for data intensive applications on cloud, this results in high cost.
- In cloud computing, low bandwidth does not meet the desired computing performance.

6. Reliability and Availability

- Most of the businesses are dependent on services provided by third-party, hence it is mandatory for the cloud systems to be reliable and robust.

Features of Cloud Computing

1. **High scalability** - It means on demand provisioning of resources on a large scale without requiring human interaction with each service provider.
2. **High availability and reliability** - Availability of servers is more reliable and high because it minimizes the chances of infrastructure failure.
3. **Agility** - It shares the resources between users and works very quickly.
4. **Multi-sharing** - Multiple user and applications work more efficiently with less cost by sharing common infrastructure using cloud computing.
5. **Maintenance** - Maintenance of cloud computing applications is easier as they are not required to be install on each computer and can also be accessed from various places,

ultimately reducing the cost.

6. **Low cost** - It is cost effective because the company no more needs to set its own infrastructure. It pays according to resources it has consumed.

7. **Services in pay-per-use mode** - APIs(Application Programming Interfaces) are provided to the users for accessing the services on the cloud and pay according to use of the service.

Cloud Service Provider

A cloud service provider, or CSP, is a company that offers some component of cloud computing -- typically infrastructure as a service (IaaS), software as a service (SaaS) or platform as a service (PaaS) to other businesses or individuals.

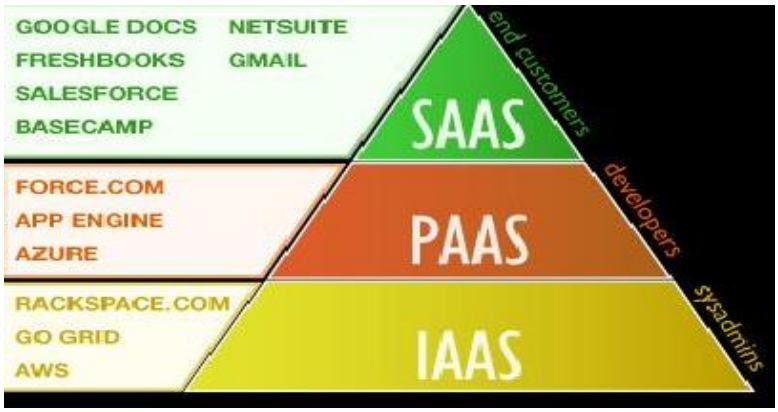

Fig 11: Cloud Service Provider

Examples of cloud service provides are:

1) Amazon Web Service (AWS)
2) Microsoft Azure.
3) Google Cloud Platform.
4) Adobe.
5) VMware.
6) IBM Cloud.
7) Rackspace.
8) Red Hat.

Fig 12: Example of Cloud Services

Cloud Computing Services:

The three major Cloud Computing Offerings are:

- **Software as a Service (SaaS)** - SaaS or software as a service is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network (internet). SaaS is becoming an increasingly prevalent delivery model as underlying technologies that supports Service Oriented Architecture (SOA) or Web Services. Through internet this service is available to users anywhere in the world.

  Traditionaly, software application needed to be purchased upfront &then installed it onto your computer. SaaS users on the other hand, instead of purchasing the software subscribes to it, usually on monthly basis via internet.

  Anyone who needs an access to a particular piece of software can be subscribing as a user, whether it is one or two people or every thousands of employees in a corporation. SaaS is compatible with all internet enabled devices.

  Many important tasks like accounting, sales, invoicing and planning all can be performed using SaaS.

- **Platform as a Service (PaaS)** - Platform as a service, is referred as PaaS, it provides a platform and environment to allow developers to build applications and services. This service is hosted in the cloud and accessed by the users via internet.

To understand in a simple terms, let compare this with painting a picture, where you are provided with paint colors, different paint brushes and paper by your school teacher and you just have to draw a beautiful picture using those tools.

PaaS services are constantly updated & new features added. Software developers, web developers and business can benefit from PaaS. It provides platform to support application development. It includes software support and management services, storage, networking, deploying, testing, collaborating, hosting and maintaining applications.

- **Infrastructure as a Service (IaaS)** - IaaS (Infrastructure As A Service) is one of the fundamental service model of cloud computing alongside PaaS(Platform as a Service). It provides access to computing resources in a virtualized environment "the cloud" on internet. It provides computing infrastructure like virtual server space, network connections, bandwidth, load balancers and IP addresses. The pool of hardware resource is extracted from multiple servers and networks usually distributed across numerous data centers. This provides redundancy and reliability to IaaS.

  IaaS(Infrastructure as a service) is a complete package for computing. For small scale businesses who are looking for cutting cost on IT infrastructure, IaaS is one of the solutions. Annually a lot of money is spent in maintenance and buying new components like hard-drives, network connections, and external storage device etc. which a business owner could have saved for other expenses by using IaaS.

Benefits and limitations of Cloud Computing:

Advantages:

- **Easy implementation** - Cloud hosting allows business to retain the same applications and business processes without having to deal with the backend technicalities. Readily manageable by the Internet, a cloud infrastructure can be accessed by enterprises easily and quickly.
- **Accessibility** - Access your data anywhere, anytime. An Internet cloud infrastructure maximizes enterprise productivity and efficiency by ensuring your application is always

accessible. This allows for easy collaboration and sharing among users in multiple locations. No hardware required. Since everything will be hosted in the cloud, a physical storage center is no longer needed. However, a backup could be worth looking into in the event of a disaster that could leave your company's productivity stagnant.

- **Cost per head** - Overhead technology costs are kept at a minimum with cloud hosting services, enabling businesses to use the extra time and resources for improving the company infrastructure.
- **Flexibility for growth** - The cloud is easily scalable so companies can add or subtract resources based on their needs. As companies grow, their system will grow with them.
- **Efficient recovery** - Cloud computing delivers faster and more accurate retrievals of applications and data. With less downtime, it is the most efficient recovery plan.

Disadvantages:

- **No longer in control** - When moving services to the cloud, you are handing over your data and information. For companies who have an in-house IT staff, they will be unable to handle issues on their own. However, Stratosphere Networks has a 24/7 live help desk that can rectify any problems immediately.
- **May not get all the features** - Not all cloud services are the same. Some cloud providers tend to offer limited versions and enable the most popular features only, so you may not receive every feature or customization you want. Before signing up, make sure you know what your cloud service provider offers.
- **No Redundancy** - A cloud server is not redundant nor is it backed up. As technology may fail here and there, avoid getting burned by purchasing a redundancy plan. Although it is an extra cost, in most cases it will be well worth it.
- **Bandwidth issues** - For ideal performance, clients have to plan accordingly and not pack large amounts of servers and storage devices into a small set of data centers.

Fig 13: Pros /Cons in Cloud Computing

POSSIBLE QUESTIONS

PART A

Q.NO 1 TO 20 (MULTIPLE CHOICE QUESTIONS)

PART B (2 MARKS)

1. Define Cloud Computing
2. Mention any two benefits and limitations in cloud computing.
3. Give few examples for cloud service providers?
4. List out any 5 cloud service providers.
5. Name any two advantages and disadvantage in Grid Computing.
6. List out any two differences between cluster computing and utility computing.
7. Mention any two prons and cons for cloud computing
8. Give a clear structure for overview of cloud computing paradigm
9. What is distributed computing
10. What is evolution of cloud computing.

PART C (6 MARKS)

1. Explain Overview of Computing Paradigm with neat sketch
2. Elucidate History of Computing..
3. Describe the challenges in cloud computing with neat diagram
4. Explain the features of cloud computing.
5. Explain some of the benefits and limitations of cloud computing.

