

## **MODULE 1**

### **Multiple Choice Type Questions**

- 1. What is Cloud Foundry?** [WBUT 2014]  
a) a factory that produces cloud components  
b) VMware-led open source PaaS  
c) an industry wide PaaS initiative  
d) VMware-led closed source PaaS  
**Answer:** (b)
- 2. Which of the following isn't an advantage of cloud?** [WBUT 2014]  
a) no worries about running out of storage  
b) easier to maintain a cloud network  
c) immediate access to computing resources  
d) paying only for what you use  
**Answer:** (b)
- 3. What feature does not belong in a private cloud?** [WBUT 2014]  
a) metered billing b) self-service portal  
c) dial-home support d) rapid elasticity  
**Answer:** (b)
- 4. What is private cloud?** [WBUT 2014, 2018]  
a) a standard cloud service offered via the Internet  
b) a cloud architecture maintained within an enterprise data center  
c) a cloud service inaccessible to anyone but the cultural elite  
d) none of these  
**Answer:** (c)
- 5. Which of the following factors should a company consider before implementing cloud computing systems?** [WBUT 2015, 2017]  
a) user satisfaction b) potential cost reduction  
c) information sensitivity d) all of these  
**Answer:** (d)
- 6. Which of the following can cloud computing replace?** [WBUT 2015, 2017]  
a) corporate data centers b) expensive computer hardware  
c) costly software upgrade d) all of these  
**Answer:** (d)
- 7. Which of the following widely used services is built on cloud-computing technology?** [WBUT 2015, 2017]  
a) Gmail b) Twitter c) YouTube d) all of these  
**Answer:** (d)

## CLOUD COMPUTING

8. Which of the following programming language did Google include for development around App Engine?  
a) C++      b) Java      c) SQL      d) Visual Basic  
Answer: (c) [WBUT 2015]
9. Which are valid dimensions of cloud cube?  
a) Service, Deployment      b) Ownership, Sourcing  
c) Security Boundary, Portability      d) Physical Location of the data, Platform  
Answer: (d) [WBUT 2016]
10. What are the technologies that played a vital role in cloud computing?  
a) Mainframe      b) Utility Computing, Grid Computing, API  
c) Web 2.0, Virtualization, Service oriented Computing      d) Database, Super computers  
Answer: (b) [WBUT 2016]
11. An example of high performance cluster file system is  
a) vMotion      b) VMFS      c) DVS      d) NTFS  
Answer: (b) [WBUT 2016]
12. Which one of the following options is true with respect to cloud computing?  
a) Hardware should be composable      b) Software should be composable  
c) Both Hardware and Software should be composable      d) Both Hardware and Software are not required to be composable  
Answer: (d) [WBUT 2016]
13. Which of these companies is not yet a leader in cloud computing?  
a) Google      b) Amazon      c) Blackboard      d) Microsoft  
Answer: (c) [WBUT 2017]
14. What does CAAS stand for?  
a) Computing as a service      b) Compliance as a service  
c) Connection as a service      d) None of these  
Answer: (d) [WBUT 2018]
15. Which of the following is essential concept related to Cloud?  
a) Reliability      b) Productivity  
c) Abstraction      d) All of the mentioned  
Answer: (c) [WBUT 2018]
16. Which of the following is a Virtual Machine Technology now owned by Oracle that can be various operating systems?  
a) V machines      b) VirtualBox  
c) ThoughtPolice      d) none of the mentioned  
Answer: (b) [WBUT 2018]

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- 17. Which of the following is provided by Identity as a Service? [WBUT 2018]**
- a) Identity governance
  - b) Provisioning
  - c) Risk and event monitoring
  - d) All of the mentioned

**Answer:** (d)

## **Short & Long Answer Type Questions**

- 1. What are the advantages and disadvantages of cloud computing? [WBUT 2014]**

**Answer:**

***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, the company is handing over the data and information. For companies who have an in-house IT staff, they will be unable to handle issues on their own.

**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 one may not receive every feature or customization he or she wants. Before signing up, companies must make sure that they know what their cloud service provider offers.

**Dependency and vendor lock-in:** One of the major disadvantages of cloud computing is the implicit dependency on the provider. This is what the industry calls "vendor lock-in" since it is difficult, and sometimes impossible, to migrate from a provider once the company has rolled with him. If a user wishes to switch to some other provider, then can be really painful and cumbersome to transfer huge data from the old provider to the new one.

## CLOUD COMPUTING

**No Redundancy:** A cloud server is not redundant nor is it backed up. As technology may fail here and there, one must try to 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.

### **2. How does cloud computing differ from grid computation and pervasive computation?** [WBUT 2014]

**Answer:**

Cloud computing refers to a client server architecture where typically the servers (called "the cloud") reside remotely and are accessed via the internet, usually via a web browser. Applications like word processors that have traditionally run locally or on a server and accessed via a dumb terminal are instead run on the remote servers and accessed via a web browser. The same goes for services, such as file storage. Often, the servers are run by a third party and host a set of applications for a variety of clients. One example is Google Docs. Microsoft and Amazon have similar offerings, as do many others.

Grid computing refers to a distributed computing architecture where a set of networked computers ("the grid", typically PCs) are utilized en masse for large computational tasks, typically ones that are embarrassingly parallel. For example, a bank might use such a network to price all their holdings each night. From the point of view of the application doing the calculations, it's just submitting a large number of independent jobs to the grid, and receives the results back. The grid infrastructure handles forwarding each job to a computer, balancing loads, etc.

Pervasive computing: Pervasive means ubiquitous which means "existing everywhere". Through the concept, computing is made to appear everywhere and anywhere. In contrast to desktop computing, ubiquitous computing can occur using any device, in any location, and in any format. A user interacts with the computer, which can exist in many different forms, including laptop computers, tablets and terminals in everyday objects such as a fridge or even a pair of glasses. Pervasive computing goes past the arena of desktops so that virtually any device, from apparel to kitchen appliances, could be embedded with microchips, connecting these devices to a boundless network of other gadgets.

### **3. What is the difference between scalability and elasticity?**

[WBUT 2014]

**Answer:**

In cloud computing, scalability is the ability on the part of software or hardware to continue to function at a high level of performance, even when the workflow volume increases. In addition to functioning well, the scaled up application should be able to take full advantage of the resources that its new environment offers. For example, if an application is scaled from a smaller operating system to a larger one should be able to handle a larger workload and offer better performance as the resources become available. Scalability usually refers to adding resources and performance. On the other hand, elasticity generally means the opposite – scaling down capacity or resources as they are no longer needed. In both cases, there is one common theme: adaptability. A cloud service that is both scalable and elastic is an adaptable solution. An adaptable cloud

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environment is one that allows the IT department to expand or contract capacity as needed in response to an ever changing business environment.

**4. Explain NIST model with diagram.**

[WBUT 2014]

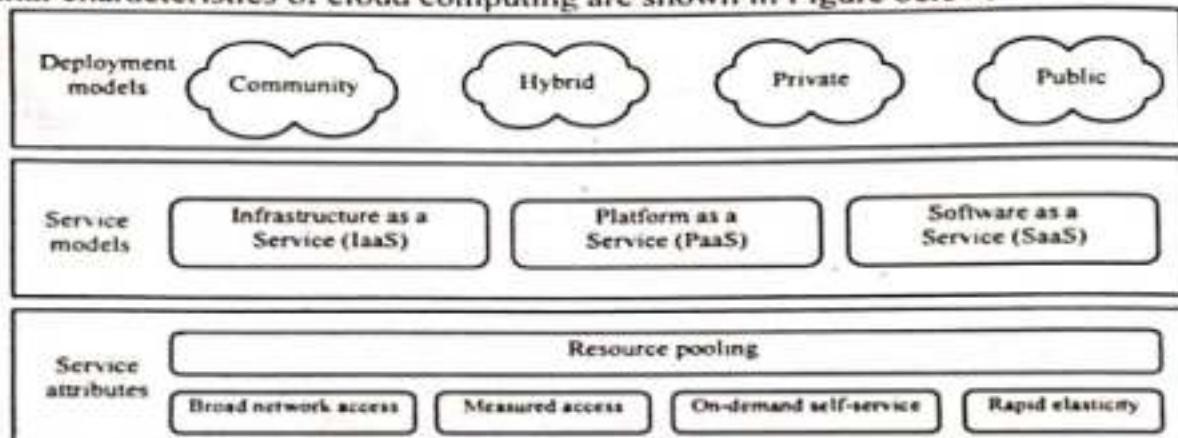
**Write about NIST Model.**

**OR,**

[WBUT 2018]

**Answer:**

The United States government is a major consumer of computer services and, therefore, one of the major users of cloud computing networks. The U.S. National Institute of Standards and Technology (NIST) has a set of working definitions (<http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc>) that separate cloud computing into service models and deployment models. Those models and their relationship to essential characteristics of cloud computing are shown in Figure below.



**5. What are the behavioral factors relating to cloud adoption?**

[WBUT 2014]

**Answer:**

A number of intrinsic properties of cloud computing create cognitive biases in people that are obstacles to cloud adoption and are worth mentioning. This goes for users as well as organizations. Harper Collins (2008) explores how people often make choices that are inconsistent based on expediency or human nature. Joe Weinman has expanded on these ideas and some others to formulate ten more 'laws' for cloud computing adoption based on human behavior.

The '10 laws of Behavioral Cloudonomics' are summarized below.

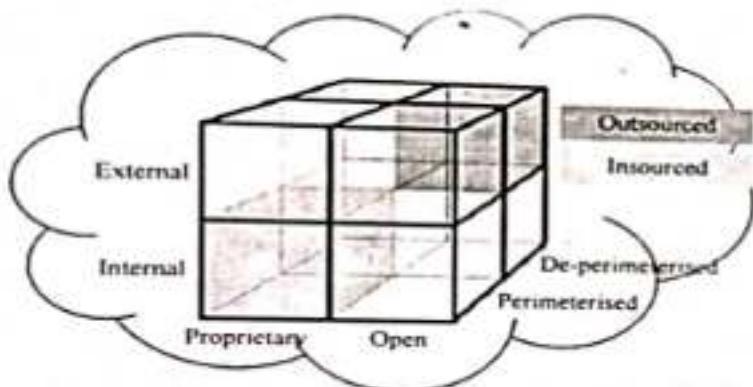
1. People are risk averse and loss averse.
2. People have a flat-rate bias.
3. People have the need to control their environment and remain anonymous.
4. People fear change.
5. People value what they own more than what they are given.
6. People favor the status quo and invest accordingly.
7. People discount future risk and favor instant gratification.
8. People favor things that are free.

9. People have the need for status.
10. People are incapacitated by choice.

**Q. a) Explain previously Jericho Forum's Cloud Cube model with diagram.  
b) Briefly explain deployment models for cloud computing? [WBUT 2014]**

**Answer:**

a) It is understood that cloud computing offers a huge potential for scalability, at almost immediate availability and low cost. Business managers are requiring IT operations to assess the risks and benefits this computing model represents. The Jericho Forum, an international independent group of information security leaders have added their input as to how to collaborate securely in the clouds. The Jericho Cloud Cube Model describes the multidimensional elements of cloud computing, framing not only cloud use cases, but also how they are deployed and used.



**The Cloud Cube Model**

#### **The Cloud Cube**

The Jericho Forum has identified four criteria to differentiate cloud formations from each other and the manner of their provision. The Cloud Cube Model effectively summarizes these four dimensions:

1. Internal/External
2. Proprietary/Open
3. Perimeterised/De-perimeterized Architectures
4. Insourced/Outsourced

#### **Dimension 1: Internal/External**

This dimension defines the physical location of the data; where does the cloud form exist - inside or outside organization boundaries? If the cloud form is within the organization's physical boundaries, then it is internal. If it is outside the organization's physical boundaries, then it's external. It's important to note that the assumption that internal is necessarily more secure than external is false. The most secure usage model is the effective use of both internal and external cloud forms.

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### **Dimension 2: Proprietary/Open**

This dimension defines the state of ownership of the cloud technology, services, interfaces, etc. It indicates the degree of interoperability, as well as enabling data/application transportability between an organization's own systems and other cloud forms and the ability to withdraw the data from a cloud form, or to move it to another without constraint. This dimension indicates any constraints on being able to share apps. "Proprietary" suggests that the organization providing the service is keeping the means of provision under its ownership. By contrast, "open" clouds use technology that is not proprietary, which means that there are likely to be more suppliers, and the organization is not as constrained in terms of ability to share data and collaborate with selected parties. Experts suggest that open clouds most effectively enhance collaboration between multiple organizations.

### **Dimension 3: Perimeterised/De-perimeterised Architectures**

"Perimeterised" suggest a system that continues to operate within the traditional IT perimeter, often characterized by "network firewalls." This approach is known to inhibit collaboration. Operating within such areas means extending an organization's perimeter into the external cloud computing domain via a VPN and operating the virtual server in its own IP domain. The organization uses its own directory services to control access. Once the computing task is complete, the perimeter is withdrawn to its original, traditional position.

"De-perimeterised" suggests that the system perimeter is designed following the principles outlined in the Jericho Forum's Commandments and Collaboration Oriented Architectures Framework. De-perimeterised areas in the Cloud Cube Model use both internal and external domains, but the collaboration or sharing of data should not be seen as internal or external. Rather, it is controlled by and limited to the parties that the using organizations select.

### **Dimension 4: Insourced/Outsourced**

This dimension has two states in each of the eight cloud forms. It responds to the question: who does the business want running the clouds? "Outsourced" means that the service is provided by a third party. Insourced means that the service is provided by the own staff under its control. These states describe the party managing the delivery of the cloud service(s) used by the organization.

**b)** The cloud isn't a technology. It's more of an approach to building IT services - an approach that harnesses the power of servers, as well as virtualization technologies that combine servers into large computing pools and divide single servers into multiple virtual machines. And there are several different deployment models for implementing cloud technology.

The four primary types of cloud models are:

- Public
- Private
- Hybrid
- Community

## CLOUD COMPUTING

Each has its advantages and disadvantages with significant implications for any organization researching or actively considering a cloud deployment.

### *Public Cloud*

A public cloud is a cloud computing model in which services, such as applications and storage, are available for general use over the Internet. Public cloud services may be offered on a pay-per-usage mode or other purchasing models. An example of a public cloud is IBM's Blue Cloud.

### *Private Cloud*

A private cloud is a virtualized data center that operates within a firewall. Private clouds are highly virtualized, joined together by mass quantities of IT infrastructure into resource pools, and privately owned and managed.

### *Hybrid Cloud*

A hybrid cloud is a mix of public and private clouds.

### *Community Cloud*

A community cloud is an infrastructure shared by several organizations which supports a specific community.

7. What is IaaS?

[WBUT 2014]

OR,

Explain what is meant by Identity as a service.

[WBUT 2016]

OR,

Write about identity as a service?

[WBUT 2018]

Mention the characteristics of IaaS.

[WBUT 2014]

Explain modern implementation of SaaS using SOA components.

[WBUT 2014]

OR,

Describe through a schematic diagram and necessary explanations how XML and SOA are used to implement an Open SaaS environment.

[WBUT 2017]

Answer:

Infrastructure as a Service (IaaS) is a cloud computing service model in which hardware is virtualized in the cloud. In this particular model, the service vendor owns the equipment: servers, storage, network infrastructure, and so forth. The developer creates virtual hardware on which to develop applications and services.



The developer interacts with the IaaS model to create virtual private servers, virtual private storage, virtual private networks, and so on, and then populates these virtual systems with the applications and services it needs to complete its solution. In IaaS, the virtualized resources are mapped to real systems. When the client interacts with an IaaS

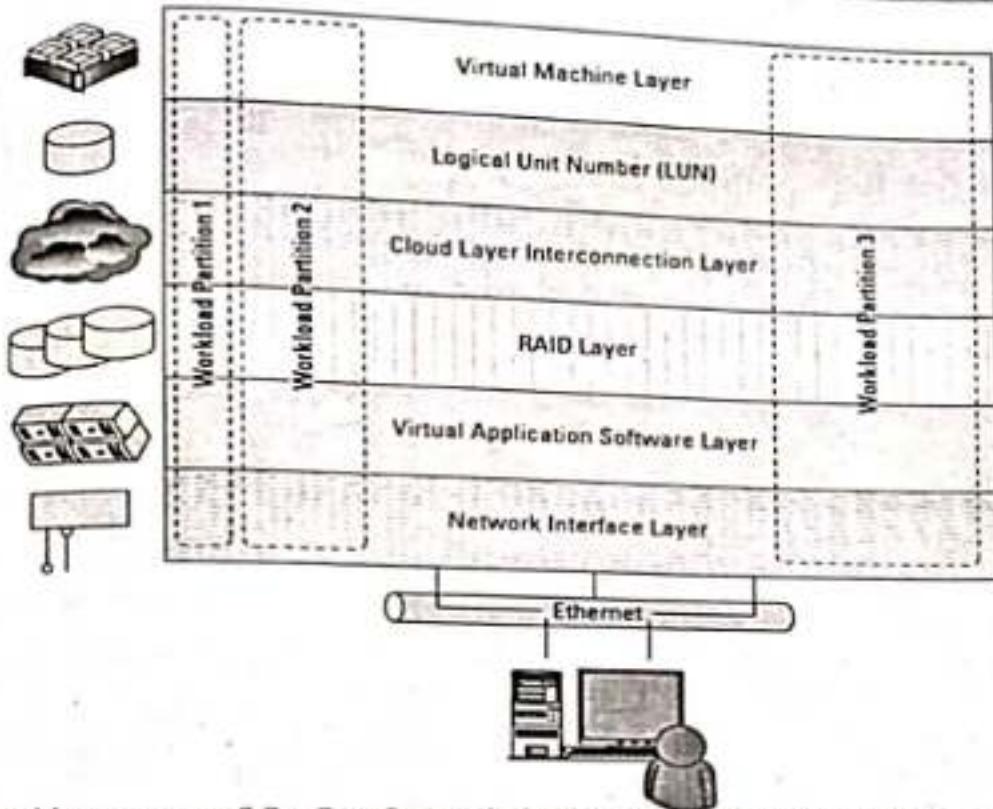
## **POPULAR PUBLICATIONS**

service and requests resources from the virtual systems, those requests are redirected to the real servers that do the actual work.

**Workload:** The fundamental unit of virtualized client in an IaaS deployment is called a *workload*. A workload simulates the ability of a certain type of real or physical server to do an amount of work.

In addition to throughput, a workload has certain other attributes such as Disk I/Os measured in Input/Output Per Second IOPS, the amount of RAM consumed under load in MB, network throughput and latency, and so forth. In a hosted application environment, a client's application runs on a dedicated server inside a server rack or perhaps as a standalone server in a room full of servers. In cloud computing, a provisioned server called an instance is reserved by a customer, and the necessary amount of computing resources needed to achieve that type of physical server is allocated to the client's needs. Figure below shows how three virtual private server instances are partitioned in an IaaS stack. The three workloads require three different sizes of computers: small, medium, and large. A client would reserve a machine equivalent required to run each of these workloads. The IaaS infrastructure runs these server instances in the data center that the service offers, drawing from a pool of virtualized machines, RAID storage, and network interface capacity. These three layers are expressions of physical systems that are partitioned as logical units. LUNs, the cloud interconnect layer, and the virtual application software layer are logical constructs. LUNs are logical storage containers, the cloud interconnect layer is a virtual network layer that is assigned IP addresses from the IaaS network pool, and the virtual application software layer contains software that runs on the physical VM instance(s) that have been partitioned from physical assets on the IaaS private cloud.

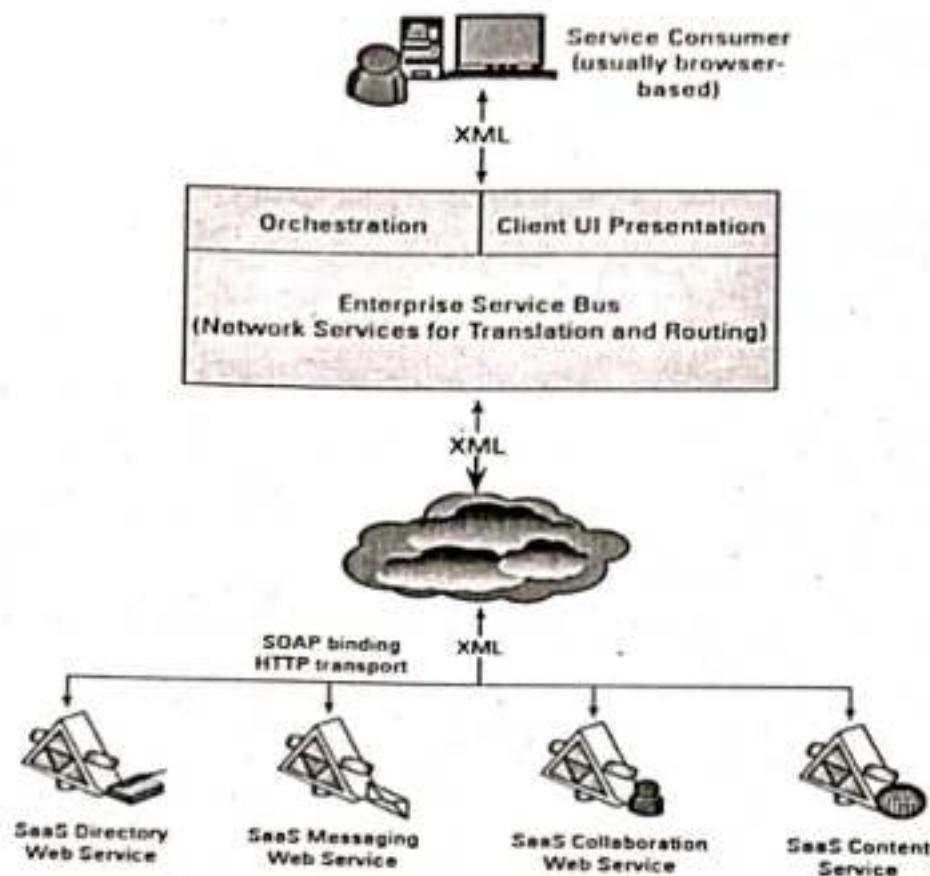
## CLOUD COMPUTING



A considerable amount of SaaS software is based on open source software. When open source software is used in a SaaS, it is referred to as *Open SaaS*. The advantages of using open source software are that systems are much cheaper to deploy because one doesn't have to purchase the operating system or software, there is less vendor lock-in, and applications are more portable. The popularity of open source software, from Linux to APACHE, MySQL, and Perl (the LAMP platform) on the Internet, and the number of people who are trained in open source software make Open SaaS an attractive proposition. The impact of Open SaaS will likely translate into better profitability for the companies that deploy open source software in the cloud, resulting in lower development costs and more robust solutions.