S.No	Questions	opt1	opt2	opt3	opt4	Answer
1	_____refers to applications and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards.	Cloud Computing	Virtual Computing	Cloud Storage	Cloud Networking	Cloud Computing
2	The term Cloud refers to _____	data center	data storage	Internet	remote location	Internet
3	_____ is a complete operating environment with applications, management, and the user interface	CaaS	PaaS	IaaS	SaaS	SaaS
4	The _____is something that you can obtain under contract from your vendor.	QoS	QpS	QtS	QaS	QoS
5	_____refers to the components and subcomponents required for Cloud Computing	Cloud Computing Storage	Cloud Computing Platform	Cloud Computing Stack	Cloud Based Delivery	Cloud Computing Stack
6	_____ computing connects geographically remote computer into a single network.	Grid	cluster	Utility	Parallel	Grid
7	_____ is one of the cloud applications in use.	Cloud backup	Cloud storage	Cloud service	Cloud Networking	Cloud backup
8	_____is the technique of linking two or more computers into a network	Grid	cluster	Utility	Parallel	cluster

9	_____ computing process which communicates with each other over a network	Grid	cluster	Utility	Distributed	Distributed
10	Google App Engine is an example of _____ services.	CaaS	PaaS	IaaS	SaaS	PaaS
11	SQL Azure is an example of _____ services.	CaaS	PaaS	IaaS	SaaS	SaaS
12	The Backend platforms are called as_____	Intercloud	Mobile device	Storage	Fat client	Storage
13	_____is taking the physical hardware and going completely virtual	IaaS	PaaS	Daas	SaaS	IaaS
14	Cloud networking is a_____ network	Non Agile	Agile	Latency	Low Latency	Agile
15	In which computing resources the customer can go pay-as-you-go for specific usage.	Grid	cluster	Utility	Distributed	Utility
16	Cloud Providers has _____ main component services in cloud computing	3	2	5	1	3
17	The abbreviation for SaaS is _____	Software as a	Software as a S	Server as a Se	Structure as a Se	Software as a Service

18	The abbreviation for IaaS is _____	Infra as a Ser	Independent as	Infrastructure	Infrastructure se	Infrastructure as a Service
19	The abbreviation for PaaS is _____	Platform as a	Plat as a Servic	Platform as a	Public as a Serv	Platform as a Service
20	_____abstracts the details of system implementation from users and developers.	Cloud Computing	Virtual Computing	Cloud Storage	Cloud Networking	Cloud Computing
21	_____consists of the particular types of services that you can access on a cloud computing platform.	Developmen t models	Deployment models	Service models	Business models	Service models
22	_____is an example of IaaS service providers	Oracle on Demand	GoogleApps	Force.com	Eucalyptus	Eucalyptus
23	In which year J.C.R. Licklider developed the ARPANET.	**1969**	1950s	1970s	1997	**1969**
24	All cloud computing applications suffer from the inherent latency that is intrinsic in their _____connectivity	MAN	WAN	LAN	LAN & MAN	WAN
25	Cloud computing is a _____system	stateful	stateup	stateless	statedown	stateless
26	A single area of concern in cloud computing is_____	privacy and network	security and storage	storage and network	privacy and security	privacy and security

27	The use of the word “cloud” makes reference to the____and___essential concepts.	Abstraction & Virtualizatio	Services & applications	Virtualizatio n & Services	Abstraction& applications	Abstraction & Virtualizatio
28	_____provides virtual machines, operating systems, applications, services, development frameworks, transactions, and control structures.	IaaS	PaaS	Daas	SaaS	PaaS
29	Expand EC2	Elastic Cloud Compute	Extended Compute Cloud	Elastic Compute Cloud	Extended Cloud Compute	Elastic Compute Cloud
30	_____can be rapidly and elastically provisioned.	Data	Network	Information	Resources	Resources
31	The abbreviation for AWS is _____	Amazon Wel	Amazon Web S	Application W	Amazon Wide S	Amazon Web Services
32	_____creates a single point of failure.	Fat Clients	The Zero Clients	Thick Clients	Cloud Clients	The Zero Clients
33	_____provides the equivalent of installed applications in the traditional delivery of applications.	IaaS	Daas	SaaS	PaaS	SaaS
34	In which year Amazon introduced the Elastic Compute Cloud (EC2) as a commercial web service.	1969	2006	2009	2010	2006
35	Google App Engine is an example of _____ services.	CaaS	PaaS	IaaS	SaaS	PaaS

36	The Backend platforms are called as_____.	Intercloud	Mobile device	Storage	Fat client	Storage
37	In which computing paradigm the job submission is non-interactive.	Grid	cluster	Utility	Parallel	Grid
38	. _____is an example of IaaS service providers	Oracle on De	GoogleApps	Force.com	Eucalyptus	Eucalyptus
39	In case of network failure, the entire system becomes unstable in _____computing	Grid	cluster	Utility	Distributed	Distributed
40	_____ is one of the large IaaS cloud service providers	Rackspace.co	Salesforce.com	GoGrid.com	Openstack.com	Rackspace.co
41	_____has the least levels of integrated functionality.	IaaS	PaaS	Daas	SaaS	IaaS
42	_____has the most levels of integrated functionality.	IaaS	SaaS	Daas	PaaS	SaaS
43	Expand SLA	Strorage Level Agreement	Service Level Agreement	Service Level Applications	Storage Level Applications	Service Level Agreement
44	_____ is not a benefit of cloud computing.	Resource pooling	Rapid elasticity	Infinite data	Measured service	Infinite data

45	If your application needs large amounts of data transfer, _____ may not be the best model for you.	Distributed computing	Load balancing	Virtualizatio n	Cloud computing	Cloud computing
46	_____ cloud is used for healthcare industry	Private cloud	Public cloud	Hybrid cloud	Community clou	Community cloud
47	_____ is not an opertaion of Quality of Service.	Data replication	Queries	System monitoring	Disaster recovery	Queries
48	A _____ cloud combines multiple clouds are bound together as a unit.	Community c	Public cloud	Private cloud	Hybrid cloud	Hybrid cloud
49	Expand VM	virtual machi	vendor machin	virtual mecha	vendor mechani	virtual machin
50	One of the fundamental components of PaaS middleware is the mapping of _____ onto the cloud infrastructure	Dynamic applications	Standalone applications	Standard applications	Distributed applications	Distributed applications
51	Cloud computing represents a _____ in the way in which systems are deployed.	Real time applications	Real Paradigm shift	Infinitely Scalable	Measurable Service	Real Paradigm shift
52	The scale of cloud computing networks and their ability to provide_____ makes them highly reliable.	Lower costs	Ease of utilization	Load balancing and failover	Simplified maintenance and upgrade	Load balancing and failover
53	Cloud computing industry continues to address _____ concerns, if you have an application that works with sensitive data.	Security	Privacy	Storage	Bigdata	Security

54	_____is not an architectural standards in Cloud computing.	Grid computi	Distributed computing	Autonomic systems	Standardized Web services	Distributed computing
55	_____ is one of the large IaaS cloud service providers	Rackspace.com	Salesforce.com	GoGrid.com	Openstack.com	Rackspace.com
56	IDaaS Stands for_____	Infrastructure as a Service	Independent as a Service	Interdependent as a Service	Identity as a Service	Identity as a Service
57	_____ has a number of operating systems and some enterprise applications that they offer on a rental basis to customers in the form of a number of canned images.	Eucalyptus	Amazon	MS Azure	GoGrid	Amazon
58	The _____ providing applications and enabling technology, infrastructure, hardware and integration	vendors	partners	business leaders	GoGrid.com	vendors
59	Expand API .	Application Pro	App Programming	Application Prog	Application Prograı	Application Programming Interfacs
60	is a CPU emulator and virtual machinemonitor	Parallels	QEMU	Jumpbox	Vmachines	QEMU

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IT Infrastructure

Traditional data centres consist of various pieces of hardware, such as a desktop computer, which are connected to a network via a remote server. This server is typically installed on the premises, and provides all employees using the hardware, access to the business's stored data and applications.

Businesses with this IT model must purchase additional hardware and upgrades in order to scale up their data storage and services to support more users. Mandatory software upgrades are also required with traditional IT infrastructure to ensure fail safe systems are in place to in case a hardware failure occurs. For many businesses with IT data centers, an in-house IT department is needed to install and maintain the hardware.

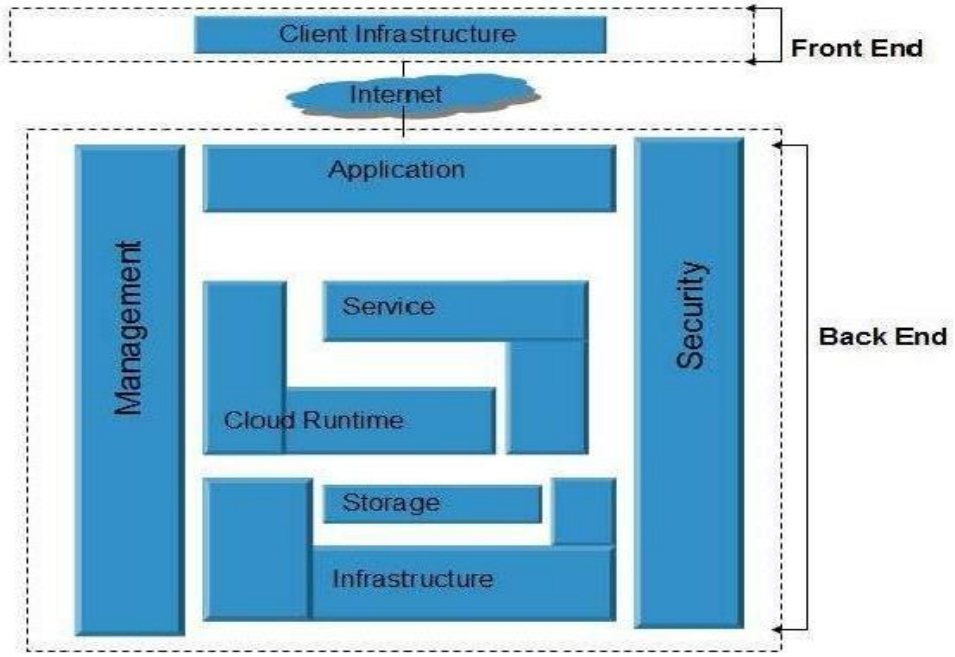
On the other hand, traditional IT infrastructures are considered to be one of the most secure data hosting solutions and allows you to maintain full control of your company's applications and data on the local server. They are a customized, dedicated system ideal for organisations that need to run many different types of applications.