A modern implement of SaaS using an Enterprise Service Bus and architected with SOA components.

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**8. Clean-and-Green Energy, a power generation and distribution company, has decided to deploy cloud-based solutions for two crucial customer-facing systems namely,**

- (i) Real-time Load Management  
(ii) Online Consumer Billing

**Discuss, in brief, the advantages / disadvantages of both systems with cloud environment.**

[WBUT 2011]

**Answer:**

**i) Real-time Load Management:**

It is highly possible to implement real time load management in cloud environment with IaaS. The advantages of moving private data center infrastructure to the cloud are: Scaling an externally facing application of service. Two key benefits of IaaS are easy and rapid scaling and global distribution. Smaller companies without excess IT capacity can enhance and scale an existing customer-facing application delivered out of an external data center. For example, a regional online travel agent can expand into new markets from its transaction processing application's primary base. Since the application in this example was built on Microsoft SQL Server, it was relatively easy to lift and shift

Azure, Microsoft's hosted cloud infrastructure. Moving to IaaS and properly scaling infrastructure tripled performance, with an additional 50% gain projected from future upgrades.

Consumer-facing marketing content. For consumer product manufacturers and retailers, the company website is often the most important way to reach customers and influence buying decisions. Websites must be dynamic, engaging and snappy, no matter where the customer is located — qualities that make them good candidates for IaaS deployment. Many consumer-facing sites use popular content management systems such as Wordpress, Joomla or Drupal along with custom code, all of which work well on cloud infrastructure. These systems are easily deployed using rebuild packages or recipes and scale as needed.

**Disaster recovery backup sites.** Disaster recovery is one of the classic infrastructure as a service examples. Smaller organizations might not have a secondary location for DR at all, in which case IaaS could save the company in a cataclysmic event. In other situations, the backup site is outfitted with old, surplus equipment that's undersized, seldom tested and at its end of life. IaaS can provide on-demand capacity equivalent to that in the main data center with no capital expenditure (Capex) on equipment. Even large enterprises with multiple regional data centers can exploit IaaS as a secondary location in each region — preventing costly, performance-sapping failovers to distant facilities.

### **Disadvantages:**

**Legacy systems.** Applications that are tightly integrated with legacy business systems and processes, where a move to IaaS could prove highly disruptive, should stay in house. Most enterprises rely on a plethora of largely static legacy applications, often in maintenance mode and sometimes highly customized, that run business-critical systems. The risk-reward ratio of changing a stable, working implementation is far too high to consider a cloud deployment.

Some organizations also prefer to keep systems with sensitive data, particularly customer and financial information, in a controlled data center. Extending the appropriate server and network security controls into the cloud, while feasible, can be complicated.

**Costly cloud instances.** It can also be prudent to pull IaaS-resident applications on to an owned infrastructure should they grow to the point where the monthly costs are well over \$10,000. In this example, IaaS operating expenditures are more expensive than the Capex and Opex involved to build and operate the requisite infrastructure in house. This case is particularly true if the application workload is relatively stable and unlikely to need dynamic capacity.

### **i) Online customer billing:**

#### *Benefits of choosing cloud based billing software*

##### **L No special equipment required.**

All the client needs in order to use online billing software is a computer with an Internet connection. Most of them works well on a Mac or PC, even tablets. Such software is hosted on a secure server, so the data stays safe, too.

## **POPULAR PUBLICATIONS**

### **2. No software to install, it's all done for the client.**

Once the data is converted from the old system, all the client need to do is sign in to the cloud's secure website. They don't have to spend hours installing a program on multiple computers or don't have to worry if it's compatible with existing operating system. Almost all cloud based online billing software integrates with every meter reading system on the market.

### **3. Never worry about computer crashes losing data.**

In all cases, the cloud based online software will perform complete back-ups of all customer data every single hour. All of data will be immediately accessible anywhere, anytime and by anyone with given access.

#### ***Disadvantages:***

***Not Foolproof:*** Regardless of which online bill paying method is selected, clients have to pay attention to monthly statements and changing circumstances. It is easy to lose track of things after completing the one-time set up.

***Payee beware:*** Consumers should check their account balances to make sure the financial service actually issued payment on time. Also, consumers must monitor their vendor account balances to make sure that electronic payments are credited to their accounts without incurring late fees, financial experts recommend.

**9. Explain, in brief, what 'multi-tenancy' is in the context of SaaS.  
Mention three significant characteristics of a typical SaaS solution.**

[WBUT 2015]

**OR,**

**What is Software-as-a-Service (SaaS) and what are the main characteristics of a SaaS solution?**

[WBUT 2017]

**Answer:**

**1<sup>st</sup> Part:**

The most complete cloud computing service model is one in which the computing hardware and software, as well as the solution itself, are provided by a vendor as a complete service offering. It is referred to as the Software as a Service (SaaS) model. SaaS provides the complete infrastructure, software, and solution stack as the service offering. Software as a Service (SaaS) may be succinctly described as software that is deployed on a hosted service and can be accessed globally over the Internet, most often in a browser. Every computer user is familiar with SaaS systems, which are either replacements or substitutes for locally installed software.

Examples of SaaS software for end-users are Google Gmail and Calendar, QuickBooks online, Zoho Office Suite, and others that are equally well known. SaaS applications come in all shapes and sizes, and include custom software such as billing and invoicing systems, Customer Relationship Management (CRM) applications, Help Desk applications, Human Resource (HR) solutions, as well as myriad online versions of familiar applications. Many people believe that SaaS software is not customizable, and in many SaaS applications this is indeed the case. However, many other SaaS solutions expose Application Programming Interfaces (API) to developers to allow them to create custom composite applications. These APIs may alter the security model used, the data

schema, workflow characteristics, and other fundamental features of the service's expression as experienced by the user. Examples of an SaaS platform with an exposed API are Salesforce.com and Quicken.com. So SaaS does not necessarily mean that the software is static or monolithic.

**Part:**

All Software as a Service (SaaS) application share the following characteristics:

1. The software is available over the Internet globally through a browser on demand.
2. The typical license is subscription-based or usage-based and is billed on a recurring basis.
3. In a small number of cases a flat fee may be charged, often coupled with a maintenance fee.
4. The software and the service are monitored and maintained by the vendor, regardless of where all the different software components are running. There may be executable client-side code, but the user isn't responsible for maintaining that code or its interaction with the service.
5. Reduces installation and maintenance costs and minimal end-user system costs generally make SaaS applications cheaper to use than their shrink-wrapped versions.
6. Such applications feature automated upgrades, updates, and patch management and much faster rollout of changes.
7. SaaS applications often have a much lower barrier to entry than their locally installed competitors, a known recurring cost, and they scale on demand (a property of cloud computing in general).
8. All users have the same version of the software so each user's software is compatible with another's.
9. SaaS supports multiple users and provides a shared data model through a single-instance, multi-tenancy model.

**10. With respect to the NIST Reference Model of Cloud Computing, explain the following with suitable schematic and examples:**

- i) Essential Characteristics  
ii) Service Models

[WBUT 2015]

[WBUT 2015, 2017]

OR,

Explain the different Cloud Service Models used with examples of products using these service models.

- iii) Deployment Models.

[WBUT 2015]

OR,

What are the essential characteristics of the different service models and the various deployment models as per the NIST Reference Model of Cloud Computing? Describe with suitable examples.

[WBUT 2017]

Compare the three service models of Cloud Computing, using suitable examples and explanations.

[WBUT 2017]

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### **Answer:**

#### **i) Essential Characteristics:**

The salient characteristics of cloud computing based on the definitions provided by the National Institute of Standards and Terminology (NIST) are outlined below:

- **On-demand self-service:** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
- **Broad network access:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).
- **Resource pooling:** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location-independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data center). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
- **Rapid elasticity:** Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- **Measured service:** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be managed, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

#### **ii) Service Models:**

Service delivery in Cloud Computing comprises three different service models, namely Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). The three service models or layer are completed by an end user layer that encapsulates the end user perspective on cloud services. If a cloud user accesses services on the infrastructure layer, for instance, she can run her own applications on the resources of a cloud infrastructure and remain responsible for the support, maintenance, and security of these applications herself. If she accesses a service on the application layer, these tasks are normally taken care of by the cloud service provider.

Three service types have been universally accepted:

- **Infrastructure as a Service:** IaaS provides virtual machines, virtual storage, virtual infrastructure, and other hardware assets as resources that clients can provision. The IaaS service provider manages all the infrastructure, while the client is responsible for all other aspects of the deployment. This can include the operating system, applications, and user interactions with the system.

- **Platform as a Service:** PaaS provides virtual machines, operating systems, applications, services, development frameworks, transactions, and control structures. The client can deploy its applications on the cloud infrastructure or use applications that were programmed using languages and tools that are supported by the PaaS service provider. The service provider manages the cloud infrastructure, the operating systems, and the enabling software. The client is responsible for installing and managing the application that it is deploying.
- **Software as a Service:** SaaS is a complete operating environment with applications, management, and the user interface. In the SaaS model, the application is provided to the client through a thin client interface (a browser, usually), and the customer's responsibility begins and ends with entering and managing its data and user interaction. Everything from the application down to the infrastructure is the vendor's responsibility.

iii) **Deployment Models:**

*Refer to Question No. 4 & 6(b) of Short & Long Answer Type Questions..*

11. Explain the concept of IaaS and SaaS. Use suitable examples and/or appropriate schematic diagrams to help establish your understanding.

[WBUT 2015]

**Answer:**

**IaaS:** *Refer to Question No. 7 of Short & Long Answer Type Questions.*

**SaaS:**

The most complete cloud computing service model is one in which the computing hardware and software, as well as the solution itself, are provided by a vendor as a complete service offering. It is referred to as the Software as a Service (SaaS) model. SaaS provides the complete infrastructure, software, and solution stack as the service offering. Software as a Service (SaaS) may be succinctly described as software that is deployed on a hosted service and can be accessed globally over the Internet, most often in a browser. Every computer user is familiar with SaaS systems, which are either replacements or substitutes for locally installed software.

Examples of SaaS software for end-users are Google Gmail and Calendar, QuickBooks online, Zoho Office Suite, and others that are equally well known. SaaS applications come in all shapes and sizes, and include custom software such as billing and invoicing systems, Customer Relationship Management (CRM) applications, Help Desk applications, Human Resource (HR) solutions, as well as myriad online versions of familiar applications. Many people believe that SaaS software is not customizable, and in many SaaS applications this is indeed the case. However, many other SaaS solutions expose Application Programming Interfaces (API) to developers to allow them to create custom composite applications. These APIs may alter the security model used, the data schema, workflow characteristics, and other fundamental features of the service's expression as experienced by the user.

Examples of an SaaS platform with an exposed API are Salesforce.com and Quicken.com. So SaaS does not necessarily mean that the software is static or monolithic.

## POPULAR PUBLICATIONS

12. a) Discuss three main advantages and two major disadvantages of cloud computing with suitable examples.  
b) Describe key parameters used in a typical Cloud Service Level Agreement.

[WBUT 2015]

**Answer:**

**a) Advantages of Cloud Computing**

- **Cost Savings:** Perhaps, the most significant cloud computing benefit is in terms of IT cost savings. Businesses, no matter what their type or size, exist to earn money while keeping capital and operational expenses to a minimum. With cloud computing, one can save substantial capital costs with zero in-house server storage and application requirements. The lack of on-premises infrastructure also removes their associated operational costs in the form of power, air conditioning and administration costs. Clients pay for what is used and disengage whenever clients like - there is no invested IT capital to worry about. It's a common misconception that only large businesses can afford to use the cloud, when in fact, cloud services are extremely affordable for smaller businesses.
- **Reliability:** With a managed service platform, cloud computing is much more reliable and consistent than in-house IT infrastructure. Most providers offer a Service Level Agreement which guarantees 24/7/365 and 99.99% availability. The organization can benefit from a massive pool of redundant IT resources, as well as quick failover mechanism - if a server fails, hosted applications and services can easily be transited to any of the available servers.
- **Manageability:** Cloud computing provides enhanced and simplified IT management and maintenance capabilities through central administration of resources, vendor managed infrastructure and SLA backed agreements. IT infrastructure updates and maintenance are eliminated, as all resources are maintained by the service provider. Clients enjoy a simple web-based user interface for accessing software, applications and services – without the need for installation - and an SLA ensures the timely and guaranteed delivery, management and maintenance of IT services.

**Disadvantages:**

- **Downtime:** As cloud service providers take care of a number of clients each day, they can become overwhelmed and may even come up against technical outages. This can lead to business processes being temporarily suspended. Additionally, if the internet connection is offline, one will not be able to access any of his applications, server or data from the cloud.
- **Security:** Although cloud service providers implement the best security standards and industry certifications, storing data and important files on external service providers always opens up risks. Using cloud-powered technologies means one will need to provide service provider with access to important business data. Meanwhile, being a public service opens up cloud service providers to security challenges on a routine basis. The ease in procuring and accessing cloud services can also give nefarious users the ability to scan, identify and exploit loopholes and vulnerabilities within a system. For instance, in a multi-tenant cloud architecture where multiple

users are hosted on the same server, a hacker might try to break into the data of other users hosted and stored on the same server. However, such exploits and loopholes are not likely to surface, and the likelihood of a compromise is not great.

- **Vendor Lock-In:** Although cloud service providers promise that the cloud will be flexible to use and integrate, switching cloud services is something that hasn't yet completely evolved. Organizations may find it difficult to migrate their services from one vendor to another. Hosting and integrating current cloud applications on another platform may throw up interoperability and support issues. For instance, applications developed on Microsoft Development Framework (.Net) might not work properly on the Linux platform.

b) A service-level agreement (SLA) is a contract between a service provider and its internal or external customers that documents what services the provider will furnish. SLAs originated with network service providers, but are now widely used by telecommunication service providers and cloud computing service providers. Corporate IT organizations, particularly those that have embraced IT service management (ITSM), enter SLAs with their in-house customers (users in other departments within the enterprise). An IT department creates an SLA so that its services can be measured, justified and perhaps compared with those of outsourcing vendors.

SLAs measure the service provider's performance and quality in a number of ways. Some metrics that SLAs may specify include:

- Availability and uptime – the percentage of the time services will be available
- The number of concurrent users that can be served
- Specific performance benchmarks to which actual performance will be periodically compared
- Application response time
- The schedule for notification in advance of network changes that may affect users
- Help desk response time for various classes of problems
- Usage statistics that will be provided.

In addition to establishing performance metrics, an SLA may include a plan for addressing downtime and documentation for how the service provider will compensate customers in the event of a contract breach. SLAs, once established, should be periodically reviewed and updated to reflect changes in technology and the impact of any new regulatory directives (changes to the PCI DSS standard, for instance).

**13. Define cloud computing. Explain different service models of cloud with [WBUT 2016]**

**Answer:**

**I<sup>th</sup> Part:**

Concept wise, cloud computing is a technology that allows users to access and use shared data and computing services via the Internet or a Virtual Private Network using a scalable range of resources without having to build infrastructure to support these resources within their own environments or networks. It uses special hardware and software to deliver a

## **POPULAR PUBLICATIONS**

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. Gmail users can access files and applications hosted by Google via the internet from any device.

**2<sup>nd</sup> Part: Refer to Question No. 10(ii) of Short & Long Answer Type Questions.**

**14. A small sized enterprise is contemplating an email solution for their employees. What are the reasons you would suggest a cloud computing solution or a traditional solution?** [WBUT 2016]

**Answer:**

**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.

**15. What are the two different kinds of cloud service offerings by Google?**

[WBUT 2016]

**Answer: Refer to Question No. 10 of Short & Long Answer Type Questions.**

**16. Write a brief note on cloud ecosystem along with examples.**

[WBUT 2016]

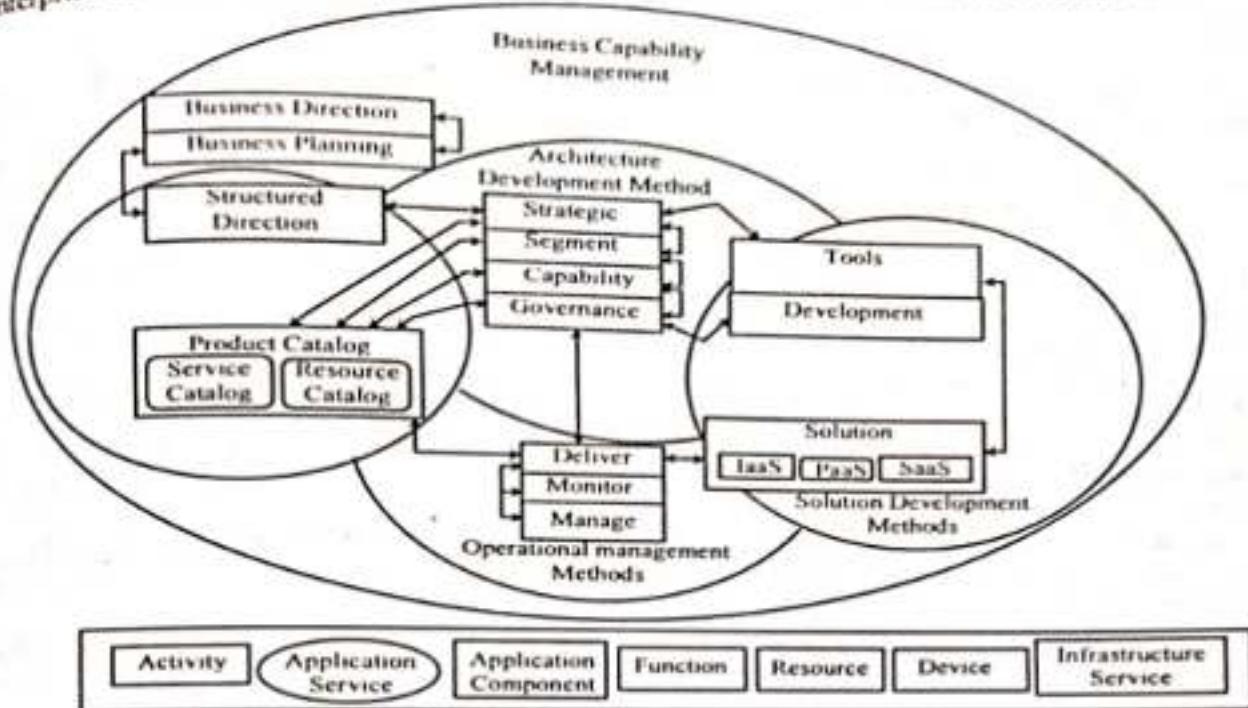
**Answer:**

The Cloud Ecosystem Reference Model serves as an abstract foundation for the instantiations of architectures and business solutions of an enterprise. It defines a flexible and agile collaborative enterprise Cloud Ecosystem. It also provides for an effective digital customer experience for sharing business information securely regardless of its underlying data location.

The Cloud Ecosystem Reference Model ensures consistency and applicability of Cloud Services within a wide variety of Enterprise Architecture management frameworks. Figure 1 describes the relationships and dependencies between the various enterprise

## CLOUD COMPUTING

frameworks to manage the life cycle of Cloud Services utilizing the Architecture Building Blocks (ABBs) identified in the Cloud Ecosystem Reference Model to deliver enterprise business solutions.



The Cloud Ecosystem Reference Model defines the major actors and their relationships and a minimum set of ABBs. The model describes the architectural capabilities to be realized and facilitated by at least one of the new or existing participants of an enterprise Cloud Ecosystem. The model establishes a common language for the various participants of an enterprise Cloud Ecosystem that supports the validations of Cloud Service Providers' solutions to achieve architectural integrity of business solutions of an enterprise.

### 17. What is the difference between traditional data centres and cloud? [WBUT 2016]

**Answer:**

The main difference between a cloud and a data center is that a cloud is an off-premise form of computing that stores data on the Internet, whereas a data center refers to on-premise hardware that stores data within an organization's local network. While cloud services are outsourced to third-party cloud providers who perform all updates and ongoing maintenance, data centers are typically run by an in-house IT department. Although both types of computing systems can store data, as a physical unit, only a data center can store servers and other equipment. As such, cloud service providers use data centers to house cloud services and cloud-based resources. For cloud-hosting purposes, vendors also often own multiple data centers in several geographic locations to safeguard

## **POPULAR PUBLICATIONS**

data availability during outages and other data center failures. For companies considering whether or not to use cloud computing versus staying with or building their own data center, there are three primary factors affecting their decision: their business needs, data security and system costs.

### **18. Discuss the business benefits involved in cloud architecture. [WBUT 2017]**

**Answer:**

**The several of the business benefits of using cloud computing:**

#### **No Need to Rip-And-Replace**

Cloud computing environments can run on existing hardware infrastructures. Businesses can make the switch from traditional to cloud computing without any costly upgrades or additions to existing infrastructure

#### **Reduce Your Costs**

Cloud computing environments enable businesses to scale their compute and storage needs up on an as-needed basis, which can keep costs low. Additionally, the cloud architecture moves IT spending from capital to operating expenditures, which makes it easier on the books and simpler to justify. Costs are directly aligned with a business' usage, so they're also easy to predict.

#### **Automation Provides Agility**

An agile business is a successful business, and agility is gained from high levels of automation. Cloud computing services are designed to be heavily automated and self-provisioning, giving end-users the ability to quickly scale their needs up and down without any manual intervention. Businesses have the ability to more quickly respond to customer demands, which improves service and responsiveness.