Cloud Computing Architecture

Cloud Computing architecture comprises of many cloud components, which are loosely coupled. We can broadly divide the cloud architecture into two parts:

- Front End
- Back End

Each of the ends is connected through a network, usually Internet. The following diagram shows the graphical view of cloud computing architecture:



Front End

The front end refers to the client part of cloud computing system. It consists of interfaces and applications that are required to access the cloud computing platforms, Example - Web Browser.

Back End

The back End refers to the cloud itself. It consists of all the resources required to provide cloud computing services. It comprises of huge data storage, virtual machines, security mechanism, services, deployment models, servers, etc.

Cloud Computing vs Traditional IT infrastructure

Cloud computing is far more abstract as a virtual hosting solution. Instead of being accessible via physical hardware, all servers, software and networks are hosted in the cloud, off premises. It's a real-time virtual environment hosted between several different servers at the same time. So rather than investing money into purchasing physical servers in-house, you can rent the data storage space from cloud computing providers on a more cost effective pay-per-use basis.

The main differences between cloud hosting and traditional web hosting are:

Resilience and Elasticity

The information and applications hosted in the cloud are evenly distributed across all the servers, which are connected to work as one. Therefore, if one server fails, no data is lost and downtime is avoided. The cloud also offers more storage space and server resources, including better computing power. This means your software and applications will perform faster.

Traditional IT systems are not so resilient and cannot guarantee a consistently high level of server performance. They have limited capacity and are susceptible to downtime, which can greatly hinder workplace productivity.

Flexibility and Scalability

Cloud hosting offers an enhanced level of flexibility and scalability in comparison to traditional data centres. The on-demand virtual space of cloud computing has unlimited storage space and more server resources. Cloud servers can scale up or down depending on the level of traffic your website receives, and you will have full control to install any software as and when you need to. This provides more flexibility for your business to grow.

With traditional IT infrastructure, you can only use the resources that are already available to you. If you run out of storage space, the only solution is to purchase or rent another server.If you hire more employees, you will need to pay for additional software licences and have these manually uploaded on your office hardware. This can be a costly venture, especially if your business is growing quite rapidly.

Automation

A key difference between cloud computing and traditional IT infrastructure is how they are managed. Cloud hosting is managed by the storage provider who takes care of all the necessary hardware, ensures security measures are in place, and keeps it running smoothly. Traditional data centres require heavy administration in-house, which can be costly and time consuming for your business. Fully trained IT personnel may be needed to ensure regular

monitoring and maintenance of your servers – such as upgrades, configuration problems, threat protection and installations.

Running Costs

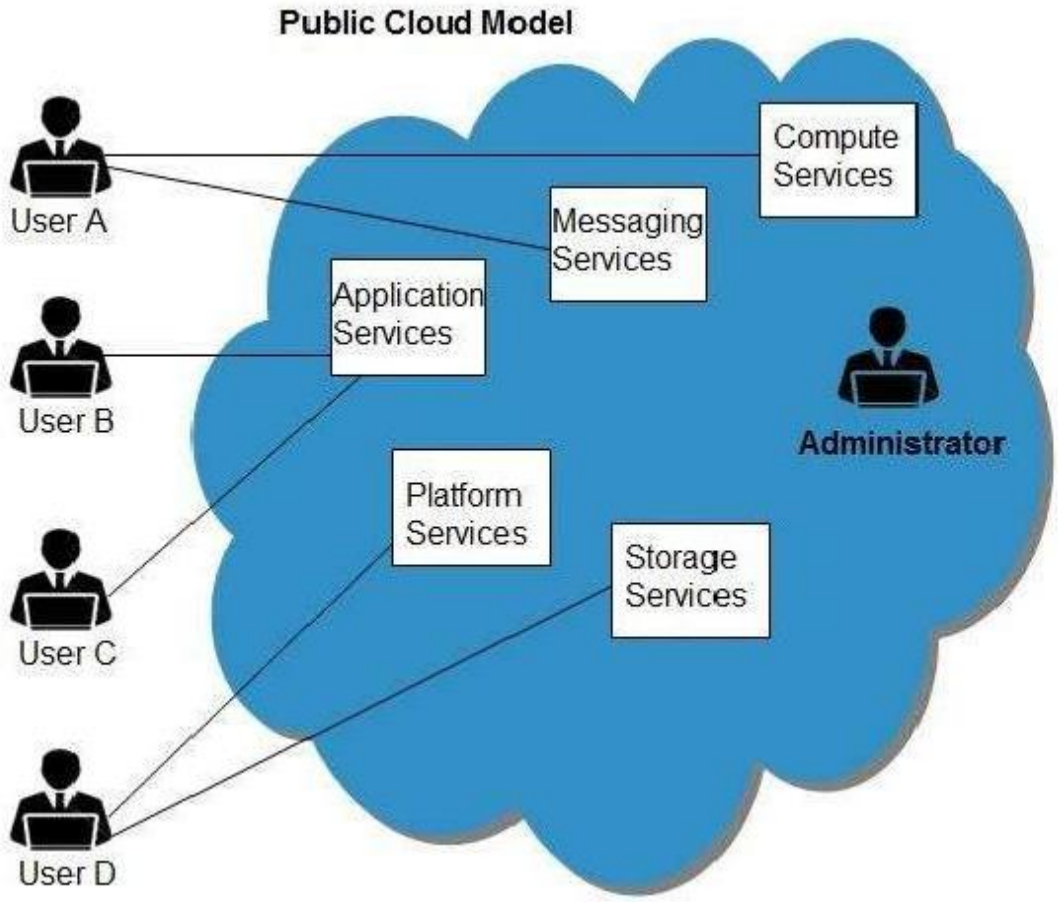
Cloud computing is more cost effective than traditional IT infrastructure due to methods of payment for the data storage services. With cloud based services, you only pay for what is used – similarly to how you pay for utilities such as electricity. Furthermore, the decreased likelihood of downtime means improved workplace performance and increased profits in the long run.

With traditional IT infrastructure, you will need to purchase equipment and additional server space upfront to adapt to business growth. If this slows, you will end up paying for resources you don't use. Furthermore, the value of physical servers decreases year on year, so the return on investment of investing money in traditional IT infrastructure is quite low.

Security

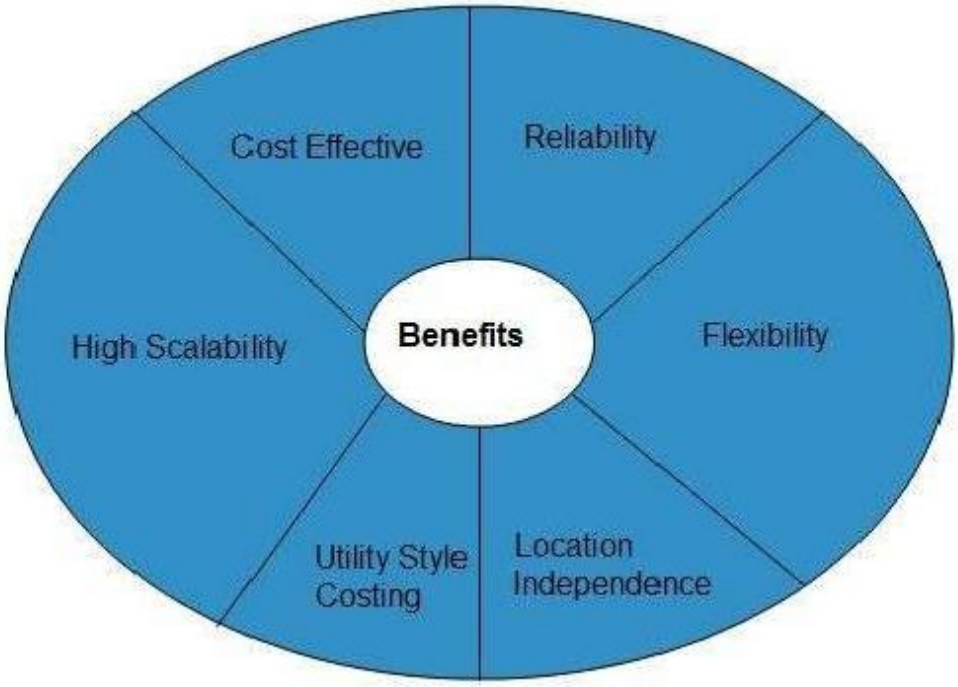
Cloud computing is an external form of data storage and software delivery, which can make it seem less secure than local data hosting. Anyone with access to the server can view and use the stored data and applications in the cloud, wherever internet connection is available. Choosing a cloud service provider that is completely transparent in its hosting of cloud platforms and ensures optimum security measures are in place is crucial when transitioning to the cloud.

Public Cloud allows systems and services to be easily accessible to general public. The IT giants such as **Google, Amazon** and **Microsoft** offer cloud services via Internet. The Public Cloud Model is shown in the diagram below.



Benefits

There are many benefits of deploying cloud as public cloud model. The following diagram shows some of those benefits:



Cost Effective

Since **public cloud** shares same resources with large number of customers it turns out inexpensive.

Reliability

The **public cloud** employs large number of resources from different locations. If any of the resources fails, public cloud can employ another one.

Flexibility

The public cloud can smoothly integrate with private cloud, which gives customers a flexible approach.

Location Independence

Public cloud services are delivered through Internet, ensuring location independence.

Utility Style Costing

Public cloud is also based on **pay-per-use** model and resources are accessible whenever customer needs them.

High Scalability

Cloud resources are made available on demand from a pool of resources, i.e., they can be scaled up or down according the requirement.

Disadvantages

- Here are some disadvantages of public cloud model:

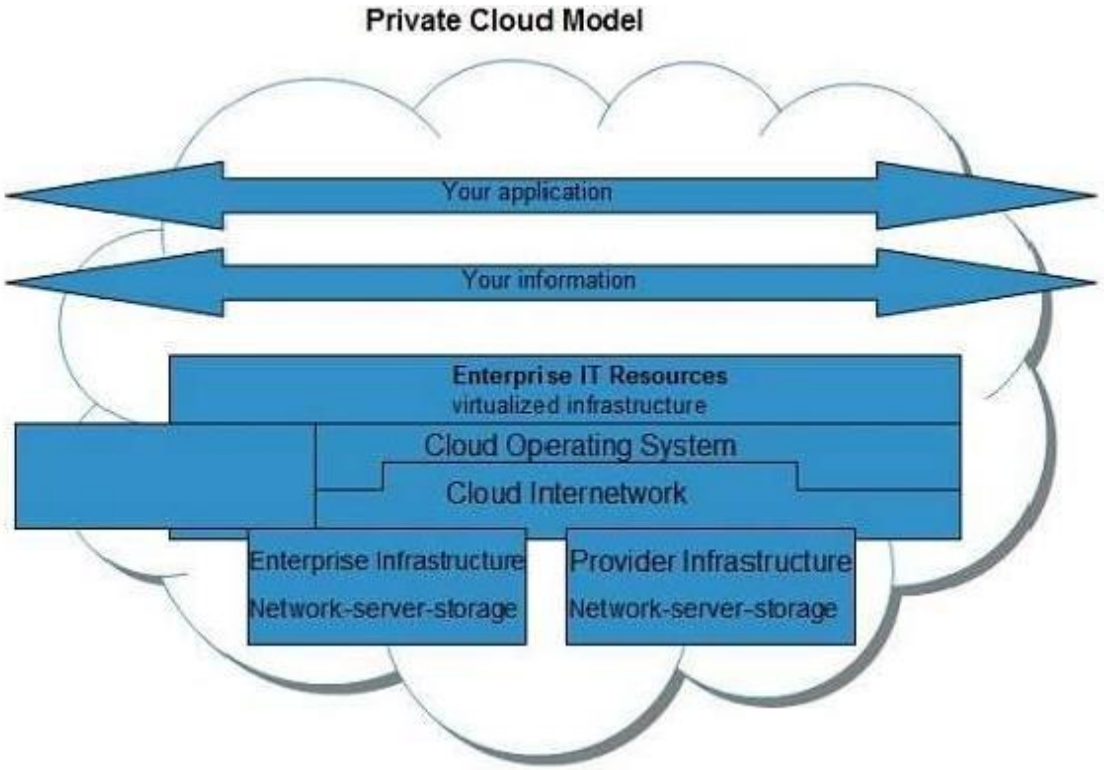
Low Security

- In **public cloud model,** data is hosted off-site and resources are shared publicly, therefore does not ensure higher level of security.

Less Customizable

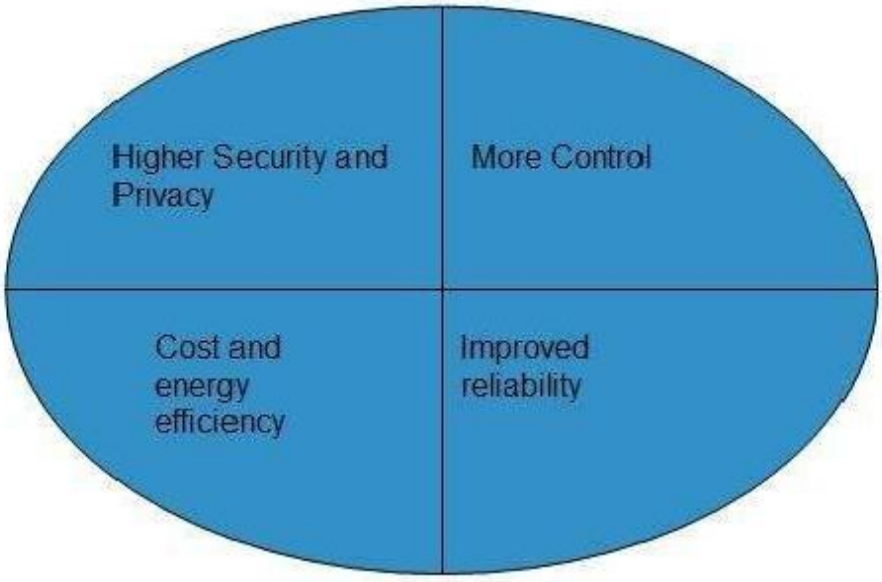
- It is comparatively less customizable than private cloud.

Private Cloud allows systems and services to be accessible within an organization. The Private Cloud is operated only within a single organization. However, it may be managed internally by the organization itself or by third-party. The private cloud model is shown in the diagram below.



Benefits

There are many benefits of deploying cloud as private cloud model. The following diagram shows some of those benefits:



High Security and Privacy

Private cloud operations are not available to general public and resources are shared from distinct pool of resources. Therefore, it ensures high **security** and **privacy.**

More Control

The **private cloud** has more control on its resources and hardware than public cloud because it is accessed only within an organization.

Cost and Energy Efficiency

The **private cloud** resources are not as cost effective as resources in public clouds but they offer more efficiency than public cloud resources.

Disadvantages

Restricted Area of Operation

- The private cloud is only accessible locally and is very difficult to deploy globally.

High Priced

- Purchasing new hardware in order to fulfill the demand is a costly transaction.

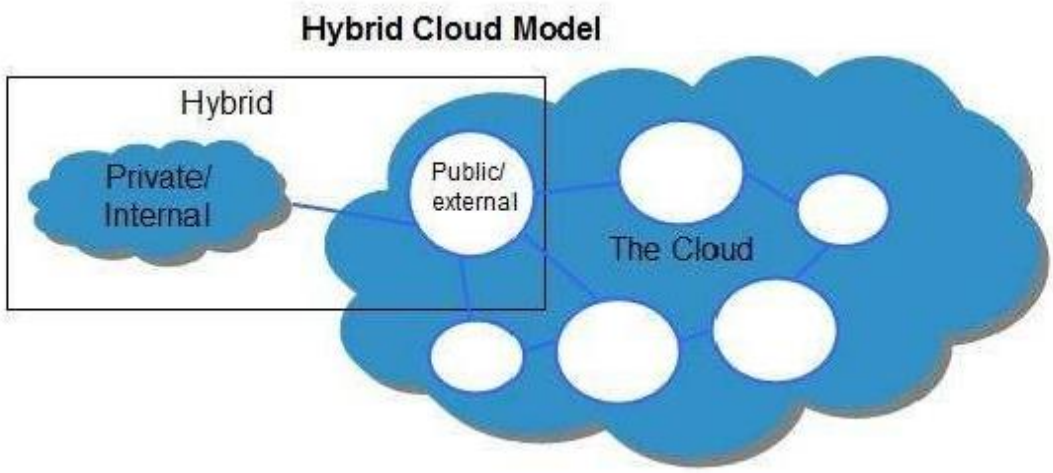
Limited Scalability

- The private cloud can be scaled only within capacity of internal hosted resources.