#### **Applications are Portable**

When designed properly, cloud computing offers the benefit of portable applications. Business applications and data can be moved from traditional computing infrastructure to the cloud and back again without any difficulty, giving businesses flexibility in how they use and manage applications and data. They can get the best of both traditional and cloud environments.

### **19. What is Identity-as a Service (IDaaS), and what are its core functions? Describe how user identity is authenticated and resource authorization is enforced in a typical IDaaS scenario. [WBUT 2017]**

**Answer:**

**1<sup>st</sup> Part: Refer to Question No. 24(b) of Short & Long Answer Type Questions.**

#### **2<sup>nd</sup> part:**

Identity as a Service or IDaaS is typically packaged as a subscription-based and remotely managed service, with an infrastructure that's hosted and maintained by a third-party service provider in the cloud.

The service itself offers authentication, user validation, oversight, and management of user privileges and access controls for corporate systems. The cloud provider may also offer to host software applications on a subscription basis, and to allow subscribers access

to specific applications or virtual desktops, based on their job titles and access rights within a company's network hierarchy.

User identity can be done through Single sign-on (SSO) which is an identification mechanism which many organizations put in place, for convenience and efficiency. It requires users to sign in only once, at the network perimeter / first login stage. If they're successfully validated by the system, they can then go on to have access to whichever of the enterprise resources, applications, and network privileges that they've been authorized to use.

Adaptive multi-factor authentication is a type of resource authorization and validation mechanism which requires users to submit multiple identifiers (such as passwords, PIN numbers, smart cards, digital tokens, or biometric characteristics), before they can gain access to a system or network. Multi-factor authentication is generally accepted as being more secure than systems which rely on a single identifier, such as a password or PIN.

**20. What is Cloud Computing? What are the advantages and limitations of cloud computing?** [WBUT 2018]

**Answer:**

**1<sup>st</sup> Part:**

Concept wise, cloud computing is a technology that allows users to access and use shared data and computing services via the Internet or a Virtual Private Network using a scalable range of resources without having to build infrastructure to support these resources within their own environments or networks. It uses special 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. Gmail users can access files and applications hosted by Google via the internet from any device.

**2<sup>nd</sup> Part: Refer to Question No. 1 of Short & Long Answer Type Questions.**

**21. What are the difference between Private Cloud and Public Cloud?** [WBUT 2018]

**Answer:**

**Refer to Question No. 6(b) of Short & Long Answer Type Questions.**

**22. What are the differences between Vertical Scalability and Horizontal Scalability?** [WBUT 2018]

**Answer:**

In cloud computing, one of the biggest features is the ability to scale. There are different ways to accomplish scaling, which is a transformation that enlarges or diminishes. One is vertical scaling and the other is horizontal scaling.

Vertical scalability refers to the ability of increasing the capacity of existing hardware or software by adding resources. In the case of vertical-scaling, the data resides on a single node. Scaling here is done through multi-core by spreading the load between the CPU and RAM resources.

## **POPULAR PUBLICATIONS**

Horizontal scalability essentially involves adding machines in the pool of existing resources. Horizontal-scaling is often based on partitioning of the data in which each node contains only part of the data. Horizontal scalability can be achieved with the help of clustering, distributed file system, load – balancing.

**23. What are the concepts about IaaS, PaaS and SaaS? Explain each with appropriate schematic diagram with example. [WBUT 2018]**

**Answer:**

**IaaS (Infrastructure as a service):** IaaS only delivers cloud infrastructure to organizations. It includes servers, networking, and storage through virtualization. These servers provide through API or dashboards to the client. IaaS handle all the servers and storage through virtual data center in the cloud. IaaS clients have to implement their own operating system, not only that in fact they have to access middleware, data, runtimes and applications.

**Features:**

- IaaS is a most flexible cloud computing model
- It is highly scalable
- Resources are available as a service
- Provides complete control of the infrastructure to organization.

**PaaS (Platform as a service):** PaaS is a cloud computing service which provides framework to application or other developers. In this developers can develop or customize the software or applications. It makes the development, testing or deployment of software easy, fast and cost- effective. Delivery is similar as SAAS mode, there is a little difference i.e. it provides the platform to create software or application where as SAAS delivers the software on the internet. Developers can easily develop his software or application in PAAS. It provides all components and developer has not need to take worry about infrastructure, server, software updates or operating system.

**Features:**

- Allows easy migration to the hybrid
- Greatly reduce the amount of coding
- Web services and databases are integrated
- PaaS provides many services to assist with the development, testing and deployment of apps.

**SaaS (Software as a service):** It is also known as application services. This service is most commonly used for business in cloud computing. SaaS uses web application and these applications are managed by the third party vendor and its interface is accessed on the client's side. SaaS makes all things easy for clients because it eliminates the installation of operating system and run application on computers. Everything will be managed by the vendors: application, data, middleware, runtime, operating system and infrastructure.

**Features**

- It reduces the time and money which consumes in installing operating system, hardware and managing software.
- It is managed from central location
- It is accessible over the internet,
- It is hosted on remote server.



24. Write short notes on the following:

- Chromium OS
- IdaaS
- Hybrid Cloud
- Cloud Cube Model of Cloud Computing

[WBUT 2014]

[WBUT 2014]

[WBUT 2014]

[WBUT 2015, 2017]

**Answer:**

**a) Chromium OS:**

Chromium OS is an open-source project that aims to build an operating system that provides a fast, simple, and more secure computing experience for people who spend most of their time on the web. At its core, Chrome is a variation of LINUX, and it is a much smaller OS that consumes almost no disk space, especially when compared to Windows. Chrome runs on x86-based computers, as well as those with ARM processors and the user interface looks much like the Chrome browser. Unlike a traditional OS, there is no need to install device drivers that let the computer work with other hardware. In Chrome, users use Google's Cloud Print service, which lets them print from any computer to any printer that's connected to the Internet.

**b) IdaaS:**

Identity as a Service provides an easy mechanism for integrating identity services into individual applications with minimal development effort. This is done by allowing the identification logic and storage of an identity's attributes to be maintained externally. IDaaS applications may be separated from other distributed security systems by their compliance with SOA standards. Therefore, cloud computing IDaaS applications must

## **POPULAR PUBLICATIONS**

rely on a set of developing industry standards to provide interoperability. The following are among the more important of these services:

- **User centric authentication (usually in the form of information cards):** The OpenID and CardSpace specifications support this type of data object.
- **The XACML Policy Language:** This is a general-purpose authorization policy language that allows a distributed ID system to write and enforce custom policy expressions. XACML can work with SAML; when SAML presents a request for ID authorization, XACML checks the ID request against its policies and either allows or denies the request.
- **The SPML Provisioning Language:** This is an XML request/response language that is used to integrate and interoperate service provisioning requests. SPML is a standard of OASIS's Provision Services Technical Committee (PSTC) that conforms to the SOA architecture.
- **The XDAS Audit System:** The Distributed Audit Service provides accountability for users accessing a system, and the detection of security policy violations when attempts are made to access the system by unauthorized users or by users accessing the system in an unauthorized way.

### **c) Hybrid Cloud:**

Hybrid cloud is a cloud computing environment which uses a mix of on-premises, private cloud and public cloud services with orchestration between the two platforms. By allowing workloads to move between private and public clouds as computing needs and costs change, hybrid cloud gives businesses greater flexibility and more data deployment options.

For example, an enterprise can deploy an on-premises private cloud to host sensitive or critical workloads, but use a third-party public cloud provider, such as Google compute engine to host less-critical resources, such as test and development workloads. To hold customer-facing archival and backup data, a hybrid cloud could also use Amazon Simple Storage Service.

Hybrid cloud is particularly valuable for dynamic or highly changeable workloads. For example, a transactional order entry system that experiences significant demand spikes around the holiday season is a good hybrid cloud candidate. The application could run in private cloud, but use cloud bursting to access additional computing resources from a public cloud when computing demands spike. To connect private and public cloud resources, this model requires a hybrid cloud environment.

Another hybrid cloud use case is big data processing. A company, for example, could use hybrid cloud storage to retain its accumulated business, sales, test and other data, and then run analytical queries in the public cloud, which can scale to support demanding distributed computing tasks.

### **d) Cloud Cube Model of Cloud Computing:**

*Refer to Question No. 6(a) of Short & Long Answer Type Questions.*

## CLOUD COMPUTING

### **25. a) What is a cloud?**

**Answer:**

The "cloud" is a set of different types of hardware and software that work collectively to deliver many aspects of computing to the end-user as an online service.

**[MODEL QUESTION]**

### **b) What is a Cloud Platform?**

**Answer:**

A "cloud platform" is a particular type of resource the users can use as part of their overall approach to cloud computing. Cloud platforms provide various services that can be used immediately to address specific business needs, or configured to create content applications, all within a browser. Cloud platforms offer numerous time- and cost-saving advantages over on-premises content management software systems while providing much greater adaptability, allowing the user to evolve and refine the system as needs change.

**[MODEL QUESTION]**

### **26. Why are organizations interested in cloud computing? [MODEL QUESTION]**

**Answer:**

Cloud computing can significantly reduce the cost and complexity of owning and operating computers and networks. If an organization uses a cloud provider, it does not need to spend money on information technology infrastructure, or buy hardware or software licences. Cloud services can often be customized and flexible to use, and providers can offer advanced services that an individual company might not have the money or expertise to develop.

### **27. What are the Benefits of Cloud Computing?**

**[MODEL QUESTION]**

**Answer:**

1. **Achieve economies of scale** – increase volume output or productivity with fewer people. The cost per unit, project or product plummets-everything is minimised.
2. **Reduce spending on technology infrastructure:** Maintain easy access to the information with minimal upfront spending. One can pay as one goes (weekly, quarterly or yearly), based on demand.
3. **Globalize the workforce on the cheap:** People worldwide can access the cloud, provided they have an Internet connection.
4. **Streamline processes.** The companies can get more work done in less time with less people.
5. **Reduce capital costs:** There's no need to spend big money on hardware, software or licensing fees.
6. **Improve accessibility:** The companies have access anytime, anywhere, making life so much easier!
7. **Monitor projects more effectively:** The business can stay within budget and ahead of completion cycle times.
8. **Less personnel training is needed:** It takes fewer people to do more work on a cloud, with a minimal learning curve on hardware and software issues.

## **POPULAR PUBLICATIONS**

9. **Minimize licensing new software:** The companies can stretch and grow without the need to buy expensive software licenses or programs.
10. **Improve flexibility:** The business can change direction without serious "people" or "financial" issues at stake

### **28. What is composability and what are the benefits?**

**[MODEL QUESTION]**

**Answer:**

Applications built in the cloud often have the property of being built from a collection of components, a feature referred to as composability. A composable system uses components to assemble services that can be tailored for a specific purpose using standard parts.

A composable component must be:

- **Modular:** It is a self-contained and independent unit that is cooperative, reusable, and replaceable.
- **Stateless:** A transaction is executed without regard to other transactions or requests.

Although cloud computing doesn't require that hardware and software be composable, it is a highly desirable characteristic from a developer or user's standpoint, because it makes system design easier to implement and solutions more portable and interoperable. Some of the benefits of composable systems are:

- Easier to assemble systems
- Cheaper system development
- More reliable operation
- A larger pool of qualified developers
- A logical design methodology

### **29. What is cloud infrastructure?**

**[MODEL QUESTION]**

**Answer:**

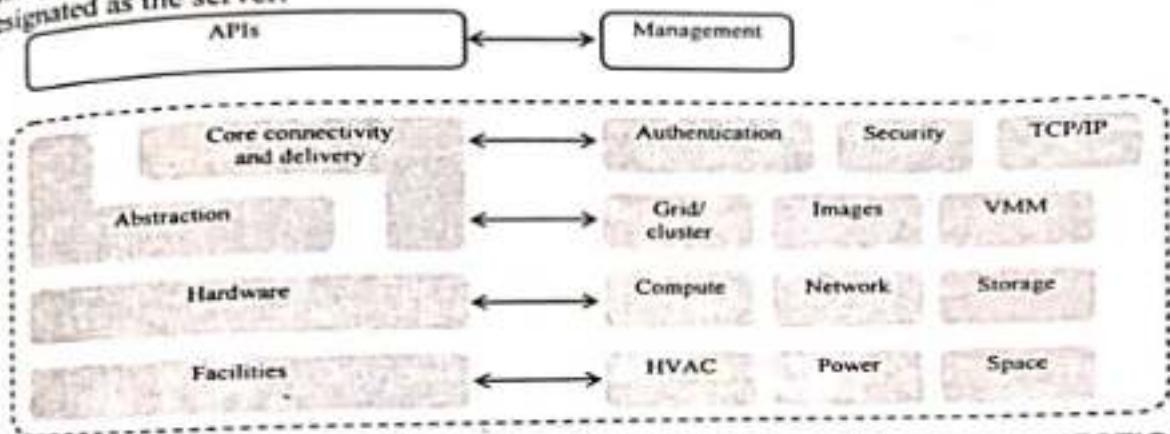
Most large Infrastructure as a Service (IaaS) providers rely on virtual machine technology to deliver servers that can run applications. Virtual servers can be described in terms of real servers that are responsible for delivering a certain number of microprocessor (CPU) cycles, memory access, and network bandwidth to customers. Virtual machines are containers that are assigned specific resources. The software that runs in the virtual machines is what defines the utility of the cloud computing system.

Figure below shows the portion of the cloud computing stack that is defined as the "server." In the diagram,

- The API is shown shaded in gray because it is an optional component that isn't always delivered with the server.
- The VMM component is the Virtual Machine Monitor, also called a hypervisor. This is the low-level software that allows different operating systems to run in their own memory space and manages I/O for the virtual machines.

- When a programmer is creating software that requires several different tasks to be performed in parallel, he might write an application that creates additional threads of execution that must be managed by the application.
- When a developer creates an application that uses a cloud service, the developer can attach to the appropriate service(s) and allow the application itself to scale the program execution.
- Thus, an application such as a three-dimensional rendering that might take a long time for a single server to accomplish can be scaled in the cloud to many servers at once for a short period of time, accomplishing the task at a similar or lower price but at a much faster rate.

**Figure**  
This architectural diagram illustrates the portion of the cloud computing stack that is designated as the server.



### 30. Explain the cloud Platform.

[MODEL QUESTION]

#### Answer:

A platform in the cloud is a software layer that is used to create higher levels of service. Platforms represent nearly the full cloud software stack, missing only the presentation layer that represents the user interface. They help the Operating system Vendors to move their development environments into the cloud with the same technologies that have been successfully used to create Web applications.

They are as follows:

- Salesforce.com's Force.com Platform
- Windows Azure Platform
- Google Apps and the Google AppEngine

These three services offer all the hosted hardware and software needed to build and deploy Web applications or services that are custom built by the developer within the context and range of capabilities that the platform allows.

Thus, one may find a platform based on a Sun xVM hypervisor virtual machine that includes a NetBeans Integrated Development Environment (IDE) and that supports

## **POPULAR PUBLICATIONS**

the Sun GlassFish Web stack programmable using Perl or Ruby. For Windows, Microsoft would be similarly interested in providing a platform that allowed Windows developers to run on a Hyper-V VM, use the ASP.NET application framework, support one of its enterprise applications such as SQL Server, and be programmable within Visual Studio—which is essentially what the Azure Platform does. This approach allows someone to develop a program in the cloud that can be used by others. Platforms often come replete with tools and utilities to aid in application design and deployment. Users would then interact with the platform, consuming services through that API, leaving the platform to manage and scale the service appropriately. Many platforms offer user interface development tools based on HTML, JavaScript, or some other technology. As the Web becomes more media-oriented, many developers have chosen to work with rich Internet environments such as Adobe Flash, Flex, or Air, or alternatives such as Windows Silverlight. The top of the cloud computing interface includes the user interface and the API for the application layer.

### **31. What are the communication protocols in cloud computing?**

[MODEL QUESTION]

#### **Answer:**

Cloud computing arises from services available over the Internet communicating using the standard Internet protocol suite underpinned by the HTTP and HTTPS transfer protocols. In order to engage in interprocess communication (IPC) processes, many client/server protocols have been applied to distributed networking over the years. Various forms of RPC (Remote Procedure Call) implementations (including DCOM, Java RMI, and CORBA) attempt to solve the problem of engaging services and managing transactions over what is essentially a stateless network.

The first of the truly Web-centric RPC technologies was XML-RPC, which uses platform-independent XML data to encode program calls that are transported over HTTP, the networking transport to which nearly everyone is connected. As Internet computing became more firmly entrenched over the last decade, several efforts began to better define methods for describing and discovering services and resources. The most widely used message-passing standard at the moment is the Simple Object Access Protocol (SOAP), which essentially replaces XML-RPC. SOAP uses XML for its messages and uses RPC and HTTP for message passing. SOAP forms the basis for most of the Web services stacks in use today.

### **32. How do businesses get connected to the clients via cloud? [MODEL QUESTION]**

#### **Answer:**

Clients can connect to a cloud service in a number of different ways. These are the two most common means:

- A Web browser
- A proprietary application

These applications can be running on a server, a PC, a mobile device, or a cell phone. There are three basic methods for securely connecting over a connection:

## CLOUD COMPUTING

- Use a secure protocol to transfer data such as SSL (HTTPS), FTPS, or IPsec, or connect using a secure shell such as SSH to connect a client to the cloud.
- Create a virtual connection using a virtual private network (VPN), or with a remote data transfer protocol such as Microsoft RDP or Citrix ICA, where the data is protected by a tunneling mechanism.
- Encrypt the data so that even if the data is intercepted or sniffed, the data will be meaningful.

The best client connections use two or more of these techniques to communicate with the cloud.

### **33. What is an identity?**

**[MODEL QUESTION]**

**Answer:**

An identity is a set of characteristics or traits that make something recognizable or known. In computer network systems, it is one's digital identity that most concerns us. A digital identity is those attributes and metadata of an object along with a set of relationships with other objects that makes an object identifiable. Databases store information and relationships in tables, rows, and columns, and the identity of information stored in this way conforms to the notion of an entity and a relationship.

### **34. What is CaaS?**

**[MODEL QUESTION]**

**Answer:**

Cloud computing by its very nature spans different jurisdictions. The laws of the country of a request's origin may not match the laws of the country where the request is processed, and it's possible that neither location's laws match the laws of the country where the service is provided. Compliance is much more than simply providing an anonymous service token to an identity so they can obtain access to a resource. Compliance is a complex issue that requires considerable expertise. While Compliance as a Service (CaaS) appears in discussions, few examples of this kind of service exist as a general product for a cloud computing architecture.

- A Compliance as a Service application would need to serve as a trusted third party, because this is a man-in-the-middle type of service. CaaS may need to be architected as its own layer of a SOA architecture in order to be trusted.
- A CaaS would need to be able to manage cloud relationships, understand security policies and procedures, know how to handle information and administer privacy, be aware of geography, provide an incidence response, archive, and allow for the system to be queried, all to a level that can be captured in a Service Level Agreement.
- It's much easier to envisage a CaaS system built inside a private cloud where the data is under the control of a single entity, thus ensuring that the data is under that entity's secure control and that transactions can be audited.
- It is easy to see how CaaS could be an incredibly valuable service. A well-implemented CaaS service could measure the risks involved in servicing compliance and ensure or indemnify customers against that risk.
- CaaS could be brought to bear as a mechanism to guarantee that an e-mail conformed to certain standards, something that could be a new electronic service of a network of

## **POPULAR PUBLICATIONS**

national postal systems—and something that could help bring an end to the scourge of spam.

Examples of vertical clouds that advertise CaaS capabilities include the following:

- **athenahealth** (<http://www.athenahealth.com/>) for the medical industry
- **bankserv** (<http://www.bankserv.com/>) for the banking industry
- **ClearPoint PCI** Compliance-as-a-Service for merchant transactions under the Payment Card

Industry Data Security Standard

- **FedCloud** (<http://www.fedcloud.com/>) for government
- **Rackspace PCI** Compliant Cloud (<http://www.rackspace.com/>; another PCI CaaS service)

**MODULE 2****Multiple Choice Type Questions**

1. Amazon Web Services is which type of cloud computing distribution model?  
 a) software as a service  
 b) infrastructure as a service  
 c) platform as a service  
 d) identity as a service [WBUT 2014]  
 Answer: (b)
2. What is the name of the Rackspace cloud service?  
 a) cloud on-demand  
 b) cloud servers  
 c) EC2  
 d) Google cloud [WBUT 2014]  
 Answer: (b)
3. Which of these service is not platform as a service?  
 a) Force.com  
 b) Microsoft azure  
 c) Amazon EC2  
 d) Joyent [WBUT 2014, 2017]  
 Answer: (c)
4. Which Amazon cloud product recently experienced a massive outage?  
 a) simple DB      b) EBS      c) S3      d) cloud front [WBUT 2014]  
 Answer: (b)
5. Which is not a major cloud computing platform? [WBUT 2014, 2015, 2017]  
 a) Google 101  
 b) IBM Deep blue  
 c) Microsoft AZURE  
 d) Amazon EC2  
 Answer: (b)
6. Which of the following techniques is vital for creating cloud computing environments?  
 a) virtualization  
 b) personalization  
 c) localization  
 d) all of these [WBUT 2015]  
 Answer: (a)
7. Which is the correct combination of cloud service provider and cloud-based service?  
 a) Google and AWS  
 b) Intuit and Quick Books Online  
 c) IBM and Azure  
 d) Microsoft and GWT [WBUT 2015]  
 Answer: (a)
8. Amazon EC2 is which type of cloud computing model?  
 a) compliance as a service  
 b) infrastructure as a service  
 c) platform as a service  
 d) software as a service [WBUT 2015]  
 Answer: (b)

## **POPULAR PUBLICATIONS**

**9. What is the expansion of WSDL expands to**

- a) Web Security Description of WSDL expands to
- b) Web Service Description Language
- c) Web Solution Description Language
- d) Web Service Differentiation Language

**Answer:** (b)

[WBUT 2016]

**10. Which one is not a second level attribute of Storage attribute?**

- a) Query
- b) Non-Relational
- c) Data Access

**Answer:** (c)

[WBUT 2016]

d) Replication

**11. Which one is not a valid category of Google API?**

- a) Ads and AdSense
- b) AJAX
- c) Google Gears
- d) Geo

**Answer:** (d)

[WBUT 2016]

**12. Which one of the following providers provides Compliance as a Service (CaaS)?**

- a) IBM
- b) HP
- c) Microsoft

**Answer:** (d)

[WBUT 2016]

d) Google

**13. Which one of the following large vendors does not have an IT Management software as a service?**

- a) IBM
- b) HP
- c) Microsoft

**Answer:** (b)

[WBUT 2016]

d) Google

**14. Which one of the following service models is closest to traditional hosting?**

- a) SaaS
- b) PaaS

**Answer:** (b)

[WBUT 2016]

**15. Which one of these is not a cloud computing pricing model?**

- a) Free
- b) Pay Per Use
- c) Subscription
- d) ladder
- e) Perpetual License

**Answer:** (d)

[WBUT 2017]

**16. Which of one of these is not a major type of cloud computing usage?**

- a) Hardware as a Service
- c) Software as a Service

**Answer:** (a)

b) Platform as a Service

d) Infrastructure as a Service

[WBUT 2017]

**17. Point out the correct combination of cloud service provider and their cloud based service**

- a) Amazon and EC2
- c) Google and Cloudburst

**Answer:** (a)

b) IBM and Azure

d) Microsoft and GWT

[WBUT 2017]

## CLOUD COMPUTING

18. What is server virtualization?

[WBUT 2018]

- a) It's a problem that crops up with cloud computing when servers go offline
- b) It's a method of modeling a cloud computing network before you actually build it so that it works properly
- c) It's partitioning a normal server so that it behaves as if it's multiple servers
- d) None of these

Answer: (c)

19. Which of the following cloud concept is related to pooling and sharing of resources?

[WBUT 2018]

- a) Polymorphism
- b) Abstraction
- c) Virtualization
- d) None of the mentioned

Answer: (c)

20. The componentized nature of SaaS solutions enables many solutions to support a feature called

[WBUT 2018]

- a) workspace
- b) workloads
- c) mashups
- d) All of the mentioned

Answer: (c)

21. The technology used to distribute service resources is referred to as

[WBUT 2018]

- a) load performing
- b) load scheduling
- c) load balancing
- d) All of the mentioned

Answer: (c)

### **Short & Long Answer Type Questions**

1. a) Explain characteristics of Amazon Cloud.

[WBUT 2014]

Answer:

When it comes to Amazon Web Services (AWS), it's vital to understand its key characteristics to ensure that the applications run well in the Amazon environment. Here are the AWS characteristics that the companies should keep in mind when planning their applications:

- **AWS offers a variety of services, all designed to deliver one set of functionality:** Each service stands alone, but the company can mix and match them to meet the specific needs of their application.
- **Each service is, well, a service, offered via an API:** Some companies choose Amazon's or a third party's user interface, while others may choose to access AWS directly via APIs or the AWS software development kit. No matter how the services are accessed, one must remember that each has its own functionality and idiosyncrasies.
- **The AWS infrastructure is failure-prone, and Amazon achieves service robustness through redundancy:** For those services that Amazon offers service level agreements (SLAs), it commonly maintains three copies of the computing and data associated with a service.

## **POPULAR PUBLICATIONS**

- **AWS is offered on an on-demand, and one can pay for what they use:** AWS can be a fantastic bargain, with very low costs when a company is first starting to develop an application. However, the meter is always running, so to speak, so it's important to track what they use.
- **AWS services are offered on a region- and availability zone-based partitioning:** Accessing data in one region from EC2 instances in another imposes network traffic charges, so knowing where the company's data is located and what applications need to run for them, is important, if someone wants to keep costs down.

**b) Compare with diagram Type I Hypervisor and Type II Hypervisor? [WBUT 2014]**

OR,

**What is a hypervisor? Explain the types of hypervisor.**

[WBUT 2016]

OR,

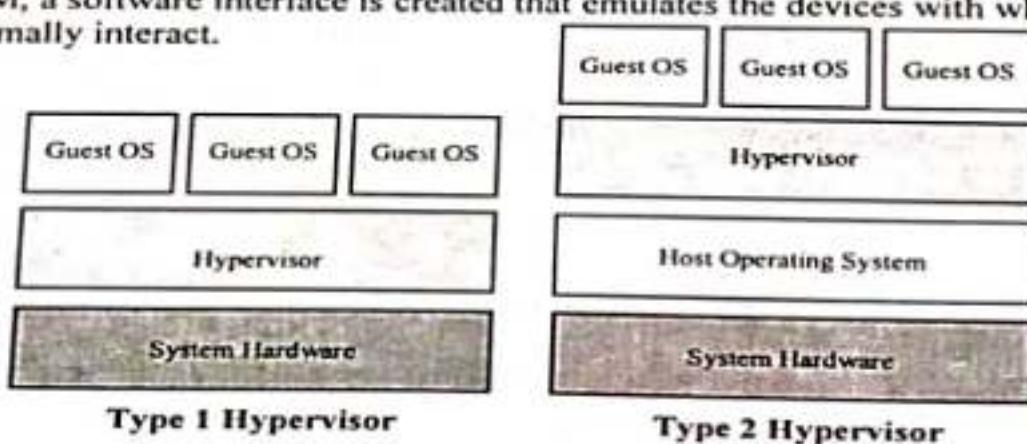
**What is Hypervisor? What are the types of Hypervisor?**

[WBUT 2018]

**Answer:**

A low-level program is required to provide system resource access to virtual machines, and this program is referred to as the hypervisor or Virtual Machine Monitor (VMM). There are different types of virtual machines. They are:

- Type 1 VM or native VM. Examples of Type 1 Virtual Machine Monitors are LynxSecure, RTS Hypervisor, Oracle VM, Sun xVM Server, VirtualLogix VLX, VMware ESX and ESXi, and Wind River VxWorks, among others. The operating system loaded into a virtual machine is referred to as the guest operating system, and there is no constraint on running the same guest on multiple VMs on a physical system. Type 1 VMs have no host operating system because they are installed on a bare system.
- Type 2 or hosted VM. Examples of Type 2 Virtual Machine Monitors are Containers, KVM, Microsoft Hyper-V, Parallels Desktop for Mac, Wind River Simics, VMWare Fusion, Virtual Server 2005 R2, Xen, Windows Virtual PC, and VMware Workstation 6.0 and Server, among others. This is a very rich product category. Type 2 virtual machines are installed over a host operating system; for Microsoft Hyper-V, that operating system would be Windows Server. On a Type 2 VM, a software interface is created that emulates the devices with which a system would normally interact.



Q) Describe VMotion, Distributed Resource Scheduler (DRS) and vNetwork Distributed Switch (DVS)? [WBUT 2014]

**Answer:** VMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. VMotion is a key enabling technology for creating the dynamic, automated, and self-optimizing datacenter. VMware VMotion allows users to:

- Perform hardware maintenance without scheduled downtime.
- Proactively migrate virtual machines away from failing or underperforming servers.
- Automatically optimize and allocate entire pools of resources for optimal hardware utilization and Alignment with business priorities

**DRS:** VMware DRS dynamically balances computing capacity across a collection of hardware resources aggregated into logical resource pools, continuously monitoring utilization across resource pools and intelligently allocating available resources among the virtual machines based on pre-defined rules that reflect business needs and changing priorities. When a virtual machine experiences an increased load, VMware DRS automatically allocates additional resources by redistributing virtual machines among the physical servers in the resource pool. VMware DRS allows IT organizations to:

- Prioritize resources to the highest value applications in order to align resources with business goals
- Optimize hardware utilization automatically and continuously to respond to changing conditions
- Provide dedicated resources to business units while still profiting from higher hardware utilization through resource pooling
- Conduct zero-downtime server maintenance

**VDS:** VMware vSphere Distributed Switch (VDS) provides a centralized interface from which users can configure, monitor and administer virtual machine access switching for the entire data center. The VDS provides:

- Simplified virtual machine network configuration
- Enhanced network monitoring and troubleshooting capabilities
- Support for advanced VMware vSphere networking features.

2 a) What is virtualization?

[WBUT 2015]

b) Compare Process-level and System-level virtualization with respect to technique and virtualization model.

**Answer:**

a) To define cloud computing, one may conceptualise it as "a collection of objects that are grouped together." It is that act of grouping or creating a resource pool that is what succinctly differentiates cloud computing from all other types of networked systems. When a company uses cloud computing, they are accessing pooled resources using a technique called virtualization. Virtualization assigns a logical name for a physical resource and then provides a pointer to that physical resource when a request is made.

## **POPULAR PUBLICATIONS**

Virtualization provides a means to manage resources efficiently because the mapping of virtual resources to physical resources can be both dynamic and facile. Virtualization is dynamic in that the mapping can be assigned based on rapidly changing conditions, and it is facile because changes to a mapping assignment can be nearly instantaneous.

**b) Refer to Question No. 1(b) of Short & Long Answer Type Questions.**

**3. a) What are the benefits of Google AdWords to the advertisers? What is 'CPC' in context of AdWords?** [WBUT 2015]

**OR,**  
**Explain the concept of Google Ad words.**

[WBUT 2016]

**Answer:**

AdWords (<http://www.google.com/AdWords>) is a targeted ad service based on matching advertisers and their keywords to users and their search profiles. This service transformed Google from a competent search engine into an industry giant and is responsible for the majority of Google's revenue stream. AdWords' two largest competitors are Microsoft adcenter (<http://adcenter.microsoft.com/>) and Yahoo! Search Marketing (<http://searchmarketing.yahoo.com/>). Ads are displayed as text, banners, or media and can be tailored based on geographical location, frequency, IP addresses, and other factors. AdWords ads can appear not only on Google.com, but on AOL search, Ask.com, and Netscape, along with other partners. Other partners belonging to the Google Display Network can also display AdSense ads. In all these cases, the AdWords system determines which ads to match to the user searches.

Here's how the system works:

- Advertisers bid on keywords that are used to match a user to their product or service.
- If a user searches for a term such as "develop abdominal muscles," Google returns products based on those terms.
- Up to 12 ads per search can be returned.
- Google gets paid for the ad whenever a user clicks it. The system is referred to as pay-per-click advertising, and the success of the ad is measured by what is called the click-through rate (CTR).
- Google calculates a *quality score* for ads based on the CTR, the strength of the connection between the ad and the keywords, and the advertiser's history with Google.
- This quality score is a Google trade secret and is used to price the minimum bid of a keyword.

**b) What are the functions of Google Analytics? How does it work for the user?**

[WBUT 2015]

**Answer:**

Google Analytics (GA; <http://google.com/analytics>) is a statistical tool that measures the number and types of visitors to a Web site and how the Web site is used. It is offered as a free service and has been adopted by many Web sites. Analytics works by using a JavaScript snippet called the Google Analytics Tracking Code (GATC) on individual

pages to implement a *page tag*. When the page loads, the JavaScript runs and creates a first-party browser cookie that can be used to manage return visitors, perform tracking, test browser characteristics, and request tracking code that identifies the location of the visitor. GATC requests and stores information from the user's account. The code stored on the user's system acts like a beacon and collects visitor data that it sends back to GA servers for processing. Among the visitors that can be tracked are those that land from search engines; referral links in e-mail, documents, and Web pages; display ads; PPC networks; and some other sources. GA aggregates the data and presents the information in a visual form. GA also is connected to the AdWords system so it can track the performance of particular ads in different contexts.

**4. a) Virtualization in the context of IaaS.**

[WBUT 2015]

**b) Benefits of Virtualization.**

**c) Differences between 'full virtualization' and 'Para-virtualization'.**

**d) Amazon Machine Images (AMI) use both types of virtualization, namely, Hardware Virtual Machine (HVM) as well as Para-virtualization (PV). Mention the respective situations in which AMI's can use PV or HVM.**

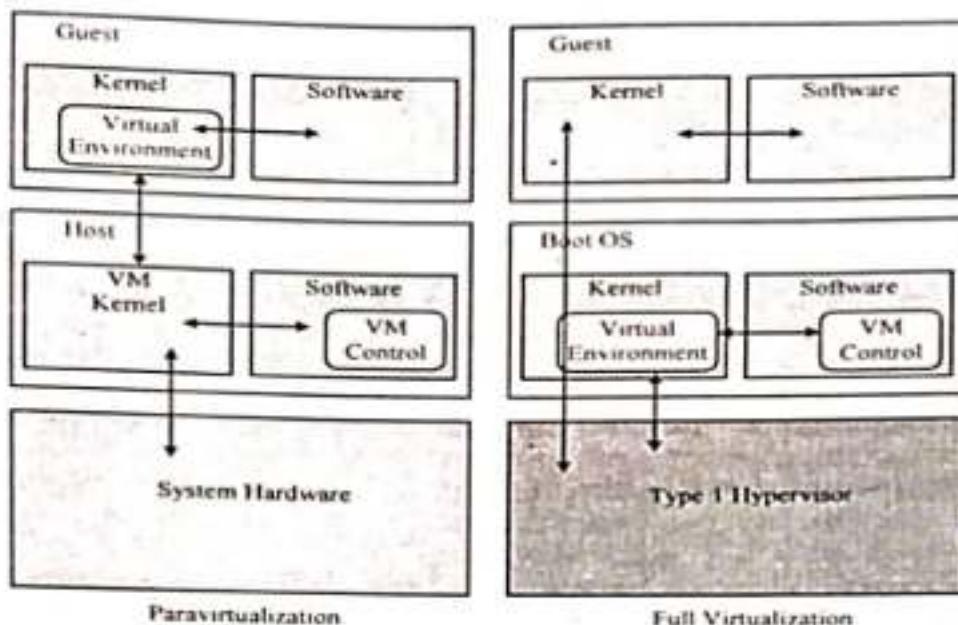
**Answer:**

a) Infrastructure as a Service is a service provided by another entity (be it a group within our company or a third party) that provides the hardware and hardware support while we maintain the virtual datacenter on top of it. In other words, they provide the infrastructure as a virtualized service and datacenter operations moves on as they always did taking care of the server operating systems and the applications they support. There are many advantages to this route.

b) Refer to Question No. 2(a) of Short & Long Answer Type Questions.

c) Paravirtualization requires that the host operating system provide a virtual machine interface for the guest operating system and that the guest access hardware through that host VM. An operating system running as a guest on a paravirtualization system must be ported to work with the host interface. Finally, in a full virtualization scheme, the VM is installed as a Type I Hypervisor directly onto the hardware. All operating systems in full virtualization communicate directly with the VM hypervisor, so guest operating systems do not require any modification. Guest operating systems in full virtualization systems are generally faster than other virtualization schemes.

## **POPULAR PUBLICATIONS**



d) PV however require that a guest OS has a PV-enabled kernel as well as PV drivers, meaning that the guests know that they are running in a hypervisor. HVM guests are fully virtualized, so the underlying hardware has to be emulated for the guests to use, incurring performance cost, unlike PV, where the guest OS is modified to be able to run without needing that emulation.

HVM requires the host machine to have a certain feature present in its hardware, whereas PV requires the guest OS to have a certain feature present in its software.

In practical terms, PV means that performance is much closer to what we would expect of the underlying hardware compared to HVM because of the extra overheads in HVM. Fully virtualized guests are usually slower than paravirtualized guests, because of the required emulation.

So we choose PV instances because of the better performance. Since PV requires software changes, it is not possible to run a paravirtualized Windows guest.

So if you need Windows, we'll need HVM. If we are using GNU Linux or Unix, we can choose either, but will (in most cases) get better performance with PV.

- 5. a) Describe key features of Amazon Elastic Component Cloud (EC2).**  
**b) What are the differences between Amazon Simple Storage Service (S3) and Elastic Block Storage (EBS)?**  
**c) What is Google APIs? Mention broad categories of Google APIs with suitable examples. Name any two programming language environments that are compatible with Google API.**  
**d) What does Google App Engine do? Mention any two services provided by it.**

[WBUT 2015]

**Answer:**

- a) Key features of Amazon Elastic Compute Cloud (EC2):
- i) When it comes to Amazon EC2, it's vital to understand its key characteristics to ensure that the client's applications run well in the Amazon environment. Here are the EC2 characteristics that one should keep in mind when planning your applications:
  - ii) EC2 offers a variety of services, all designed to deliver one set of functionality. Each service stands alone, but one can mix and match them to meet the specific needs of the application.
  - iii) Each service is, well, a service, offered via an API. Some clients may choose to use Amazon's or a third party's user interface, while others may choose to access EC2 directly via APIs or the EC2 software development kit. No matter how one accesses the services, each has its own functionality and idiosyncrasies.
  - iv) The EC2 infrastructure is failure-prone, and Amazon achieves service robustness through redundancy. For those services that Amazon offers service level agreements (SLAs), it commonly maintains three copies of the computing and data associated with a service.
  - v) EC2 is offered on an on-demand, pay for what is used model. AWS can be a fantastic bargain, with very low costs when the client is first starting to develop an application. However, the meter is always running, so to speak, so it's important to track what they use.
  - vi) AWS services are offered on a region- and availability zone-based partitioning. Accessing data in one region from EC2 instances in another imposes network traffic charges, so knowing where the data is located and the applications need to run is important if the client want to keep costs down.

b) Amazon Elastic Block Storage (Amazon EBS) is a new type of storage designed specifically for Amazon EC2 instances. Amazon EBS allows us to create volumes that can be mounted as devices by EC2 instances. Amazon EBS volumes behave as if they were raw unformatted external hard drives and can be formatted using a file system such as ext3 (Linux) or NTFS (Windows) and mounted on an EC2 instance; files are accessed through the file system. They have user supplied device names and provide a block device interface.

For a 20 GB volume, Amazon estimates an annual failure rate for EBS volumes from 1-in-200 to 1-in-1000. The failure rate increases as the size of the volume increases.

Therefore we either need to keep an up-to-date snapshot on S3, or have a backup of the contents somewhere else that we can restore quickly enough to meet our needs in the event of a failure.

EBS accounts can have a maximum of 20 volumes unless a higher limit is requested from Amazon. The maximum size of a volume is 1 TB and the storage on a volume is limited to the provisioned size and cannot be changed. EBS volumes can only be accessed from an EC2 instance in the same availability zone whereas snapshots on S3 can be accessed from any availability zone.

## **POPULAR PUBLICATIONS**

Amazon S3 provides a simple web services interface that can be used to store and retrieve any amount of data, at any time, from anywhere on the web. It gives any developer access to the same highly scalable, reliable, fast, inexpensive data storage infrastructure that Amazon uses to run its own global network of web sites. The service aims to maximize benefits of scale and to pass those benefits on to developers. S3 needs software to be able to read and write files but is hugely scalable, stores 6 copies of data for HA and redundancy, and is rumoured to be written in Erlang and is hugely scalable. S3 accounts can have a maximum of 100 buckets, each with unlimited storage and an unlimited number of files. The maximum size of a single file is 5 GB.

S3 is subject to "eventual consistency" which means that there may be a delay in writes appearing in the system whereas EBS has no consistency delays. Also EBS can only be accessed by one machine at a time whereas snapshots on S3 can be shared.

In terms of performance S3 has the higher latency and also has higher variation in latency. S3 write latency can also be higher than read latency. EBS on the other hand has lower latency with less variation. It also has writeback caching for very low write latency. However be aware that writeback caching and out-of-order flushing could result in either an unpredictable file system or a database corruption.

In terms of throughput S3 has maximum throughput (single threaded) of approximately 20 MB/s or 25 MB/s for multithreaded. This is on a small instance. This rises to 50 MB/s on the large and extra large instances. EBS has a maximum throughput limited by the network. This is approximately 25 MB/s on a small instance and 50 MB/s on large instances, and 100 MB/s on extra large instances. As both S3 and EBS are shared resources they are subject to slowdown under heavy load.

For file listing S3 is slow and search is by prefix only whereas EBS has fast directory listing and searching. S3 is performance optimized by using multiple buckets. The write performance is optimized by writing keys in sorted order. EBS single volume performance is similar to a disk drive with writeback caching.

c) Google API is a great set of developer's tools. These tools make programmers able to perform operations using google API and living within their development framework. Google API provides a way to use its features easily. You can use its maps api, google feeds api, google search api and google friends connect which is very useful tools for any site.

Google's APIs can be categorized as belonging to the following categories:

- **Ads and AdSense:** These APIs allow Google's advertising services to be integrated into Web applications. The most commonly used services in this category are AdWords, AdSense, and Google Analytics.
- **AJAX:** The Google AJAX APIs provide a means to add content such as RSS feeds, maps, search boxes, and other information sources by including a snippet of JavaScript into your code.
- **Browser:** Google has several APIs related to building browser-based applications, including four for the Chrome browser. This category includes the Google Cloud Print API, the Installable Web Apps API for creating installation packages, the

## CLOUD COMPUTING

Google Web Toolkit for building AJAX applications using Java, and V8, which is a high-performance JavaScript engine.

- **Data:** The Data APIs are those that exchange data with a variety of Google services. The list of Google Data APIs includes Google Apps, Google Analytics, Blogger, Base, Book, Calendar, Code Search, Google Earth, Google Spreadsheets, Google Notebook, and Picasa Web Albums.
- **Geo:** A number of APIs exist to give location-specific information hooking into maps and geo-specific databases. Some of the more popular APIs in this category include Google Earth, Directions, JavaScripts Maps, Maps API for Flash, and Static Maps.
- **Search:** The search APIs leverage Google's core competency and its central service. APIs such as Google AJAX Search, Book Search, Code Search, Custom Search, and Webmaster Tools Data APIs allow developers to include Google searches in their applications and web sites.
- **Social:** Many Google APIs are used for information exchange and communication tools. They support applications such as Gmail, Calendar, and others, and they provide a set of foundation services. The popular social APIs are Blogger Data, Calendar, Contacts, OpenSocial, Picasa, and YouTube.