Additional Skills

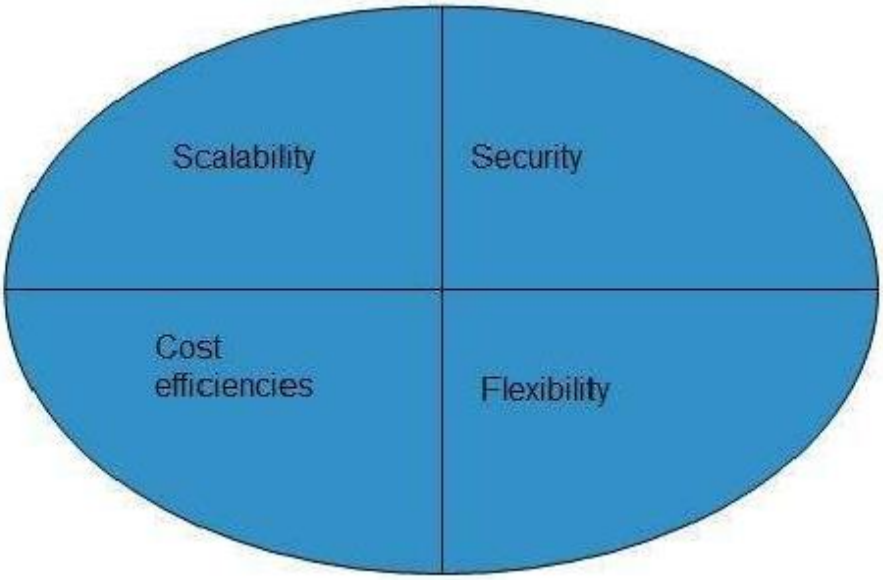
- In order to maintain cloud deployment, organization requires skilled expertise.

Hybrid Cloud is a mixture of **public** and **private** cloud. Non-critical activities are performed using public cloud while the critical activities are performed using private cloud. The Hybrid Cloud Model is shown in the diagram below.



Benefits

There are many benefits of deploying cloud as hybrid cloud model. The following diagram shows some of those benefits:



Scalability

- It offers features of both, the public cloud scalability and the private cloud scalability.

Flexibility

- It offers secure resources and scalable public resources.

Cost Efficiency

- Public clouds are more cost effective than private ones. Therefore, hybrid clouds can be cost saving.

Security

- The private cloud in hybrid cloud ensures higher degree of security.

Disadvantages

Networking Issues

- Networking becomes complex due to presence of private and public cloud.

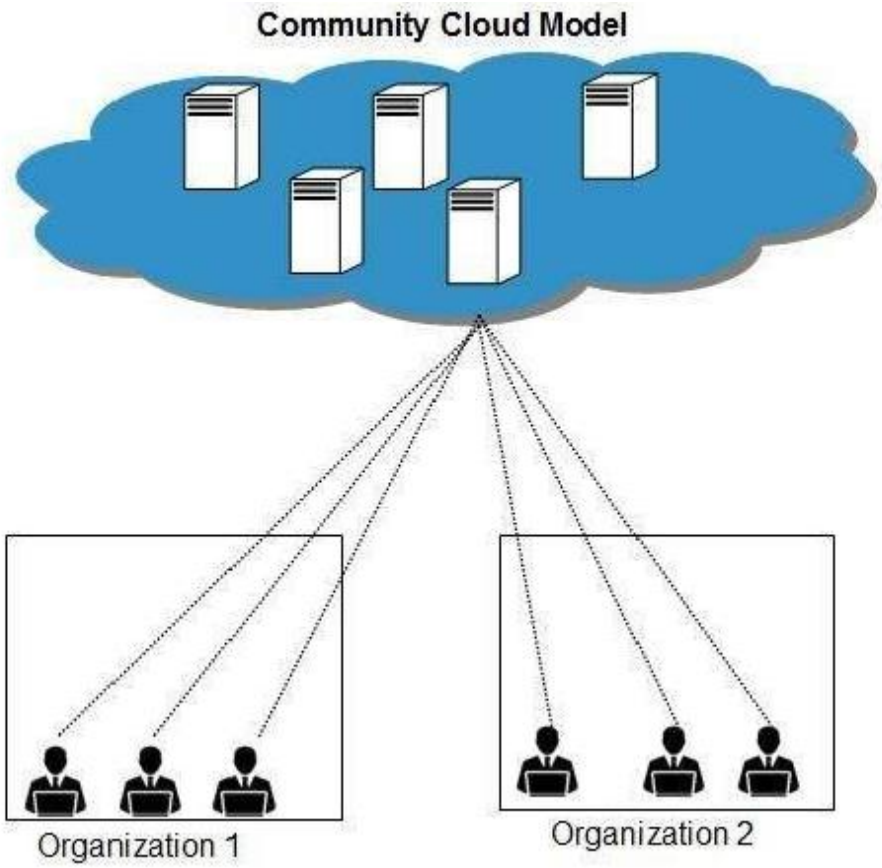
Security Compliance

- It is necessary to ensure that cloud services are compliant with security policies of the organization.

Infrastructure Dependency

- The **hybrid cloud model** is dependent on internal IT infrastructure, therefore it is necessary to ensure redundancy across data centers.

Community Cloud allows system and services to be accessible by group of organizations. It shares the infrastructure between several organizations from a specific community. It may be managed internally by organizations or by the third-party. The Community Cloud Model is shown in the diagram below.



Benefits

There are many benefits of deploying cloud as **community cloud model.**

Cost Effective

- **Community cloud** offers same advantages as that of private cloud at low cost.
- Sharing Among Organizations
- Community cloud provides an infrastructure to share cloud resources and capabilities among several organizations.

Security

- The community cloud is comparatively more secure than the public cloud but less secured than the private cloud.

Issues

- Since all data is located at one place, one must be careful in storing data in community cloud because it might be accessible to others.
- It is also challenging to allocate responsibilities of governance, security and cost among organizations.

NIST ARCHITECTURE

The NIST cloud computing reference architecture is a generic high-level conceptual model that is a powerful tool for discussing the requirements, structures, and operations of cloud computing. The model is not tied to any specific vendor products, services, or reference implementation, nor does it define prescriptive solutions that inhibit innovation. It defines a set

of actors, activities, and functions that can be used in the process of developing cloud computing architectures, and relates to a companion cloud computing taxonomy. It contains a set of views and descriptions that are the basis for discussing the characteristics, uses, and standards for cloud computing.

The NIST cloud computing reference architecture focuses on the requirements of what cloud service provides, not on a design that defines a solution and its implementation. It is intended to facilitate the understanding of the operational intricacies in cloud computing. The reference architecture does not represent the system architecture of a specific cloud computing system; instead, it is a tool for describing, discussing, and developing the system-specific architecture using a common framework of reference..

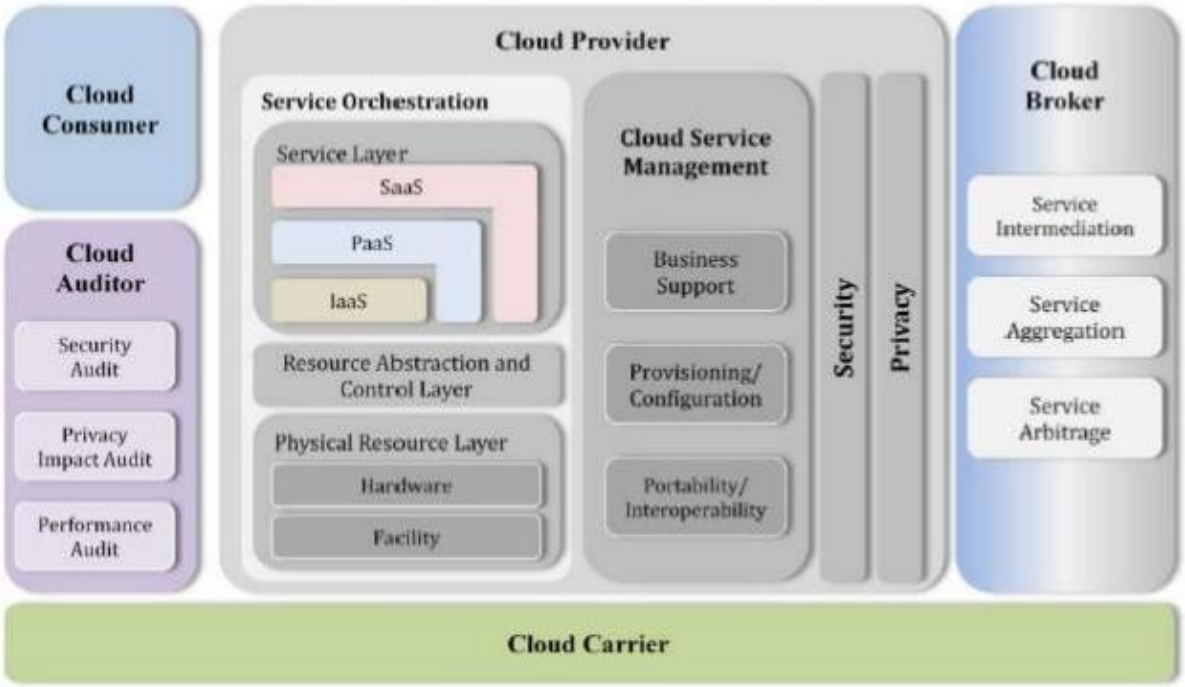
NIST working group

- Cloud Computing Target Business Use Cases
- Cloud Computing Reference Architecture and Taxonomy
- Cloud Computing Standards Roadmap
- Cloud Computing SAJACC (Standards Acceleration to Jumpstart the Adoption of Cloud Computing)
- Cloud Computing Security

Objectives

The design of the NIST cloud computing reference architecture serves the objectives to: illustrate and understand various cloud services in the context of an overall cloud computing conceptual model; provide technical references to USG agencies and other consumers to understand, discuss, categorize, and compare cloud services; and communicate and analyze

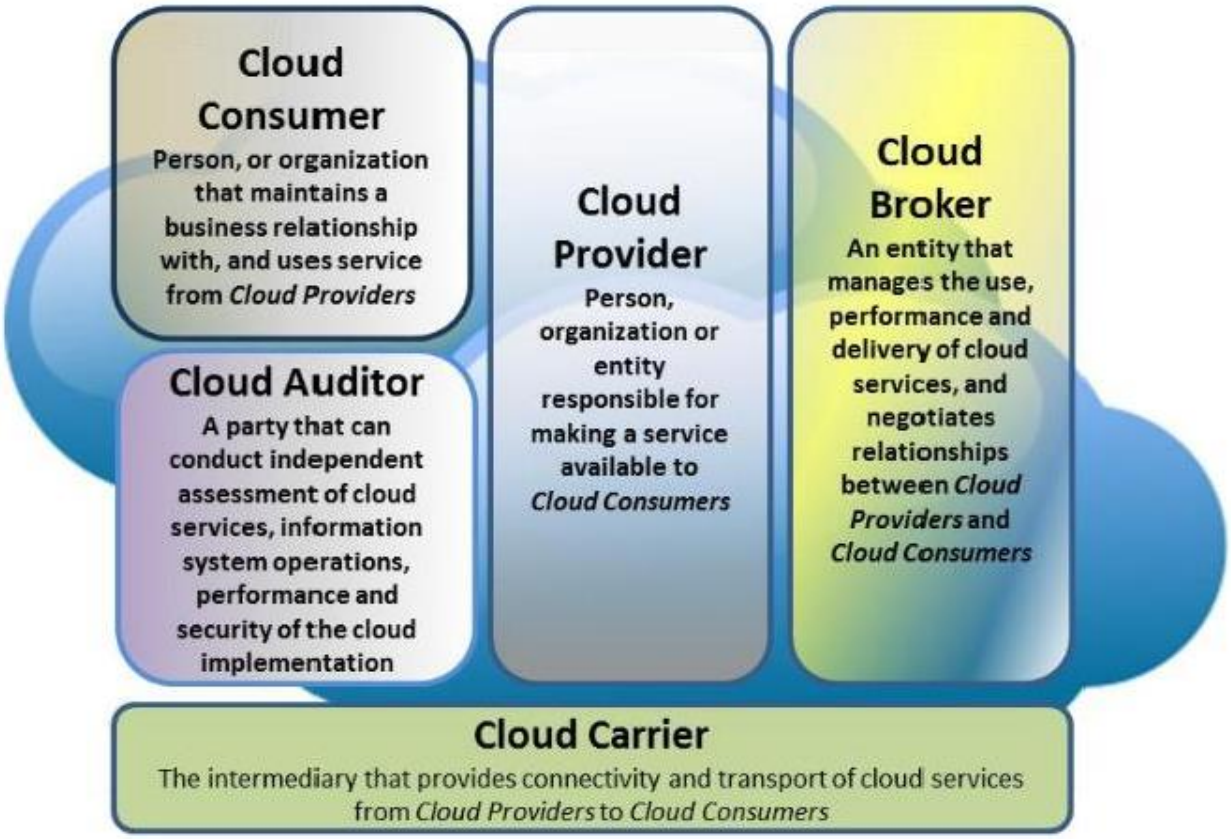
security, interoperability, and portability candidate standards and reference implementations.



Cloud Computing Reference Architecture

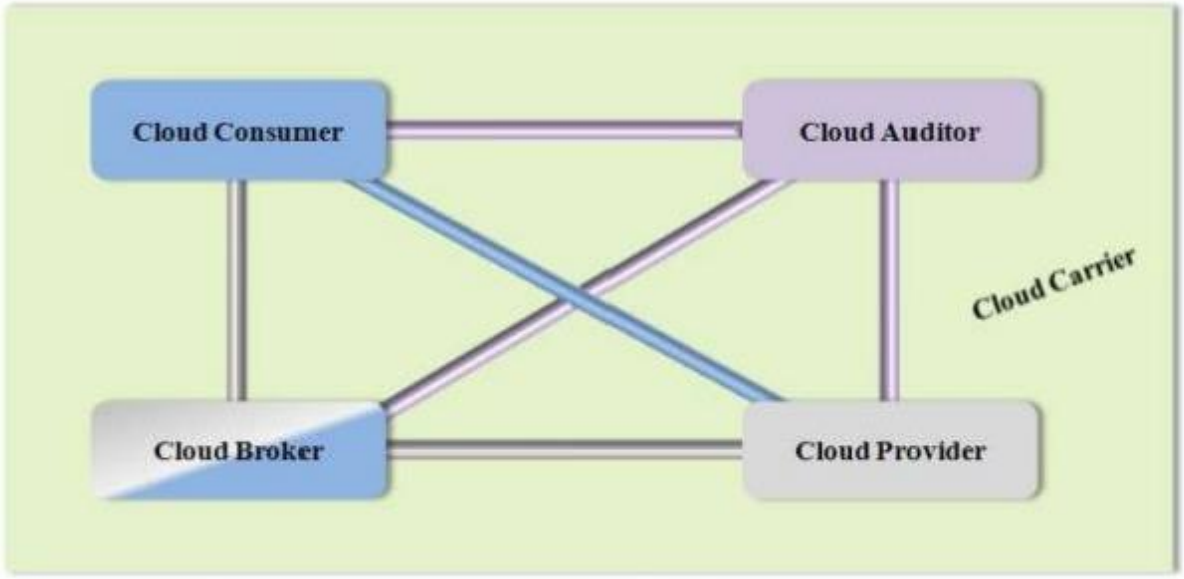
Overview

The Overview of the Reference Architecture describes five major actors with their roles and responsibilities using the newly developing Cloud Computing Taxonomy. **The NIST cloud computing reference architecture defines five major actors: cloud consumer, cloud provider, cloud auditor, cloud broker, and cloud carrier (Cloud Actors).** These core individuals have key roles in the realm of cloud computing. Each actor is an entity (a person or an organization) that participates in a transaction or process and/or performs tasks in cloud computing.



Cloud Actors

An interaction between the Actors in Cloud Computing shows the interactions among the actors in the NIST cloud computing reference architecture. A cloud consumer may request cloud services from a cloud provider directly or via a cloud broker. A cloud auditor conducts independent audits and may contact the others to collect necessary information. The details will be discussed in the following sections and be presented as successive diagrams in increasing levels of detail.