Two programming language environments that are compatible with Google API are Java and .NET.

d) **Google App Engine (GAE)** is a Platform as a Service (PaaS) cloud-based Web hosting service on Google's infrastructure. This service allows developers to build and deploy Web applications and have Google manage all the infrastructure needs, such as monitoring, failover, clustering, machine instance management, and so forth. For an application to run on GAE, it must comply with Google's platform standards, which narrows the range of applications that can be run and severely limits those applications' portability. Applications running in GAE are isolated from the underlying operating system, which Google describes as running in a sandbox. This allows GAE to optimize the system so Web requests can be matched to the current traffic load. It also allows applications to be more secure because applications can connect only to computers using the specified URLs for the e-mail and fetch services using HTTP or HTTPS over the standard well-known ports. URL fetch uses the same infrastructure that retrieves.

Web pages on Google. The mail service also supports Gmail's messaging system. Applications also are limited in that they can only read files; they cannot write to the file system directly. To access data, an application must use data stored in the memcache (memory cache), the datastore, or some other persistent service. Memcache is a fast in-memory key-value cache that can be used between application instances. For persistent data storage of transactional data, the datastore is used.

Additionally, an application responds only to a specific HTTP request—in real-time, part of a queue, or scheduled—and any request is terminated if the response requires more than 30 seconds to complete. GAE has a distributed datastore system that

## **POPULAR PUBLICATIONS**

supports queries and transactions. This datastore is non-relational or "schema-less," but it does store data objects or entities that are assigned properties.

### **6. What is disintermediation?**

[WBUT 2016]

**Answer:**

Disintermediation is a process in which the end users can have a direct access to the product, information or services without any need of a middleman, like a retailer or a wholesaler, or a salesperson. All the end users have to do is to search for the product or service they need, and get information as they need. Example: world wide web has eliminated the need of a middleman.

### **7. What are the different factors to be considered while choosing a database for AWS?**

[WBUT 2016]

**Answer:** Refer to Question No. II(c) of Short & Long Answer Type Questions.

### **8. a) Explain Amazon EC2 service characteristics.**

[WBUT 2016]

**Answer:**

Amazon Elastic Compute Cloud (EC2) is a virtual server platform that allows users to create and run virtual machines on Amazon's server farm. With EC2, users can launch and run server instances called Amazon Machine Images (AMIs) running different operating systems such as Red Hat Linux and Windows on servers that have different performance profiles. One can add or subtract virtual servers elastically as needed, cluster, replicate, and load balance servers; and locate these different servers in different data centers or "zones" throughout the world to provide fault tolerance. The term *elastic* refers to the ability to size the capacity quickly as needed.

### **b) What is dark web? Write down the difference between deep web and dark web.**

[WBUT 2016]

**Answer:**

**1<sup>st</sup> Part:**

The dark web is the World Wide Web content that exists on darknets, overlay networks which use the Internet but require specific software, configurations or authorization to access. Users of the dark web refer to the regular web as Clearnet due to its unencrypted nature.

**2<sup>nd</sup> Part:**

The Dark Web actually refers to a set of accessible, albeit anonymously hosted, websites that exist within the Deep Web. Because these websites are not indexed by normal search engines, users can access them only with special software that disguises his IP address. The most common software used to access the Dark Web is The Onion Browser, referred to as TOR. The Dark Web is much smaller than the Deep Web, and it's made up of numerous types of sites. But it's perhaps most popular for its anonymous marketplaces that often sell illegal products like drugs or weapons.

**Q. What is an Amazon EC2 instance? Explain the process of launching an Amazon EC2 instance. [WBUT 2016]**

**Answer:**

An EC2 instance is a virtual server in Amazon's Elastic Compute Cloud (EC2) for running applications on the Amazon Web Services (AWS) infrastructure.

**Step 1 – Sign-in to AWS account and open IAM console by using the following link <https://console.aws.amazon.com/iam/>.**

**Step 2 – In the navigation Panel, create/view groups and follow the instructions.**

**Step 3 – Create IAM user. Choose users in the navigation pane. Then create new users and add users to the groups.**

**Step 4 – Create a Virtual Private Cloud using the following instructions.**

- Open the Amazon VPC console by using the following link  
– <https://console.aws.amazon.com/vpc/>
- Select VPC from the navigation panel. Then select the same region in which we have created key-pair.
- Select start VPC wizard on VPC dashboard.
- Select VPC configuration page and make sure that VPC with single subnet is selected. Then choose Select.
- VPC with a single public subnet page will open. Enter the VPC name in the name field and leave other configurations as default.
- Select create VPC, then select Ok.

**Step 5 – Create WebServerSG security groups and add rules using the following instructions.**

- On the VPC console, select Security groups in the navigation panel.
- Select create security group and fill the required details like group name, name tag, etc.
- Select your VPC ID from the menu. Then select yes, create button.
- Now a group is created. Select the edit option in the inbound rules tab to create rules.

**Step 6 – Launch EC2 instance into VPC using the following instructions.**

- Open EC2 console by using the following link  
– <https://console.aws.amazon.com/ec2/>
- Select launch instance option in the dashboard.
- A new page will open. Choose Instance Type and provide the configuration. Then select Next: Configure Instance Details.
- A new page will open. Select VPC from the network list. Select subnet from the subnet list and leave the other settings as default.
- Click Next until the Tag Instances page appears.

**Step 7 – On the Tag Instances page, provide a tag with a name to the instances. Select Next: Configure Security Group.**

**Step 8 – On the Configure Security Group page, choose the Select an existing security group option. Select the WebServerSG group that we created previously, and then choose Review and Launch.**

## **POPULAR PUBLICATIONS**

**Step 9 – Check Instance details on Review Instance Launch page then click the Launch button.**

**Step 10 – A pop up dialog box will open. Select an existing key pair or create a new key pair. Then select the acknowledgement check box and click the Launch Instances button.**

### **10. What are the different components used in Amazon AWS?**

[WBUT 2016]

**Answer:**

- **Route53**

It is a highly available, scalable, and feature rich domain name service (DNS) web service. What a DNS service does is translate a domain name like "setfive.com" into an IP address like 64.22.80.79 which allows a client's computer to "find" the correct server for a given domain name. In addition, Route53 also has several advanced features normally only available in pricey enterprise DNS solutions. Route53 would typically replace the DNS service provided by common registrar like GoDaddy or Register.com.

- **Simple Email Service**

It is a hosted transactional email service. It allows users to easily send highly deliverable emails using a RESTful API call or via regular SMTP without running his or her own email infrastructure.

- **Identity and Access Management**

It provides enhanced security and identity management for users AWS account. In addition, it allows them to enable "multi factor" authentication to enhance the security of their AWS account.

- **Simple Storage Service**

It is a flexible, scalable, and highly available storage web service. It is like having an infinitely large hard drive where users can store files which are then accessible via a unique URL. S3 also supports access control, expiration times, and several other useful features. Additionally, the payment model for S3 is "pay as you go" so you'll only be billed for the amount of data users store and how much bandwidth users use to transfer it in and out.

- **Elastic Compute Cloud**

It is the central piece of the AWS ecosystem. EC2 provides flexible, on-demand computing resources with a "pay as you go" pricing model. Concretely, what this means is that you can "rent" computing resources for as long as you need them and process any workload on the machines you've provisioned. Because of its flexibility, EC2 is an attractive alternative to buying traditional servers for unpredictable workloads.

- **Elastic Block Store**

It provides persist storage volumes that attach to EC2 instances to allow you to persist data past the lifespan of a single EC2. Due to the architecture of elastic compute cloud, all the storage systems on an instance are ephemeral. This means that when an instance is terminated all the data stored on that instance is lost. EBS addresses this issue by providing persistent storage that appears on instances as a regular hard drive.

• **CloudWatch**

It provides monitoring for AWS resources including EC2 and EBS. CloudWatch enables administrators to view and collect key metrics and also set a series of alarms to be notified in case of trouble. In addition, CloudWatch can aggregate metrics across EC2 instances which provides useful insight into how your entire stack is operating.

11. For infrastructure as a service also known as IaaS, mention the resources that are provided by it. Explain the various reasons which are causing more and more data centers to migrate to the cloud.

[WBUT 2017]

Answer:

i) Infrastructure as a Service (IaaS) is the foundation of cloud computing. Rather than purchasing or leasing space in an expensive datacenter, labor, real estate, and all of the utilities to maintain and deploy computer servers, cloud networks and storage, Cloud buyers rent space in a virtual data center from an IaaS provider. They have access to the virtual data center via the Internet. This type of cloud computing provides the "raw materials" for IT, and users usually only pay for the resources they consume, including (but not limited to) CPU cores, RAM, hard disk or storage space, and data transfer – examples IaaS providers include ProfitBricks, and other Cloud Computing IaaS providers. All true Cloud providers allow users to "rent" virtual servers and storage while creating networks to tie them all together. When renting from a cloud IaaS provider, users are renting the hardware and the provisioning software that autoamates it.

ii) Benefits of cloud migration

- Unlimited Scalability -The major benefit of cloud migration lies in the flexibility to scale up or scale down the IT infrastructure depending on the enterprise needs. This means that the enterprise do not have to worry about future needs as the IT infrastructure they need can be set up in minimal time.
- Reduced cost -Cloud migration can reduce both capital expense and operating expense costs because resources are only acquired when needed and are only paid for when used. In cloud computing environment resources are managed by third party, so they are responsible for resource maintenance and upgrade.
- Increased storage -Various numbers of cloud providers are available in cloud to provide storage as a service. You can store more data on the cloud than on a private network. Plus, if you need more it's easy enough to get that extra storage from cloud providers.
- Automation-Your IT staff no longer needs to worry that an application is up to date because that is the job of cloud providers. And they know that they have to keep it up to date otherwise they will start losing customers.
- Flexibility -You have more flexibility with a cloud solution. Applications can be tested and deployed with ease. You can get application as a service from cloud service provider, and if that application is not getting the job done, you can switch to another cloud provider. When you move to a cloud solution, you have the flexibility of being able to access your company files anywhere you have access to the internet.

## **POPULAR PUBLICATIONS**

- Better mobility -As cloud service is available through internet, users can access the cloud from anywhere with an Internet connection. This is ideal for road warriors or telecommuters or someone who needs to access the system after office hours.

**12. Define Hypervisor in cloud computing and their types. Discuss Hypervisor Baseline functions.** [WBUT 2017]

**Answer:**

**1<sup>st</sup> Part: Refer to Question No. 1(b) of Short & Long Answer Type Questions.**

**2<sup>nd</sup> Part:**

One of the key functions a hypervisor provides is isolation, meaning that a guest cannot affect the operation of the host or any other guest, even if it crashes. As such, the hypervisor must carefully emulate the hardware of a physical machine, and (except under carefully controlled circumstances), prevent access by a guest to the real hardware. How the hypervisor does this is a key determinant of virtual machine performance. But because emulating real hardware can be slow, hypervisors often provide special drivers, so called 'paravirtualized drivers' or 'PV drivers', such that virtual disks and network cards can be represented to the guest as if they were a new piece of hardware, using an interface optimized for the hypervisor. These PV drivers are operating system and (often) hypervisor specific. Use of PV drivers can speed up performance by an order of magnitude, and are also a key determinant to performance.

**13. What is virtualization and why has it gained prominence in the context of Cloud Computing? What are the major components and the characteristics of a virtualized environment? Explain with suitable examples.** [WBUT 2017]

**Answer:**

**1<sup>st</sup> Part:**

Without virtualization, cloud computing would leave the data unstable, uncontrolled and unsafe. It is an important and probably an inseparable element of cloud computing services. Virtualization allows us to consolidate multiple physical components so that they can be managed at one place. With the help of virtualization, organizations have a better visibility and also a greater control of their infrastructure making security management simpler for the cloud.

It is due to virtualization that the cloud computing services are so cost-effective. Moreover, it is also responsible for the simplicity of delivering services by providing a platform for optimizing complex IT resources.

A few examples to convince you on the above thought –

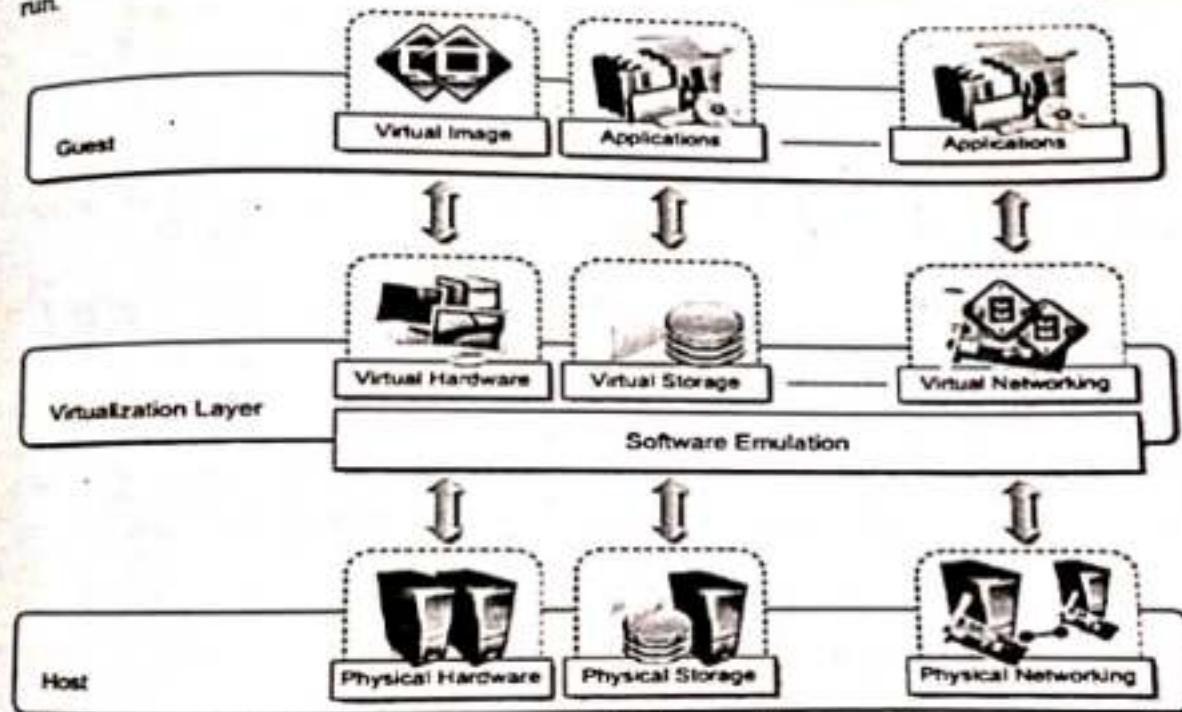
- **Intelligent use of single computers:** Virtualization software enables 1 computer to perform as though it were 20 computers. It empowers you to move your data center with thousands of computers to a single one that supports as few as a couple of hundreds.
- **Virtual memory:** Computer systems can use virtual memory to borrow extra memory from the hard disk. Although, it performs slower than the disk spaces, this substitution works considerably well.

## CLOUD COMPUTING

- **Efficient use of IT resources:** Cloud data storage services let you optimize your resources/capacity based on your needs. Whenever you need more capacity, you can easily leverage the cloud provider's infrastructure.
- **Easily migrate and balance workload:** When your workloads vary greatly (mostly happens with e-commerce websites), the cloud computing environments can proactively add more capacity in anticipation of the need.

Part:  
Three major components of Virtualized Environments

- Guest – system component that interacts with Virtualization Layer.
- Host – original environment where guest runs.
- **Virtualization Layer** – recreate the same or different environment where guest will run.



**Virtualization** is using computer resources to imitate other computer resources or whole computers. It separates resources and services from the underlying physical delivery environment.

Virtualization has three characteristics that make it ideal for cloud computing:

- **Partitioning:** In virtualization, many applications and operating systems (OSes) are supported in a single physical system by *partitioning* (separating) the available resources.

## **POPULAR PUBLICATIONS**

- **Isolation:** Each virtual machine is isolated from its host physical system and other virtualized machines. Because of this isolation, if one virtual-instance crashes, it doesn't affect the other virtual machines. In addition, data isn't shared between one virtual container and another.
- **Encapsulation:** A virtual machine can be represented (and even stored) as a single file, so you can identify it easily based on the service it provides. In essence, the encapsulated process could be a business service. This encapsulated virtual machine can be presented to an application as a complete entity. Therefore, encapsulation can protect each application so that it doesn't interfere with another application.

**14. What is Virtualization? Write about Load Balancing.**

[WBUT 2018]

**Answer:**

**1<sup>st</sup> Part: Refer to Question No. 2(a) of Short & Long Answer Type Questions.**

**2<sup>nd</sup> Part:**

One characteristic of cloud computing is virtualized network access to a service. No matter where the business is located, to access the service, it can be directed to the available resources. The technology used to distribute service requests to resources is referred to as *load balancing*. Load balancing can be implemented in hardware, through servers, or in software, such as the Squid proxy and cache daemon.

**Importance:**

- Load balancing is an optimization technique; it can be used to increase utilization and throughput, lower latency, reduce response time, and avoid system overload.
- Without load balancing, cloud computing would very difficult to manage.
- Load balancing provides the necessary redundancy to make an intrinsically unreliable system reliable through managed redirection.
- It also provides fault tolerance when coupled with a failover mechanism.

**15. a) Write about VMware's vSphere Cloud Computing Infrastructure Model?**

**b) What are the advantages of Virtualizations?**

[WBUT 2018]

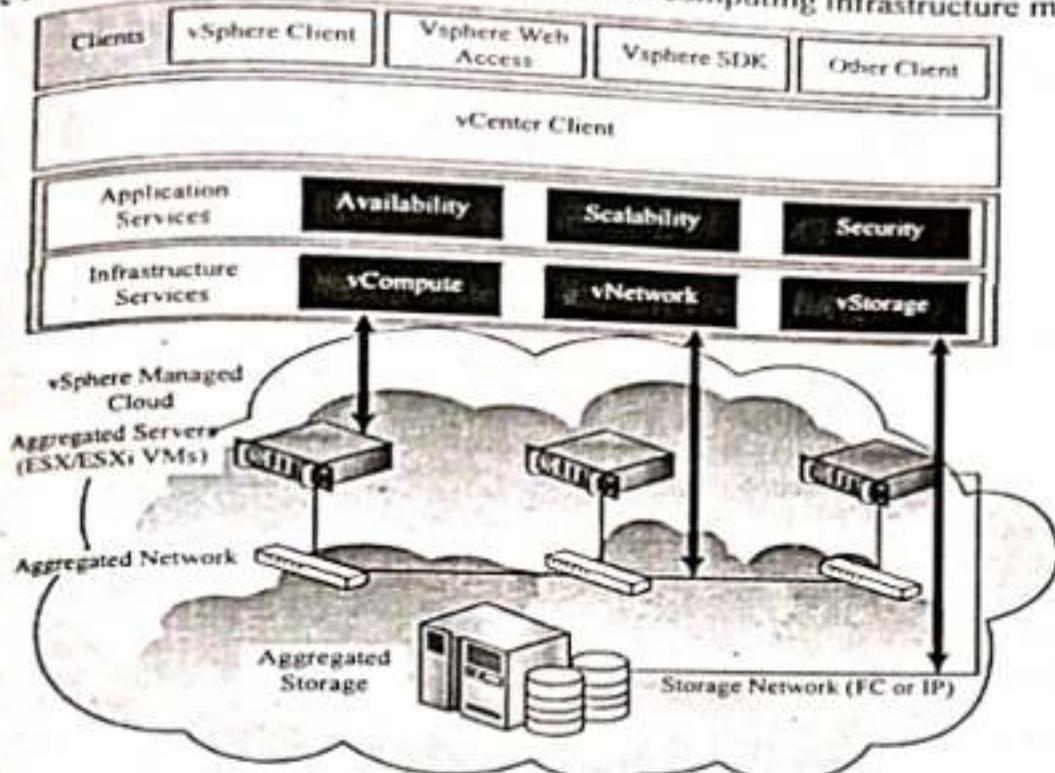
**Answer:**

**a)** VMware vSphere is a management infrastructure framework that virtualizes system, storage, and networking hardware to create cloud computing infrastructures. vSphere is the branding for a set of management tools and a set of products previously labeled VMware Infrastructure. vSphere provides a set of services that applications can use to access cloud resources, including these:

- **VMware vCompute:** A service that aggregates servers into an assignable pool
- **VMware vStorage:** A service that aggregates storage resources into an assignable pool
- **VMware vNetwork:** A service that creates and manages virtual network interfaces
- **Application services:** Such as HA (High Availability) and Fault Tolerance
- **vCenter Server:** A provisioning, management, and monitoring console for VMware cloud infrastructures.

## CLOUD COMPUTING

Figure below shows the VMware's vSphere cloud computing infrastructure model



b) Refer to Question No. 2(a) of Short & Long Answer Type Questions.

16. What is Eucalyptus? Explain the Eucalyptus architecture with diagram. Write about Walrus, Storage controller, Vmware Broker. [WBUT 2018]

Answer:

I<sup>st</sup> Part:  
Eucalyptus is free and open-source computer software for building Amazon Web Services (AWS)-compatible private and hybrid cloud computing environments marketed by the company Eucalyptus Systems. Eucalyptus is the acronym for Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems. Eucalyptus enables pooling compute, storage, and network resources that can be dynamically scaled up or down as application workloads change. Eucalyptus commands can manage either Amazon or Eucalyptus instances. Users can also move instances between a Eucalyptus private cloud and the Amazon Elastic Compute Cloud to create a hybrid cloud. Hardware virtualization isolates applications from computer hardware details.