Interactions between the Actors in Cloud Computing

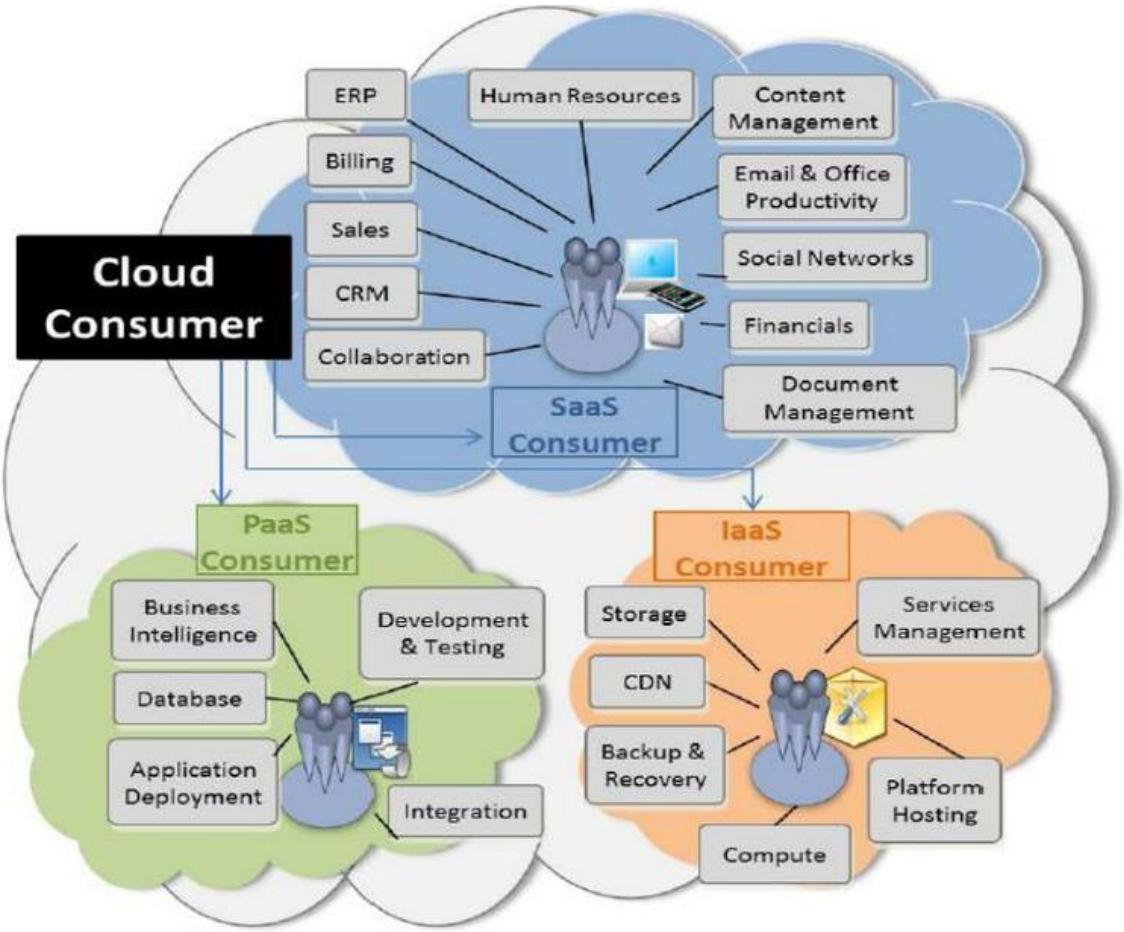
CLOUD CONSUMER

The cloud consumer is the ultimate stakeholder that the cloud computing service is created to support. A cloud consumer represents a person or organization that maintains a business relationship with, and uses the service from, a cloud provider. A cloud consumer browses the service catalog from a cloud provider, requests the appropriate service, sets up service contracts with the cloud provider, and uses the service. The cloud consumer may be billed for the service provisioned, and needs to arrange payments accordingly. Depending on the services requested, the activities and usage scenarios can be different among cloud consumers.

Service Models	Consumer Activities	Provider Activities
SaaS	Uses application/service for Business process operations.	Installs, manages, maintains, and supports the software application on a cloud Infrastructure.

PaaS	Develops, tests, deploys, and manages applications hosted in a Cloud system.	Provisions and manages cloud infrastructure and middleware for the platform consumers; provides development, deployment, and Administration tools to platform consumers.
IaaS	Creates/installs, manages, and monitors services for IT infrastructure operations	Provisions and manages the physical processing, storage, networking, and the hosting environment and cloud Infrastructure for IaaS consumers.

Cloud Consumer and Cloud Provider



Examples of Services Available to a Cloud Consumer

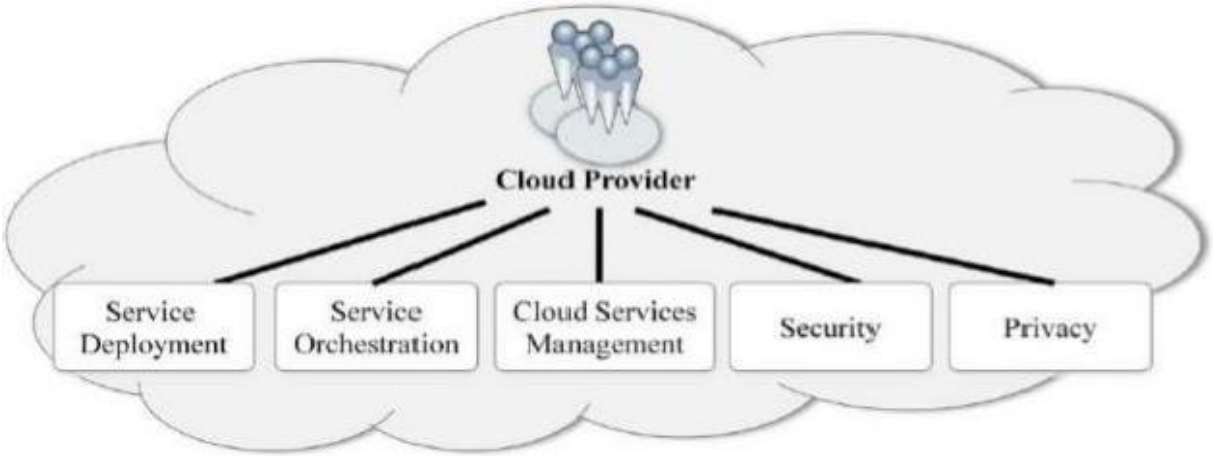
SaaS applications are usually deployed as hosted services and are accessed via a network

connecting SaaS consumers and providers. The SaaS consumers can be organizations that provide their members with access to software applications, end users who directly use software applications, or software application administrators who configure applications for end users. SaaS consumers access and use applications on demand, and can be billed on the number of consumers or the amount of consumed services. The latter can be measured in terms of the time in use, the network bandwidth consumed, or the amount/duration of data stored.

For PaaS, cloud consumers employ the tools and execution resources provided by cloud providers for the purpose of developing, testing, deploying, and managing applications hosted in a cloud system. PaaS consumers can be application developers who design and implement application software, application testers who run and test applications in various cloud systems, application deployers who publish applications into a cloud system, and application administrators who configure and monitor application performance on a platform. PaaS consumers can be billed by the number of consumers, the type of resources consumed by the platform, or the duration of platform usage.

For IaaS, consumers are provisioned with the capabilities to access virtual computers, network accessible storage, network infrastructure components, and other fundamental computing resources,on which consumers can deploy and run arbitrary software. IaaS consumers can be system developers, system administrators, and information technology (IT) managers who are interested in creating, installing, managing and monitoring services for IT infrastructure operations. IaaS consumers are provisioned with the capabilities to access these computing resources, and are billed for the amount of resources consumed.

Cloud Provider



Cloud Provider - Major Activities

A cloud provider can be a person, an organization, or an entity responsible for making a service available to cloud consumers. A cloud provider builds the requested software/platform/ infrastructure services, manages the technical infrastructure required for providing the services, provisions the services at agreed-upon service levels, and protects the security and privacy of the services. Cloud Provider: Major Activities, cloud providers undertake different tasks for the provisioning of the various service models.

For SaaS, the cloud provider deploys, configures, maintains, and updates the operation of the software applications on a cloud infrastructure so that the services are provisioned at the expected service levels to cloud consumers. The provider of SaaS assumes most of the responsibilities in managing and controlling the applications and the infrastructure, while the cloud consumers have limited administrative control of the applications.

For PaaS, the cloud provider manages the cloud infrastructure for the platform, and provisions tools and execution resources for the platform consumers to develop, test, deploy, and administer applications. Consumers have control over the applications and possibly the hosting environment settings, but cannot access the infrastructure underlying the platform including network, servers, operating systems, or storage.

For IaaS, the cloud provider provisions the physical processing, storage, networking, and other fundamental computing resources, as well as manages the hosting environment and cloud infrastructure for IaaS consumers. Cloud consumers deploy and run applications, have more control over the hosting environment and operating systems, but do not manage or control the underlying cloud infrastructure (e.g., the physical servers, network, storage, hypervisors, etc.).

The activities of cloud providers can be discussed in greater detail from the perspectives of Service Deployment, Service Orchestration, Cloud Service Management, Security and Privacy.

As identified in the NIST cloud computing definition, a cloud infrastructure may be operated in one of the following deployment models: public cloud, private cloud, community cloud, or hybrid cloud.

A public cloud is one in which the cloud infrastructure and computing resources are made available to the general public over a public network. A public cloud is owned by an organization selling cloud services and serves a diverse pool of clients.

For private clouds, the cloud infrastructure is operated exclusively for a single organization. A private cloud gives the organization exclusive access to and usage of the infrastructure and computational resources. It may be managed either by the organization or by a third party, and may be implemented at the organization's premise (i.e., on-site private clouds) or outsourced to a hosting company (i.e., outsourced private clouds).