**2<sup>nd</sup> Part:  
Architecture of eucalyptus:**

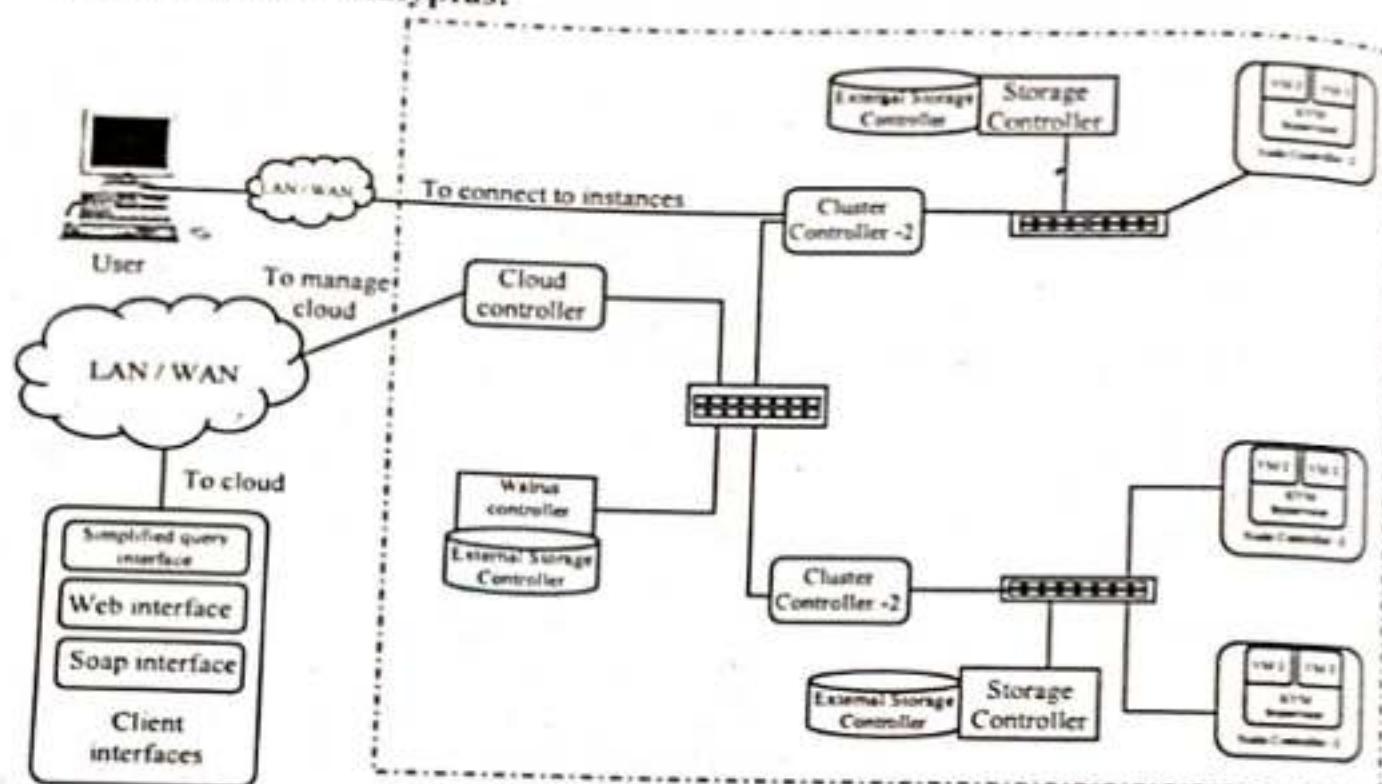


Fig: Eucalyptus based cloud

**Components of Eucalyptus:**

- 1. Cluster Controller (CC)** Cluster Controller manages the one or more Node controller and responsible for deploying and managing instances on them. It communicates with Node Controller and Cloud Controller simultaneously. CC also manages the networking for the running instances under certain types of networking modes available in Eucalyptus.
- 2. Cloud Controller (CLC)** Cloud Controller is front end for the entire ecosystem. CLC provides an Amazon EC2/S3 compliant web services interface to the client tools on one side and interacts with the rest of the components of the Eucalyptus infrastructure on the other side.
- 3. Node Controller (NC)** It is the basic component for Nodes. Node controller maintains the life cycle of the instances running on each nodes. Node Controller interacts with the OS, hypervisor and the Cluster Controller simultaneously.
- 4. Walrus Storage Controller (WS3)** Walrus Storage Controller is a simple file storage system. WS3 stores the machine images and snapshots. It also stores and serves files using S3 APIs.
- 5. Storage Controller (SC)** Allows the creation of snapshots of volumes. It provides persistent block storage over AoE or iSCSI to the instances.

**3<sup>rd</sup> Part:**

**Walrus:** Walrus is a component of Eucalyptus, which is a paid open-source software for building cloud computing environments. Eucalyptus environments are compatible with Amazon Web Services. Walrus is the equivalent of the Amazon S3. It provides the persistent storage environment in a Eucalyptus cloud.

**Storage controller:** It is a Java program equivalent to EBS in AWS. It can interface with Cluster Controller and Node Controller to manage persistent data via Walrus.

**VMWare Broker:** It is an optional component in Eucalyptus. It provides AWS compatible interface to VMWare environment.

**17. Write short notes on the following:**

- |                                  |                   |
|----------------------------------|-------------------|
| a) Google Cloud                  | [WBUT 2014]       |
| b) Windows AZURE service         | [WBUT 2014, 2018] |
| c) Amazon AWS                    | [WBUT 2015, 2018] |
| d) Google GWT                    | [WBUT 2015]       |
| e) Microsoft SQL Azure           | [WBUT 2015, 2017] |
| f) Virtual Machine Monitor (VMM) | [WBUT 2015]       |
| g) Amazon EC2                    | [WBUT 2017, 2018] |
| h) Google API                    | [WBUT 2017]       |
| i) P2V, D2C                      | [WBUT 2018]       |
| j) Virtual Machine               | [WBUT 2018]       |

**Answer:**

**a) Google Cloud:**

Google is the single most heavily visited site on the Internet; that is, Google gets the most hits. The investment Google has made in infrastructure is enormous, and the Google cloud is one of the largest in use today. Google has many datacenters around the world. It is estimated that Google runs over a million servers worldwide, processes a billion search requests, and generates twenty petabytes of data per day. Google distributes its traffic by pooling IP addresses and performing several layers of load balancing. Google maintains a pool of hundreds of IP addresses, all of which eventually resolve to its Mountain View, California, headquarters. When users initiate a Google search, the query is sent to a DNS server, which then queries Google's DNS servers. The Google DNS servers examine the pool of addresses to determine which addresses are geographically closest to the query origin and uses a round robin policy to assign an IP address to that request. The request usually goes to the nearest datacenter, and that IP address is for a cluster of Google servers. This DNS assignment acts as a first level of IP virtualization, a pool of network addresses have been load balanced based on geography. A Google cluster can contain thousands of servers. Google servers run a customized version of Linux with applications of several types. When the query request arrives at its destination, a Google cluster is sent to a load balancer, which forwards that request to a Squid proxy server and Web cache daemon. This is the second level of IP distribution, based on a measure of the current system loading on proxy servers in the cluster. The Squid server checks its cache, and if it finds a match to the query, that match is returned and the query has been satisfied. If

### **POPULAR PUBLICATIONS**

there is no match in the Squid cache, the query is sent to an individual Google Web Server based on current Web server utilizations, which is the third level of network load balancing, again based on utilization rates. It is the Google Web Servers that perform the query against the Google index and then format the results into an HTML page that is returned to the requester. This procedure then performs two more levels of load balancing based on utilization rates. Google doesn't use hardware virtualization; it performs server load balancing to distribute the processing load and to get high utilization rates. The workload management software transfers the workload from a failed server over to a redundant server, and the failed server is taken offline. Multiple instances of various Google applications are running on different hosts, and data is stored on redundant storage systems.

#### **b) Windows AZURE service:**

Microsoft calls their cloud operating system the Windows Azure Platform. Azure is Microsoft's Infrastructure as a Service (IaaS) Web hosting service. Windows Azure serves as a cloud operating system with a fabric infrastructure of virtual machines hosted in Microsoft datacenters. With Azure's architecture an application can run locally, run in the cloud, or some combination of both. Applications on Azure can be run as applications, as background processes or services, or as both. The Azure Windows Services Platform API uses the industry standard REST, HTTP, and XML protocols that are part of any Service Oriented Architecture cloud infrastructure to allow applications to talk to Azure. The Azure Service Platform hosts runtime versions of .NET Framework applications written in any of the languages in common use, such as Visual Basic, C++, C#, Java, and any application that has been compiled for .NET's Common Language Runtime (CLR). Azure also can deploy Web-based applications built with ASP.NET, the Windows Communication Foundation (WCF), and PHP, and it supports Microsoft's automated deployment technologies.

P2V enables developers to transfer their physical environment into a digital one, using less hardware and physical space, while giving developers the advantages of VMs, such as more flexibility since VMs can run on multiple platforms.

D2C:

D2C stands for datacenter to cloud. D2C help developers and companies to automate routine DevOps tasks like deployment, configuring, scaling and management apps on servers. D2C is a PaaS for automation of the developer's routine tasks such as configuring the IT-infrastructure, scaling and deployment.

A fast-growing and constantly evolving project requires a managed IT architecture. All the time you have to create test hosts, deploy apps, update the sources, add resources and balance the load.

IT-infrastructure management takes a lot of specialists' time. This is why we have created a PaaS which automates this kind of work and complicated operations reduce to a couple of mouse clicks in the web interface.

**Virtual Machine:**

One of the key features of Load balancing is that it virtualizes systems and resources by mapping a logical address to a physical address. Another fundamental technology for abstraction is to create virtual systems out of physical systems. A virtual machine is a computer that is walled off from the physical computer. Given a computer system with a certain set of resources, one can set aside portions of those resources to create a virtual machine. A virtual machine has all the attributes and characteristics of a physical system but is strictly software that emulates a physical machine. A system virtual machine (or a hardware virtual machine) has its own address space in memory, its own processor resource allocation, and its own device I/O using its own virtual device drivers. Some virtual machines are designed to run only a single application or process and are referred to as process virtual machines. Virtual machines provide the capability of running multiple machine instances, each with their own operating system. Applications running inside an application virtual machine are generally slow, but these programs are very popular because they provide portability, offer rich programming languages, come with many advanced features, and allow platform independence for their programs.

**11. What are the different types of virtualization in cloud computing?**

[MODEL QUESTION]

Answer:

These are among the different types of virtualization that are characteristic of cloud computing:

- **Access:** A client can request access to a cloud service from any location.
- **Application:** A cloud has multiple application instances and directs requests to an instance based on conditions.
- **CPU:** Computers can be partitioned into a set of virtual machines with each machine being assigned a workload. Alternatively, systems can be virtualized through load-balancing technologies.

## **POPULAR PUBLICATIONS**

- **Storage:** Data is stored across storage devices and often replicated for redundancy.

**19. Discuss about the mobility patterns of cloud computing. [MODEL QUESTION]**

**Answer:**

The different types of mobility patterns are:

- **P2V:** Physical to Virtual
- **V2V:** Virtual to Virtual
- **V2P:** Virtual to Physical
- **P2P:** Physical to Physical
- **D2C:** Datacenter to Cloud
- **C2C:** Cloud to Cloud
- **C2D:** Cloud to Datacenter
- **D2D:** Datacenter to Datacenter

**20. What are the several key attributes of cloud computing for which virtualization acts as a key enabler? [MODEL QUESTION]**

**Answer:**

Virtualization is a key enabler of the first four of five key attributes of cloud computing:

- **Service-based:** A service-based architecture is where clients are abstracted from service providers through service interfaces.
- **Scalable and elastic:** Services can be altered to affect capacity and performance on demand.
- **Shared services:** Resources are pooled in order to create greater efficiencies.
- **Metered usage:** Services are billed on a usage basis.
- **Internet delivery:** The services provided by cloud computing are based on Internet protocols and formats.

**21. What is the process of load balancing?**

**[MODEL QUESTION]**

**Answer:**

A load-balancing system can use different mechanisms to assign service direction.

- In the simplest load-balancing mechanisms, the load balancer listens to a network port for service requests.
- When a request from a client or service requester arrives, the load balancer uses a scheduling algorithm to assign where the request is sent.
- Typical scheduling algorithms in use today are round robin and weighted round robin, fastest response time, least connections and weighted least connections, and custom assignments based on other factors.
- A session ticket is created by the load balancer so that subsequent related traffic from the client that is part of that session can be properly routed to the same resource. Without this session record or persistence, a load balancer would not be able to correctly failover a request from one resource to another.
- Other methods can use the client's browser to store a client-side cookie or through the use of a rewrite engine that modifies the URL. Of all these methods, a session cookie stored on the client has the least amount of overhead for a load

## CLOUD COMPUTING

balancer because it allows the load balancer an independent selection of resources.

22. Mention several network resources that can be load balanced.

[MODEL QUESTION]

Answer:

The following network resources can be load balanced:

- Network interfaces and services such as DNS, FTP, and HTTP
- Connections through intelligent switches
- Processing through computer system assignment
- Storage resources
- Access to application instances

23. What is advanced Load balancing?

[MODEL QUESTION]

Answer:

The work of a load balancer include determination of the current utilization of the resources in their pool, the response time, the work queue length, connection latency and capacity, and other factors in order to assign tasks to each resource. Sometimes these load balancers are combined with application servers to make them even more effective and powerful. They are hence known as advance load balancer and their functions are mentioned as advanced load balancing. Google's cloud is a good example of the use of load balancing.

24. What is an ADC?

[MODEL QUESTION]

Answer:

An Application Delivery Controller (ADC) is a combination load balancer and application server that is a server placed between a firewall or router and a server farm providing Web services. An Application Delivery Controller is assigned a virtual IP address (VIP) that it maps to a pool of servers based on application specific criteria. An ADC is a combination network and application layer device. ADCs are sometimes referred to as a content switch, multilayer switch, or Web switch. Some of the vendors selling ADC systems are:

- Cisco Systems (<http://www.cisco.com/>)
- Citrix Systems (<http://www.citrix.com/>)
- F5 Networks (<http://www.f5.com/>)
- Nortel Networks (<http://www.nortel.com/>)
- Coyote Point Systems (<http://www.coyotepoint.com/>)

An ADC is considered to be an advanced version of a load balancer because apart from the regular jobs of a conventional load balancer, they also provide services like data compression, content caching, server health monitoring, security, SSL offload and advanced routing based on current conditions. An ADC is considered to be an application accelerator, and the current products in this area are usually focused on two areas of technology: network optimization, and an application or framework optimization. ADC's are also tuned to accelerate ASP.NET or AJAX applications.

## **POPULAR PUBLICATIONS**

### **25. What is an ADN?**

**[MODEL QUESTION]**

**Answer:**

ADN is an architectural layer containing ADC and it is considered to provide WAN optimization services. The purpose of an ADN is to distribute content to resources based on application specific criteria. ADN provide a caching mechanism to reduce traffic, traffic prioritization and optimization, and other techniques. Most of the ADC vendors offer commercial ADN solutions.

In addition to the ADC vendors in the list above, these are additional ADN vendors, among others:

- Akamai Technologies (<http://www.akamai.com/>)
- Blue Coat Systems (<http://www.bluecoat.com/>)
- CDNetworks (<http://www.cdnetworks.com/>)
- Crescendo Networks (<http://www.crescendonetworks.com/>)
- Expand Networks (<http://www.expand.com/>)
- Juniper Networks (<http://www.juniper.net/>)

### **26. What is paravirtualization?**

**[MODEL QUESTION]**

**Answer:**

On a Type 2 VM, a software interface is created that emulates the devices with which a system would normally interact. This abstraction is meant to place many I/O operations outside the virtual environment, which makes it both programmatically easier and more efficient to execute device I/O than it would be inside a virtual environment. This type of virtualization is sometimes referred to as *paravirtualization*, and it is found in hypervisors such as Microsoft's Hyper-V and Xen.

It is the host operating system that is performing the I/O through a para-API.

### **27. What is machine imaging?**

**[MODEL QUESTION]**

**Answer:**

A system image makes a copy or a clone of the entire computer system inside a single container such as a file. The system imaging program is used to make this image and can be used later to restore a system image. Some imaging programs can take snapshots of systems, and most allow users to view the files contained in the image and do partial restores.

The one open standard for storing a system image is the **Open Virtualization Format or OVF**.

### **28. Explain the concept of simple cloud API.**

**[MODEL QUESTION]**

**Answer:**

Interoperability is a great concern in cloud computing. If an application is built on a platform such as Microsoft Azure, porting that application to Amazon Web Services or GoogleApps may be difficult, if not impossible. In an effort to create an interoperability standard, Zend Technologies has started an open source initiative to create a common application program interface that will allow applications to be portable. The initiative is called the Simple API for Cloud Application Services (<http://www.simplecloud.org/>), and

The effort has drawn interest from several major cloud computing companies. Among the founding supporters are IBM, Microsoft, Nirvanix, Rackspace, and GoGrid.

Simple Cloud API has as its goal a set of common interfaces for:

- **File Storage Services:** Currently Amazon S3, Windows Azure Blob Storage, Nirvanix, and Local storage is supported by the Storage API. There are plans to extend this API to Rackspace Cloud Files and GoGrid Cloud Storage.
- **Document Storage Services:** Amazon SimpleDB and Windows Azure Table Storage are currently supported. Local document storage is planned.
- **Simple Queue Services:** Amazon SQS, Windows Azure Queue Storage, and Local queue services are supported.

Zend intends to add the interface to their open source PHP Framework (<http://www.framework.zend.com>) as the Zend\_Cloud framework component. Vendors such as Microsoft and IBM are supplying adapters that will use part of the Simple Cloud API for their cloud application services.

### 28. What is an AppZero Virtual Application Appliance?

[MODEL QUESTION]

**Answer:**  
Applications that run in datacenters are captive to the operating systems and hardware platforms that they run on. So moving an application from one platform to another isn't nearly as simple as moving a machine image from one system to another. The situation is further complicated by the fact that applications are tightly coupled with the operating systems on which they run. An application running on Windows, for example, isn't isolated from other applications. When the application loads, it often loads or uses different Dynamic Link Libraries (DLL), and it is through the sharing or modification of DLLs that Windows applications get themselves in trouble. Further modifications include modifying the registry during installation. These factors make it difficult to port applications from one platform to another without lots of careful work. The ability to run an application from whatever platform you want is not one of the characteristics of cloud computing. While the Simple Cloud API is useful for applications written in PHP, other methods may be needed to make applications easily portable. One company working on this problem is AppZero (<http://www.appzero.com/>), and its solution is called the Virtual Application Appliance (VAA).

### 29. How does a VAA work?

[MODEL QUESTION]

**Answer:**

The following steps may put some light on how VAA works.

- AppZero solution creates a virtual application appliance as an architectural layer between the Windows or the UNIX operating system and applications.
- The virtualization layer serves as the mediator for file I/O, memory I/O, and application calls and response to DLLs, which has the effect of sandboxing the application.
- The running application in AppZero changes none of the registry entries or any of the files on the Windows Server.

## **POPULAR PUBLICATIONS**

- VAA creates a container that encapsulates the application and all the application's dependencies within a set of files; it is essentially an Application Image for a specific OS.
- This container forms an installable server-side application stack that can be run after installation, but has no impact on the underlying operating system.
- VAAs are created using the AppZero Creator wizard, managed with the AppZero Admin tool, and may be installed using the AppZero Director, which creates a VAA runtime application. If desired, an application called AppZero Dissolve removes the VAA virtualization layer from the encapsulated application and installs that application directly into the operating system.

### **31. Define a PaaS service.**

**[MODEL QUESTION]**

#### **Answer:**

Platform as a Service model is the most interesting of all the hosted services in cloud computing. PaaS models span a broad range of services, including these, among others:

- **Application development:** A PaaS platform either provides the means to use programs the users create in a supported language or offers a visual development environment that writes the code for him.
- **Collaboration:** Many PaaS systems are set up to allow multiple individuals to work on the same projects.
- **Data management:** Tools are provided for accessing and using data in a data store.
- **Instrumentation, performance, and testing:** Tools are available for measuring the applications and optimizing their performance.
- **Storage:** Data can be stored in either the PaaS vendor's service or accessed from a third-party storage service.
- **Transaction management:** Many PaaS systems provide services such as transaction managers or brokerage service for maintaining transaction integrity.

### **32. Write about the application development of PaaS.**

**[MODEL QUESTION]**

#### **Answer:**

A PaaS provides the tools needed to construct different types of applications that can work together in the same environment. These are among the common application types:

- Composite business applications
- Data portals
- Mashups of multiple data sources

A *mashup* is a Web page that displays data from two or more data sources. The various landmarks and overlays found in Google Earth, or annotated maps, are examples of mashups. These applications must be able to share data and to run in a multi-tenant environment. To make applications work together more easily, a common development language such as Java or Python is usually offered. The use of application frameworks such as Ruby on Rails is useful in making application building easier and more powerful. Most of the application building tools in PaaS create their own frameworks. Many are

based on visual tools, and often these tools allow developers to extend applications using a common language for Web application development. These applications almost always adopt a Service Oriented Architecture model and use SOAP/REST with XML data exchange.

**33. What is a PaaS application framework?****[MODEL QUESTION]**

**Answer:** Application frameworks provide a means for creating applications hosted by PaaS using a unified development environment or an *integrated development environment* (IDE). PaaS IDEs may be created from a tool that requires a dedicated programming staff to create and run to point-and-click graphical interfaces. The interfaces may be navigated by knowledgeable computer users and create something useful. The portability of the applications that can be created in a PaaS is an extremely valuable feature.

**34. What is a CMS?****[MODEL QUESTION]**

**Answer:** Many Web sites are based on the notion of information management and organization; they are referred to as *content management systems* (CMS). A database is a content management system, but the notion of a Web site as a CMS adds a number of special features to the concept that includes rich user interaction, multiple data sources, and extensive customization and extensibility. The Drupal CMS was chosen as an example of this type of PaaS because it is so extensively used and has broad industry impact, and it is a full-strength developer tool. Whereas Drupal is used in major Web sites and organizes vast amounts of information, the site Squarespace.com was chosen to illustrate a point-and-click CMS system aimed at supporting individuals, small businesses, and other small organizations. Squarespace is often associated with blogging tools (as is Drupal), but it is more than that. Squarespace works with photos, imports information from other social tools, and allows very attractive Web sites to be created by average users.

**35. What are the common characteristics of the web based applications created via PaaS?****[MODEL QUESTION]****Answer:**

The various characteristics are as follows:

- They separate data-handling from presentation (user interface).
- They offer tools for establishing business objects or entities and the relationships between them.
- They support the incorporation of business rules, logic, and actions.
- They provide tools for creating data entry controls (forms), views, and reports.
- They provide instrumentation, tools for measuring application performance.
- They support packaging and deployment of applications.

## **MODULE 3**

### **Multiple Choice Type Questions**

- 1. What is the name of the organization helping to foster security standards for cloud computing? [WBUT 2014]**
- a) cloud security standards working      b) cloud security alliance  
c) cloud security watchdog      d) security in the cloud alliance
- Answer: (c)**
- 2. What is the number one concern about cloud computing? [WBUT 2014, 2017]**
- a) too expensive      b) security concerns  
c) too many platforms      d) accessibility
- Answer: (b)**
- 3. Which of the following is perceived as the number one concern about cloud computing? [WBUT 2015]**
- a) complex accessibility      b) too expensive  
c) high latency      d) information security
- Answer: (d)**
- 4. Geographic distribution of data across a cloud service provider's network is perceived as a major issue for many organizations because it: [WBUT 2015]**
- a) makes data recovery harder      b) adds more latency  
c) complicates regulatory compliance      d) raises security concerns
- Answer: (d)**
- 5. Which one is not a PaaS Service? [WBUT 2016]**
- a) Windows Azure      b) Google App Engine  
c) Salesforce      d) Oracle Database as a Service
- Answer: (c)**
- 6. DCOM, RMI, COBRA are different forms of [WBUT 2016]**
- a) RPC      b) IPC      c) SOA      d) Web Services
- Answer: (a)**
- 7. Different message passing topologies in SOA are respectively Circular, Network, Star and [WBUT 2016]**
- a) Stove and Pipe      b) Hub and Spoke  
c) Mesh      d) Hierarchical
- Answer: (a)**

**Short & Long Answer Type Questions**

1. a) Describe briefly with suitable diagram life cycle management of cloud service.  
[WBUT 2014]

OR,

What is Life Cycle of Cloud Computing? Explain.

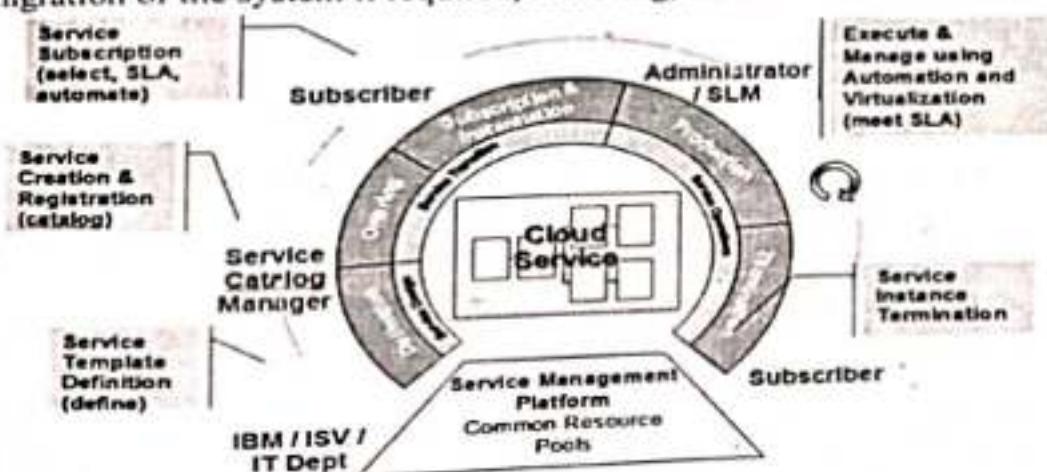
[WBUT 2018]

b) Draw the diagram of CSA cloud reference model with security boundaries.  
[WBUT 2014]

**Answer:**

a) Cloud services have a defined lifecycle that a management program needs to know and implement at each of the six different stages in that lifecycle:

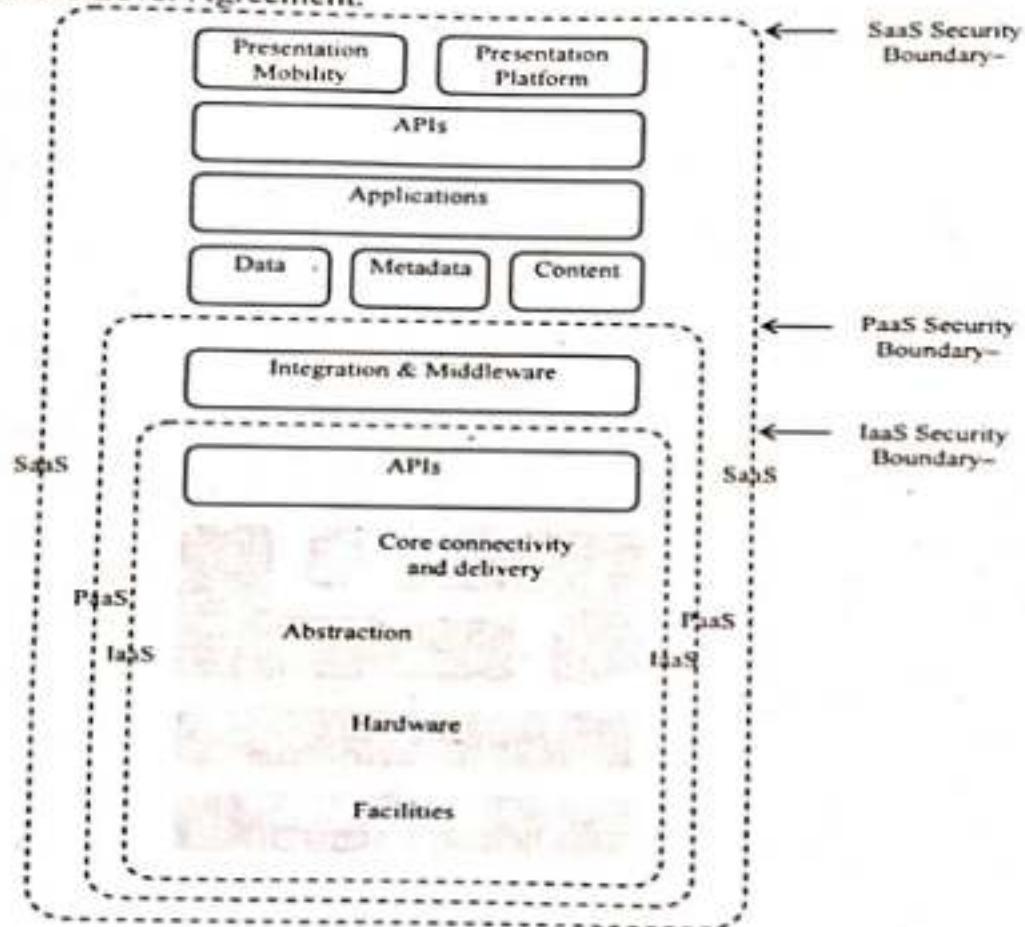
1. **Phase 1:** Define the services to be provided in a template: The tasks include creating, updating, deleting the templates that are used for creating instances in the cloud.
2. **Phase 2:** Interactions of the services through an SLA: The main task of this phase is to manage and maintain the clients relationships, create and manage the service contracts.
3. **Phase 3:** Deployment of the instance to the cloud and managing them at the runtime: This phase deals with creating, updating and deleting the service offerings.
4. **Phase 4:** Defining the attributes of the operating services, and modifying the properties: Few tasks like managing the operating services and modification of the same are involved in this phase.
5. **Phase 5:** Managing the instances and performing routine maintenance: The business must monitor the resources, track, respond to events, perform reporting and billing, and other tasks.
6. **Phase 6:** Retirement of the service: At this phase the tasks are to protect the data, migration of the system if required, archiving, service contract renewal etc.



## **POPULAR PUBLICATIONS**

b) Service in cloud computing includes IaaS, PaaS, SaaS etc. The security of the services vary to a great extent, from each other. For example, IaaS has the lowest level of security, whereas the other two is more secured. As one moves upward in the stack, each service model inherits the capabilities of the model beneath it, as well as all the inherent security concerns and risk

factors. IaaS supplies the infrastructure; PaaS adds application development frameworks, transactions, and control structures; and SaaS is an operating environment with applications, management, and the user interface. As one ascends the stack, IaaS has the least levels of integrated functionality and the lowest levels of integrated security, and SaaS has the most. The most important lesson from this discussion of architecture is that each different type of cloud service delivery model creates a security boundary at which the cloud service provider's responsibilities end and the customer's responsibilities begin. Any security mechanism below the security boundary must be built into the system, and any security mechanism above must be maintained by the customer. As one move up the stack, it becomes more important to make sure that the type and level of security is part of your Service Level Agreement.



## CLOUD COMPUTING

In the SaaS model, the vendor provides security as part of the Service Level Agreement, with the compliance, governance, and liability levels stipulated under the contract for the entire stack. For the PaaS model, the security boundary may be defined for the vendor to include the software framework and middleware layer. In the PaaS model, the customer would be responsible for the security of the application and UI at the top of the stack. The model with the least built-in security is IaaS, where everything that involves software of any kind is the customer's problem.

Model Type	Infrastructure Security Management	Infrastructure Owner	Infrastructure Location	Trust condition
Hybrid	Both vendor and Customer	Both vendor and customer	Both on- and off-premises	Both trusted and untrusted
Private	Customer	Customer	On or off-premises	Trusted
Private	Customer	Vendor	On or off-premises	Trusted
Private	Vendor	Customer	On or off-premises	Trusted
Private	Vendor	Vendor	On or off-premises	Trusted
Public	Vendor	Vendor	Off Premises	Untrusted

2. Describe Cloud Security Model as defined by Cloud Security Alliance.

[WBUT 2015]

OR,

Explain cloud computing security architecture.

[WBUT 2016]

Answer:

It is important for the business house to know what security is already built in the cloud computing system deployed in the organization, and according to CSA (Cloud Security Alliance) there are several security boundaries of the system:

- Governance and enterprise risk management
- Legal and electronic discovery
- Compliance and audit
- Information lifecycle management
- Portability and interoperability
- Traditional security, business continuity, and disaster recovery
- Datacenter operations
- Incidence response, notification, and remediation
- Application security
- Encryption and key management
- Identity and access management
- Virtualization

Also Refer to Question No. 1(b) of Short & Long Answer Type Questions.

3. What are the types of services required in implementation of the cloud computing system?

[MODEL QUESTION]

Answer:

Implementing a cloud computing system is not an easy task to achieve, in fact it takes lots of planning, consulting and in most cases lots of time like from 3 months to 1 year. Cloud computing for many larger organizations can be extremely complex. Implementing

## **POPULAR PUBLICATIONS**

a cloud computing system will ultimately require significant changes on staff and work practices. While it may seem reasonable for an in house IT staff to head the project, it is widely advised that cloud computing implementation consultants be used. The main reason is that the consultants are usually more cost effective and are specifically trained in implementing these types of systems.

One of the most important traits that an organization should have when implementing an cloud computing system is ownership of the project. Because so many changes take place and its broad effect on almost every individual in the organization, it is important to make sure that everyone is on board and will help make the project and using the new cloud computing system a success.

Usually organizations use cloud computing vendors or consulting companies to implement their customized cloud computing system. There are three types of professional services that are provided when implementing a cloud computing system: Consulting, Configuration, Customization and Support.

- **Consulting Services:** usually consulting services are responsible for the initial stages of cloud computing implementation, they help an organization go live with their new system, with product training, workflow, improve cloud computing use in the specific organization, etc.
- **Configuration:** Before starting the installation of the software, a check is made on the systems to verify whether they could meet the requirements for the software and service to run without any problem. If the systems don't meet the requirement, the company should upgrade their system configuration. Once the configurations are verified, installation procedure is started.
- **Customization Services:** Customization services work by extending the use of the new cloud computing system or changing its use by creating customized interfaces and/or underlying application code. While cloud computing systems are made for many core routines, there are still some needs that need to be built or customized for an organization.
- **Support Services:** Support services include both support and maintenance of cloud computing systems. For instance, trouble shooting and assistance with cloud computing issues.

### **4. What are the features of a Network Management system? [MODEL QUESTION]**

**Answer:**

These fundamental features are offered by traditional network management systems:

- Administration of resources
- Configuring resources
- Enforcing security
- Monitoring operations
- Optimizing performance
- Policy management
- Performing maintenance
- Provisioning of resources

## CLOUD COMPUTING

5. Name few Network management vendors.

ANSWER:

- BMC PATROL,
- CA Unicenter,
- IBM Tivoli,
- HP OpenView, and
- Microsoft System Center.

[MODEL QUESTION]

6. How to monitor an entire cloud computing deployment stack?

[MODEL QUESTION]

ANSWER:  
To monitor an entire cloud computing deployment stack, you monitor six different categories:

1. End-user services such as HTTP, TCP, POP3/SMTP, and others
2. Browser performance on the client
3. Application monitoring in the cloud, such as Apache, MySQL., and so on
4. Cloud infrastructure monitoring of services such as Amazon Web Services, GoGrid, Rackspace, and others
5. Machine instance monitoring where the service measures processor utilization, memory usage, disk consumption, queue lengths, and other important parameters
6. Network monitoring and discovery using standard protocols like the Simple Network Management Protocol (SNMP), Configuration Management Database (CMDB), WindowsManagement Instrumentation (WMI).

7. What are the security concerns of the cloud?

[MODEL QUESTION]

ANSWER:

Cloud computing security concerns differ from model to model, and each of them need a different security services. Inbuilt security is least in the IaaS whereas the maximum amount of security is provided by the SaaS. The concerns are:

- Determine which resources (data, services, or applications) you are planning to move to the cloud.
- Storing data which is huge in amount
- Proper encryption is needed while storing them as well as transferring them from one user to the other.
- Proxy servers may be used to ensure that the clients are not getting the direct access to the shared cloud storage.
- Restrictions must be provided in logging, auditing, and maintaining regulatory compliances, by the users as well as by the administrator.
- Maintaining data integrity and privacy is also a security concern for cloud computing.
- Recovering data from the cloud also needs few security measures to protect them from being misused.
- Determine the risks associated with the type of clouds (private, public and hybrid) or cloud service models (SaaS, PaaS, IaaS).

## **POPULAR PUBLICATIONS**

### **8. What is the security boundary of cloud computing?**

[MODEL QUESTION]

**Answer:**

It is important for the business house to know what security is already built in the cloud computing system deployed in the organization, and according to CSA (Cloud Security Alliance) there are several security boundaries of the system:

- Governance and enterprise risk management
- Legal and electronic discovery
- Compliance and audit
- Information lifecycle management
- Portability and interoperability
- Traditional security, business continuity, and disaster recovery
- Datacenter operations
- Incidence response, notification, and remediation
- Application security
- Encryption and key management
- Identity and access management
- Virtualization

### **9. Give an overview of the security mapping.**

[MODEL QUESTION]

**Answer:**

The cloud service model that a business hours chooses determines where the variety of security features, compliance auditing, and other requirements must be placed. To determine the particular security mechanisms the business house must perform a mapping of the particular cloud service model to the particular application deployed. These mechanisms must be supported by the various controls that are provided by the service provider, the organization, or a third party. A security control model includes the security that is normally used for the applications, data, management, network, and physical hardware. The business may also need to account for any compliance standards that are required for that particular industry. A compliance standard can be any government regulatory framework such as Payment Card Industry Data Security Standards (PCI-DSS), Health Insurance Portability and Accountability Act (HIPPA), Gramm-Leach-Bliley Act (GLBA), or the Sarbanes-Oxley Act (SOX) that requires the business to operate in a certain way and keep records.

### **10. What are the different means of securing data?**

[MODEL QUESTION]

**Answer:**

Securing data sent to, received from, and stored in the cloud is the single largest security concern that most organizations should have with cloud computing. As with any WAN traffic, the organization must assume that any data can be intercepted and modified. That's why, as a matter of course, traffic to a cloud service provider and stored off-premises is encrypted. This is as true for general data as it is for any passwords or account IDs.

These are the key mechanisms for protecting data mechanisms:

- Access control
- Auditing
- Authentication
- Authorization

Whatever service model the business house chooses should have mechanisms operating in all four areas that meet the security requirements, whether they are operating through the cloud service provider or at the local infrastructure.

#### 11. What is brokered cloud storage access?

[MODEL QUESTION]

Answer:

The problem with the data stored in the cloud is that it can be located anywhere in the cloud service provider's system: in another datacenter, another state or province, and in many cases even in another country. With other types of system architectures, such as client/server, the business could count on a firewall to serve as the network's security perimeter; cloud computing has no physical system that serves this purpose. Therefore, to protect cloud storage assets, one must want to find a way to isolate data from direct client access.

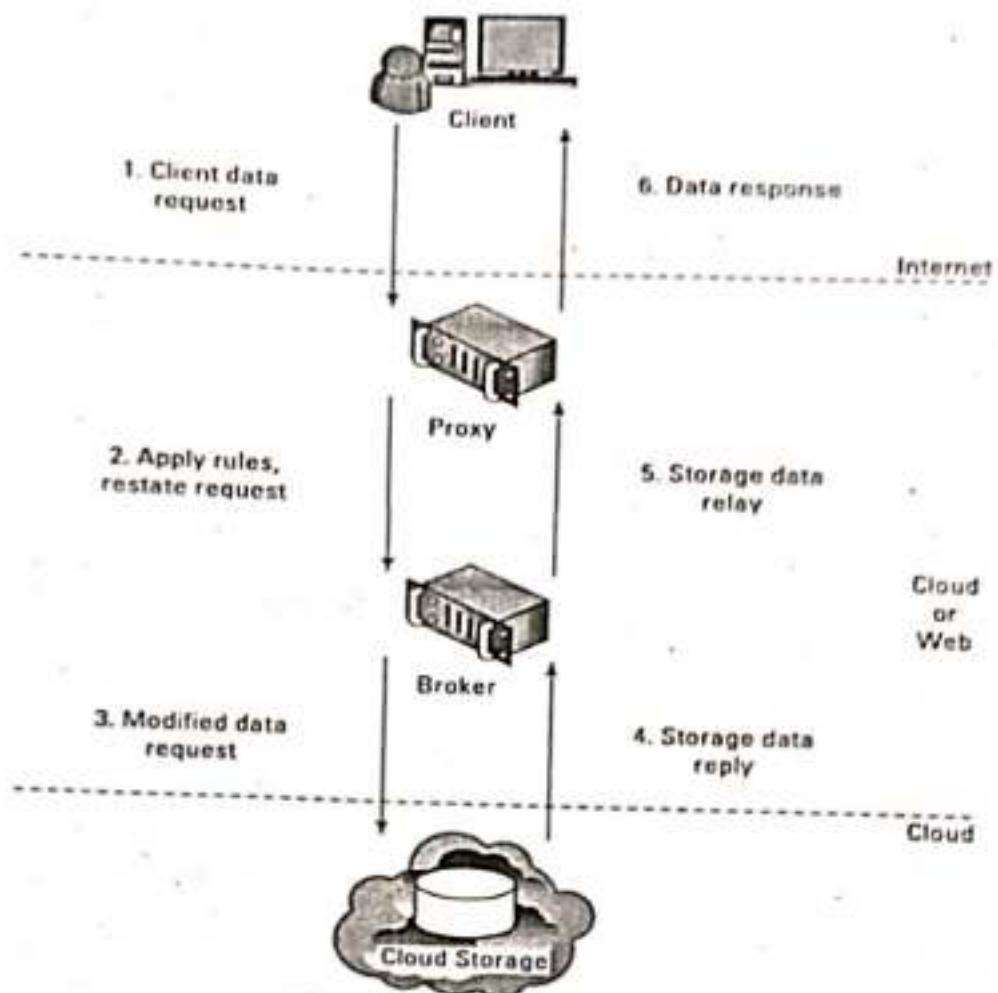
One approach to isolating storage in the cloud from direct client access is to create layered access to the data. In one scheme, two services are created: a broker with full access to storage but no access to the client, and a proxy with no access to storage but access to both the client and broker. The location of the proxy and the broker is not important (they can be local or in the cloud); what is important is that these two services are in the direct data path between the client and data stored in the cloud.

Under this system, when a client makes a request for data, here's what happens:

1. The request goes to the external service interface (or endpoint) of the proxy, which has only a partial trust.
2. The proxy, using its internal interface, forwards the request to the broker.
3. The broker requests the data from the cloud storage system.
4. The storage system returns the results to the broker.
5. The broker returns the results to the proxy.
6. The proxy completes the response by sending the data requested to the client.

This design relies on the proxy service to impose some rules that allow it to safely request data that is appropriate to that particular client based on the client's identity and relay that request to the broker. The broker does not need full access to the cloud storage, but it may be configured to grant READ and QUERY operations, while not allowing APPEND or DELETE. The proxy has a limited trust role, while the broker can run with higher privileges or even as native code.

## **POPULAR PUBLICATIONS**



### **12. Why is encryption important for cloud computing?**

**Answer:**

**[MODEL QUESTION]**

Strong encryption technology is a core technology for protecting data in transit to and from the cloud as well as data stored in the cloud. The goal of encrypted cloud storage is to create a virtual private storage system that maintains confidentiality and data integrity while maintaining the benefits of cloud storage: ubiquitous, reliable, shared data storage. Encryption should separate stored data (data at rest) from data in transit. Depending upon the particular cloud provider, the business can create multiple accounts with different keys as per the platform chosen. Microsoft allows up to five security accounts per client, and one can use these different accounts to create different zones. On Amazon Web Service, one can create multiple keys and rotate those keys during different sessions. Although encryption protects data from unauthorized access, it does nothing to prevent data loss. Indeed, a common means for losing encrypted data is to lose the keys that provide access to the data.

## CLOUD COMPUTING

Therefore, one needs to approach key management seriously. Keys should have a defined lifecycle. Among the schemes used to protect keys are the creation of secure key stores that have restricted role-based access, automated key stores backup, and recovery techniques. It's a good idea to separate key management from the cloud provider that hosts the data.