Similar to private clouds, a community cloud may be managed by the organizations or by a third party, and may be implemented at the customer's location (i.e., on-site community cloud) or outsourced to a hosting company (i.e., outsourced community cloud). However, a community cloud serves a set of organizations that have common security, privacy, and compliance considerations, rather than serving a single organization as does a private cloud.

A hybrid cloud is a composition of two or more cloud deployment models (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability. As discussed in this section, both private clouds and community clouds can be either implemented on-site or outsourced to a third party. Therefore, each constituent cloud of a hybrid cloud can be one of the five variants.

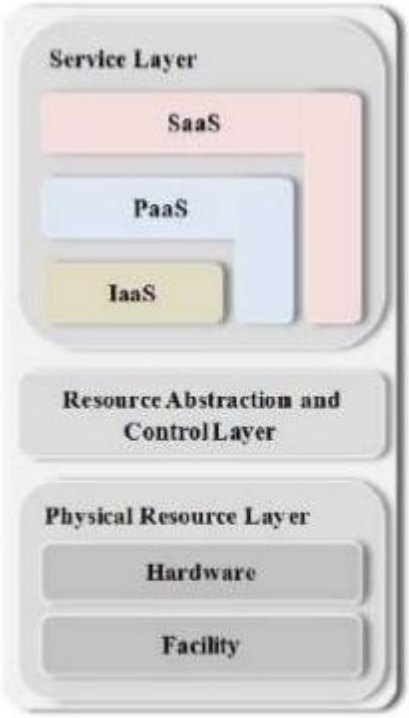
SERVICE ORCHESTRATION

Service orchestration refers to the arrangement, coordination, and management of cloud infrastructure to provide the optimizing capabilities of cloud services, as a cost-effective way of managing IT resources, as dictated by strategic business requirements.

The top layer is the service layer, where a cloud provider defines and provisions each of the three service models.

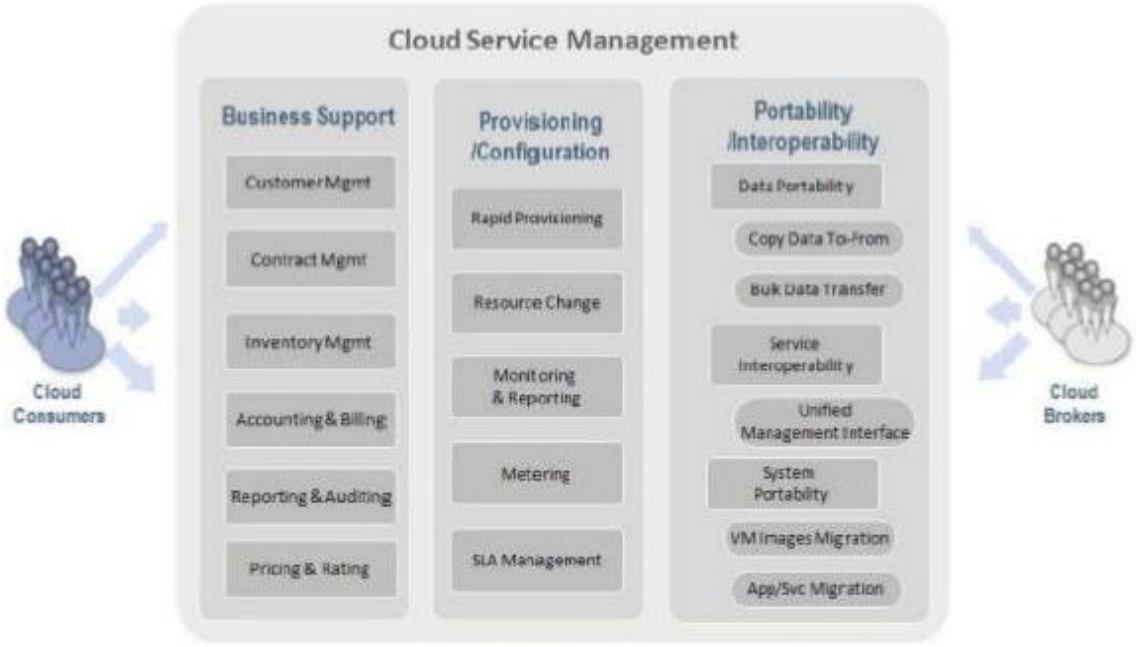
The middle layer is the resource abstraction and control layer. This layer contains the system components that a cloud provider uses to provide and manage access to the physical computing resources through software abstraction.

The lowest layer in the framework is the physical resource layer, which includes all the physical computing resources. This layer includes hardware resources, such as computers (CPU and memory), networks (routers, firewalls, switches, network links, and interfaces), storage components (hard disks), and other physical computing infrastructure elements



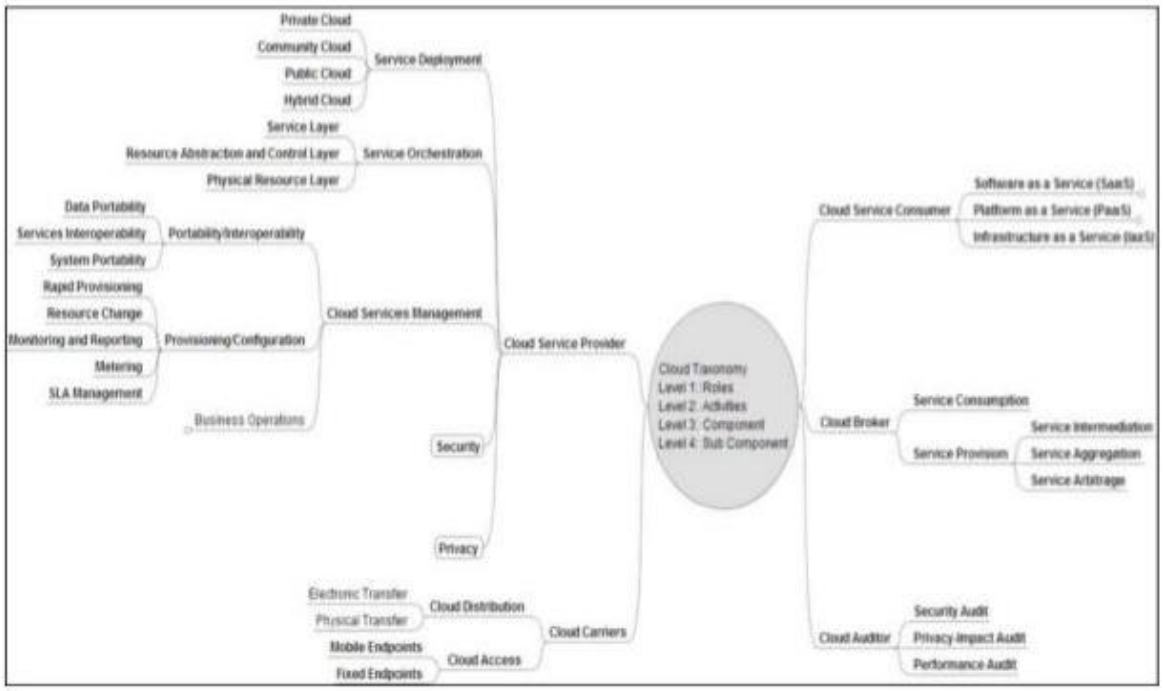
Cloud Provider - Service Orchestration

Cloud Service Management - includes all of the service-related functions that are necessary for the management and operation of those services required by or proposed to cloud consumers. cloud service management can be described from the perspective of business support, provisioning and configuration, and from the perspective of portability and interoperability requirements.



Cloud Provider - Cloud Service Management

Cloud Taxonomy



Cloud Taxonomy

POSSIBLE QUESTIONS

PART A

Q.NO 1 TO 20 (MULTIPLE CHOICE QUESTIONS)

PART B (2 MARKS)

1. State the difference between a private cloud and public cloud
2. Compare the characteristics of PaaS and SaaS.
3. What do you mean by SaaS, IaaS, PaaS?
4. Define IaaS.
5. Generalize on PaaS and SaaS..
6. What is Cloud Taxonomy?
7. What is Cloud Service Management in NIST?
8. What does Service Orchestration refer in NIST?
9. List out Cloud Provider major activities.
10. Define NIST Architecture.
11. List out the interactions actors between in cloud computing.

PART C (6 MARKS)

1. Define cloud computing. Enlist and explain different service models.
2. Describe four cloud deployment models with neat diagram and example.
3. Explain the NIST cloud computing reference architecture?
4. Explain in detail software-as- a –service. What are different advantages and disadvantages of SAAS
5. Explain in detail, different implementation level of virtualization?