### **13. What is the importance of auditing and compliance in cloud computing?**

[MODEL QUESTION]

**Answer:** In business, Logging is the recording of events into a repository; auditing is the ability to monitor the events to understand performance. Logging and auditing is an important function because it is not only necessary for evaluation performance, but it is also used to investigate security and when illegal activity has been perpetrated. Logs should record system, application, and security events, at the very minimum. Logging and auditing are unfortunately one of the weaker aspects of early cloud computing service offerings. Cloud service providers often have proprietary log formats that you need to be aware of. Whatever monitoring and analysis tools one uses, he needs to be aware of these logs and able to work with them. As it stands now, nearly all regulations were written without keeping cloud computing in mind. A regulator or auditor isn't likely to be familiar with the nature of running applications and storing data in the cloud. Even so, laws are written to ensure compliance, and the client is held responsible for compliance under the laws of the governing bodies that apply to the location where the processing or storage takes place.

Therefore, the business must understand the following:

- Which regulations apply to use of a particular cloud computing service
- Which regulations apply to the cloud service provider and where the demarcation line falls for responsibilities
- How the cloud service provider will support the need for information associated with regulation
- How to work with the regulator to provide the information necessary regardless of who had the responsibility to collect the data.

### **14. What are identity control protocols?**

[MODEL QUESTION]

**Answer:**

Identity management is a primary mechanism for controlling access to data in the cloud, preventing unauthorized uses, maintaining user roles, and complying with regulations. Identities also are important from a security standpoint because they can be used to authenticate client requests for services in a distributed network system such as the Internet or, in this case, for cloud computing services. There are few protocols that provide identity services, which are as follows:

- OpenID 2.0 (<http://openid.net/>) is the standard associated with creating an identity and having a third-party service authenticate the use of that digital identity. It is the key to creating Single Sign-On (SSO) systems. Some cloud service providers have

## POPULAR PUBLICATIONS

adopted OpenID as a service, and its use is growing. OpenID doesn't specify the means for authentication of an identity, and it is up to the particular system how the authentication process is executed. Authentication can be by a Challenge and Response Protocol (CHAP), through a physical smart card, or using a flying finger or evil eye through a biometric measurement. In OpenID, the authentication procedure has the following steps:

1. The end-user uses a program like a browser that is called a user agent to enter an OpenID identifier, which is in the form of a URL or XRI. An OpenID might take the form of *name openid provider org*.
  2. The OpenID is presented to a service that provides access to the resource that is desired.
  3. An entity called a relaying party queries the OpenID identity provider to authenticate the veracity of the OpenID credentials.
  4. The authentication is sent back to the relaying party from the identity provider and access is either provided or denied.
- The second protocol used to present identity-based claims in cloud computing is a series of authorization markup languages that create files in the form of being XACML and SAML. SAML (Security Assertion Markup Language; [http://www.oasis-open.org/committees/tc\\_home.php?wg\\_abbrev=security](http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=security)) is gaining growing acceptance among cloud service providers. It is a standard of OASIS and an XML standard for passing authentication and authorization between an identity provider and the service provider. SAML is a complimentary mechanism to OpenID and is used to create SSO systems.
  - An open standard called OAuth (<http://oauth.net/>) provides a token service that can be used to present validated access to resources. OAuth is similar to OpenID, but provides a different mechanism for shared access. The use of OAuth tokens allows clients to present credentials that contain no account information (userID or password) to a cloud service. The token comes with a defined period after which it can no longer be used. Several important cloud service providers have begun to make OAuth APIs available based on the OAuth 2.0 standard, most notably Facebook's Graph API and the Google Data API.

**MODULE 4****Multiple Choice Type Questions**

1. Which company recently shut the doors on its storage service? [WBUT 2014]  
 a) Hitachi data systems      b) savvis  
 c) iron mountain      d) Symantec  
 Answer: (c)
2. Which one of these techniques is vital for creating cloud-computing centers?  
 a) Virtualization      b) Transubstantiation [WBUT 2017]  
 c) Cannibalization      d) Insubordination  
 Answer: (a)
3. An internal cloud is [WBUT 2017]  
 a) An overhanging threat  
 b) A career risk for a CIO  
 c) A cloud that sits behind a corporate firewall  
 d) The group of knowledge workers who use a social network for water-cooler gossip.  
 Answer: (c)
4. Rackspace Cloud Service is an example of [WBUT 2018]  
 a) IaaS      b) SaaS      c) PaaS      d) All of these  
 Answer: (a)
5. \_\_\_\_\_ is a standard method for requesting services from distributed components and managing the results. [MODEL QUESTION]  
 a) Service oriented architecture      b) Service orientation architecture  
 c) service operable architecture      d) service management architecture  
 Answer: (a)
6. Which one is the commonly used message passing format for SOA? [MODEL QUESTION]  
 a) XML      b) SOAP      c) WLAN      d) none of these  
 Answer: (b)
7. Which one of them is not a feature of ESB? [MODEL QUESTION]  
 a) Monitoring services      b) Data abstraction services  
 c) Data delivery service      d) Security services  
 Answer: (c)
8. An example of non relational cloud storage systems is [MODEL QUESTION]  
 a) Microsoft data center      b) Amazon storage system  
 c) Windows server 2008      d) Windows Azure  
 Answer: (d)

## POPULAR PUBLICATIONS

9. A cloud can serve as excess capacity at times of high volume. This is called [MODEL QUESTION]  
 a) Cloud storage  
 b) cloud bursting  
 c) cloud management  
 d) cloud monitoring
- Answer: (b)
10. VMWare vCloud is a [MODEL QUESTION]  
 a) Cloud API  
 b) cloud monitor  
 b) Cloud storage  
 d) none of these
- Answer: (a)

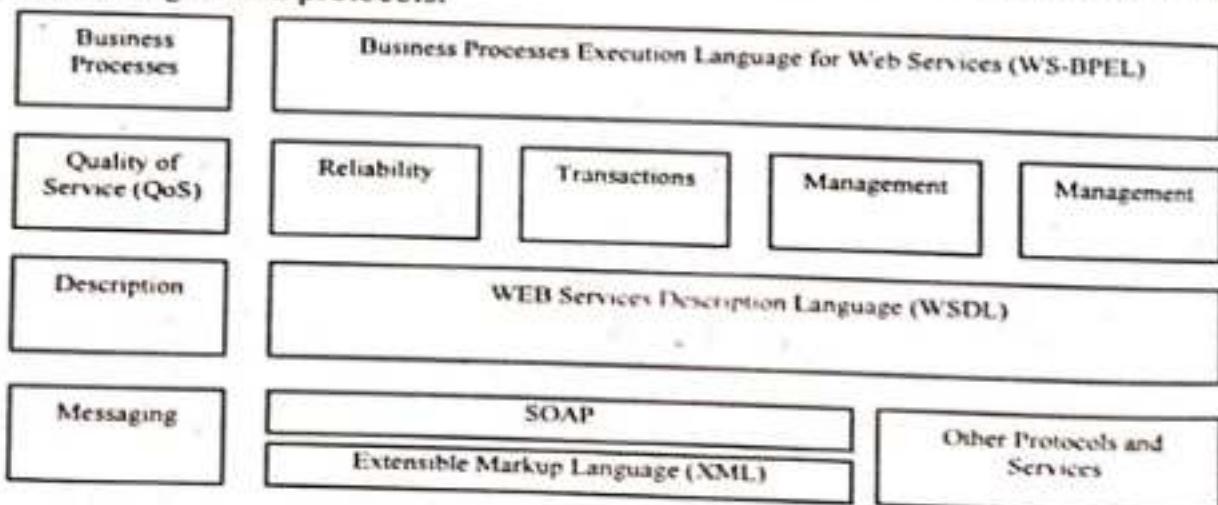
## Short & Long Answer Type Questions

1. Previously explain protocol Stack for a SOA architecture with diagram. [WBUT 2010]

OR,  
 Explain the protocol stack for Service oriented Architecture (SOA) with a new diagram. [WBUT 2010]

Answer:

SOA provides the framework needed to allow clients of any type to engage in a request-response mechanism with a service. Figure below shows a protocol stack for an SOA architecture and how those different protocols execute the functions required in the Service Oriented Architecture. In the figure, the box labeled Other Services could include Common Object Request Broker Architecture (CORBA), Representational State Transfer (REST), Remote Procedure Calls (RPC), Distributed Common Object Model (DCOM), Jini, Data Distribution Service (DDS), Windows Communication Foundation (WCF), and other technologies and protocols.



2. What are typical features of an ESB? What are the different types of catalogues? [WBUT 2010]

**Answer:**

**1<sup>st</sup> Part:** These typical features are found in ESBs, among others:

- **Monitoring services** aid in managing events.
- **Process management services** manage message transactions.
- **Data repositories or registries** store business logic and aid in governance of business processes.
- **Data services** pass messages between clients and services.
- **Data abstraction services** translate messages from one format to another, as required.
- **Governance** is a service that monitors compliance of the business operations with governmental regulation, which can vary from state to state and from country to country.
- **Security services** validate clients and services and allow messages to pass from one to the other.

**2<sup>nd</sup> Part:**

Service catalogs are dynamic and under constant modification. Catalog servers have these features:

- They can be **standalone catalog servers** serving a single site.
- They serve the role of a **global catalog service** where two or more catalog servers are merged to include several sites. A global service usually requires some sort of synchronization or update to maintain a unified data store across the servers involved.
- They can be part of a **federated catalog service** where two or more global catalog servers have access to one another's information through a trusted query relationship.

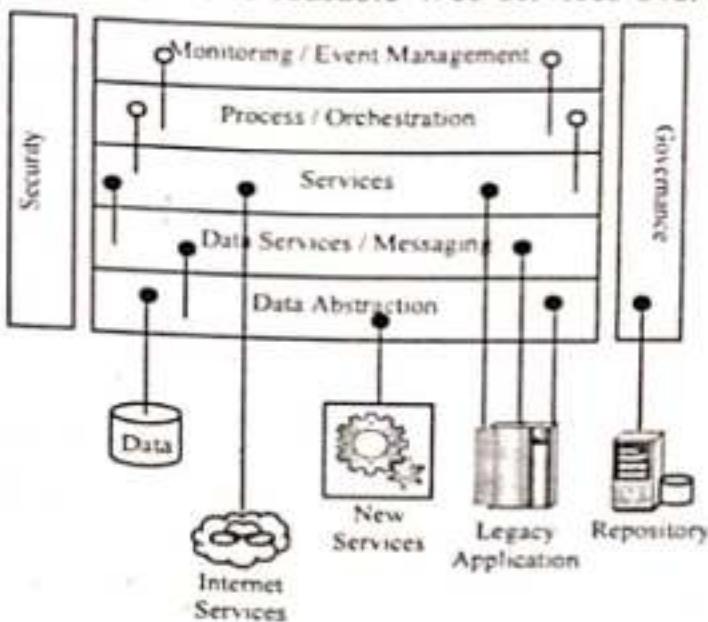
Catalog services have an enormous impact on large system performance and eventually become essential as a SOA internetwork system grows. An internetwork is a network that is constructed through the consolidation of separate networks, in the same manner that the Internet has been built.

**3. What is SOA?****[MODEL QUESTION]****Answer:**

A service is a repeatable task within a business process, and a business task is a composition of services. Service Oriented Architecture (SOA) describes a standard method for requesting services from distributed components and managing the results. The clients requesting services, the components providing the services, the protocols used to deliver messages, and the responses can vary widely, hence SOA is required. Service Oriented Architecture (SOA) is a specification and a methodology for providing platform- and language-independent services for use in distributed applications. SOA provides the translation and management layer in an architecture that removes the barrier for a client obtaining desired services. With SOA, clients and components can be written in different languages and can use multiple messaging protocols and networking protocols to communicate with one another. SOA provides the standards that transport

## POPULAR PUBLICATIONS

the messages and provides access to reusable Web services over a TCP/IP network, as well.



### **4. How does SOA work through a message based transactions?**

**[MODEL QUESTION]**

**Answer:**

SOA describes a message-passing wayout for a component-based architecture that provides services to clients upon demand.

- Clients access a component that complies with SOA by passing a message containing metadata to be acted upon in a standard format.
- The component acts on that message and returns a response that the client then uses for its own purpose.
- A common example of a message is an XML file transported over a network protocol such as SOAP.
- Usually service providers and service consumers do not pass messages directly to each other.
- Implementations of SOA employ middleware software to play the role of transaction manager (or broker) and translator. That middleware can discover and list available services, as well as potential service consumers, often in the form of a registry, because SOA describes a distributed architecture security and trust services are built directly into many of these products to protect communication.
- Middleware products also can be where the logic of business processes reside; they can be general-purpose applications, industry-specific, private, or public services.
- Middleware services manage lookup requests. The Universal Description Discovery and Integration (UDDI) protocol is the one most commonly used to broadcast and discover available Web services, often passing data in the form of an Electronic Business using eXtensible Markup Language (ebXML) documents.

## CLOUD COMPUTING

- Service consumers find a Web service in a broker registry and bind their service requests to that specific service; if the broker supports several Web services, it can bind to any of the ones that are useful.
- The message presents data to the service, and the service responds. It is up to the client to determine if the service returned an appropriate result.
- An SOA is then seen as a method for creating an integrated process as a set of linked services. The component exposes itself as an "endpoint" (a term of art in SOA) to the client.

### **5. What are the commonly used message passing format for SOA?**

[MODEL QUESTION]

**Answer:**

The most commonly used message-passing format is an Extensible Markup Language (XML) document using Simple Object Access Protocol (SOAP), but many more are possible, including Web Services Description Language (WSDL), Web Services Security (WSS), and Business Process Execution Language for Web Services (WS-BPEL). WSDL is commonly used to describe the service interface, how to bind information, and the nature of the component's service or endpoint. The Service Component Definition Language (SCDL) is used to define the service component that performs the service, providing the component service information that is not part of the Web service and that therefore wouldn't be part of WSDL.

### **6. What is an event driven SOA?**

[MODEL QUESTION]

**Answer:**

Event-driven SOA is an extension of the Service Oriented Architecture to respond to events that occur as a result of business processes or perhaps cause and influence a business process. For example, in a business process, sales at a certain Web site are processed. If the business process recognizes the rate at which sales are occurring, it could perform an analysis to determine what events might influence the buying decision. This is the sort of analysis that event-driven SOA is meant to address. Event driven SOA is often termed as SOA 2.0.

- To perform these tasks in SOA 2.0, a Causal Vector Engine (CVE) with some built-in artificial intelligence must be added to the SOA design.
- Events are analyzed in terms of event sequences, event relationships, and event timing to establish whether a certain condition has occurred by the CVE.
- The CVE then determines how to react to the condition using a set of rules that are built into the system.
- From the standpoint of the service requestor or consumer (client), the client simply needs to know the form required to initiate the action of the provider (service) and how to interpret the results returned from the service provider.
- The nature of the component's processing is unknown, the location where the processing is done is unknown, and the various operating systems and applications involved are unknown.

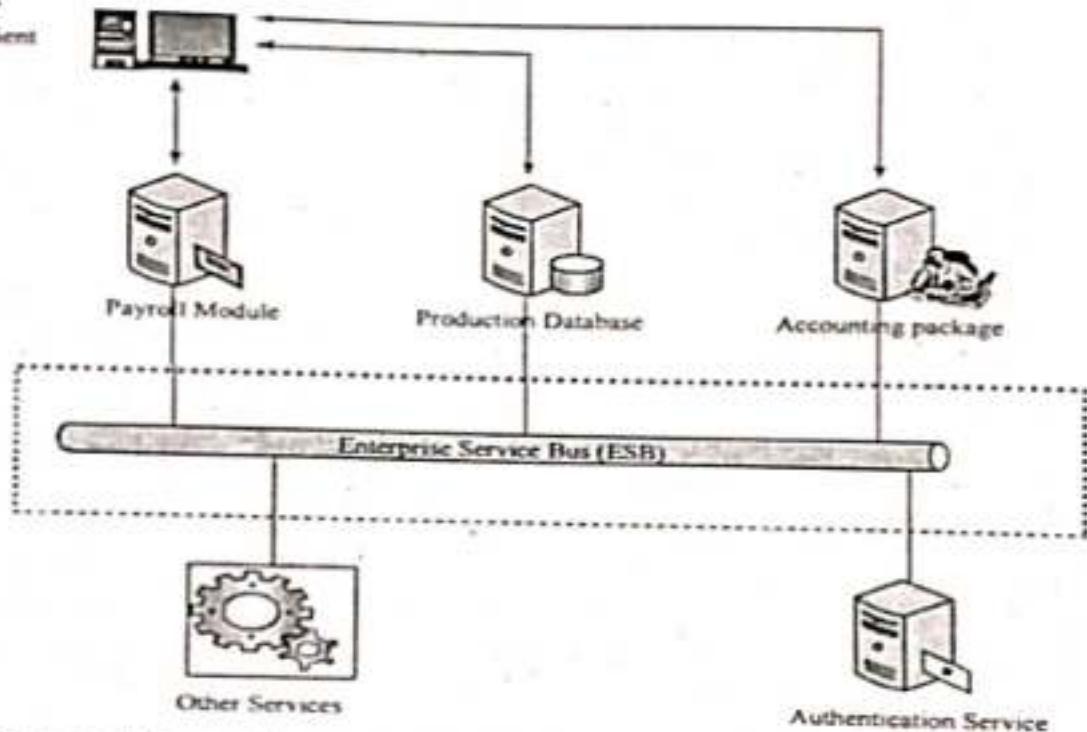
## **POPULAR PUBLICATIONS**

- The client is responsible for validating that the service returned the results that were expected.
- The SOA component is essentially a black box to the client. That is, SOA makes no demands of the component other than to conform to the rules of a standard endpoint. This level of abstraction offers operational advantages to Web service providers in that components can be continually upgraded, replaced, or moved to improve efficiencies without disrupting the clients that depend on those services, and the Quality of Service for that service can be accurately measured and delivered.
- In SOA, the service has been virtualized.

### **7. What is an enterprise service bus in cloud computing?**

**[MODEL QUESTION]**

**Answer:**



An ESB is a architectural pattern comprised of a set of network services that manage transactions in a Service Oriented Architecture. In the figure, three hypothetical different applications are shown interfaced with an authentication module through an Enterprise Service Bus (ESB). Messages flow from client to component through the ESB, which manages these transactions, even though the location of the services comprising the ESB may vary widely. An ESB therefore plays the role of a transaction broker in SOA, ensuring that messages go where they are supposed to go and are acted upon properly. The service bus performs the function of mediation: message translation, registration, routing, logging, auditing, and managing transactional integrity. Transactional integrity is similar to ACID in a database system—atomicity, consistency, isolation, and durability.

## CLOUD COMPUTING

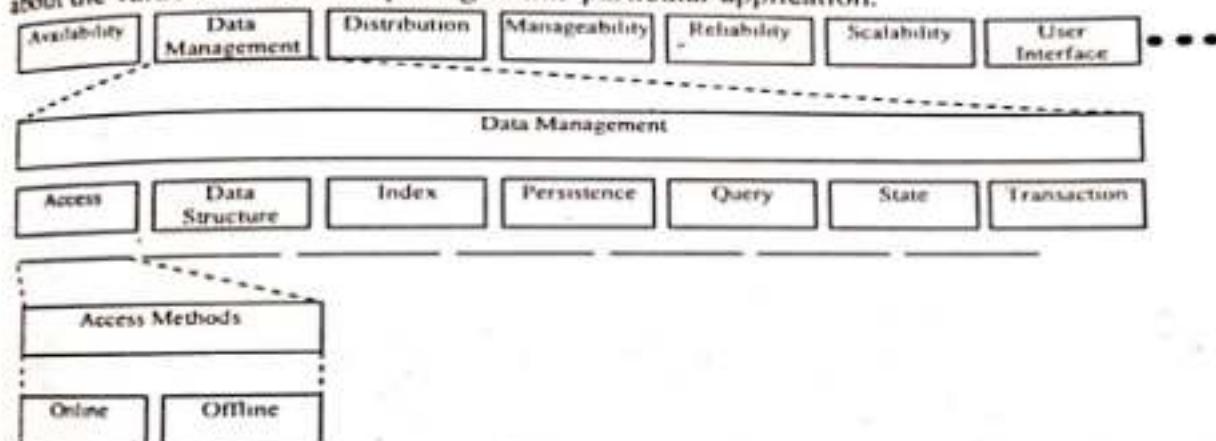
the essence of which is that transactions succeed or they fail and are rolled back. An ESB may be part of a network operating system or may be implemented using a set of middleware products. An ESB creates a virtual environment layered on top of an enterprise messaging system where services are advertised and accessed.

### 8. What is functionality mapping in Cloud Computing?

[MODEL QUESTION]

Answer:

When applications/data is stored in the cloud, some of them do not need any translation whereas the others do. It is necessary sometimes to deconstruct the functions of the applications into its basic components and then figure out which of them are needed and supported by the cloud. For example there are some applications that need quick access to data which might not be able to be matched with the cloud's features. Usually non relational cloud storage systems like Amazon Simple Storage Service (S3) or Windows Azure Storage Service are secure and store large amounts of data, but they have very slow access to that data and do not support query and retrieval well. In the figure below, an attribute tree is constructed for an order transaction system where the functionality is decomposed into different functional areas. At the top are high-level attributes; some of these functions are essential to the operation of the application while others are not. So maintaining the relationship of the basic functions of the applications with the cloud's structure is called functional mapping. Each cloud platform also has its own set of attributes that need to be mapped. To support the application's data access, the developers might end up building a synchronization or replication feature, which adds more overhead to the application. This type of mapping exercise leads to some conclusions about the value of cloud computing to this particular application.



### 9. What are the different cloud service attributes for cloud storage?

[MODEL QUESTION]

Answer:

There are several cloud service attributes needed to be matches with the application attributes. They are:

## **POPULAR PUBLICATIONS**

- Applications
- Core services
- Infrastructure
- Platform features
- Storage

### **10. What are the different system abstraction in cloud computing?**

**[MODEL QUESTION]**

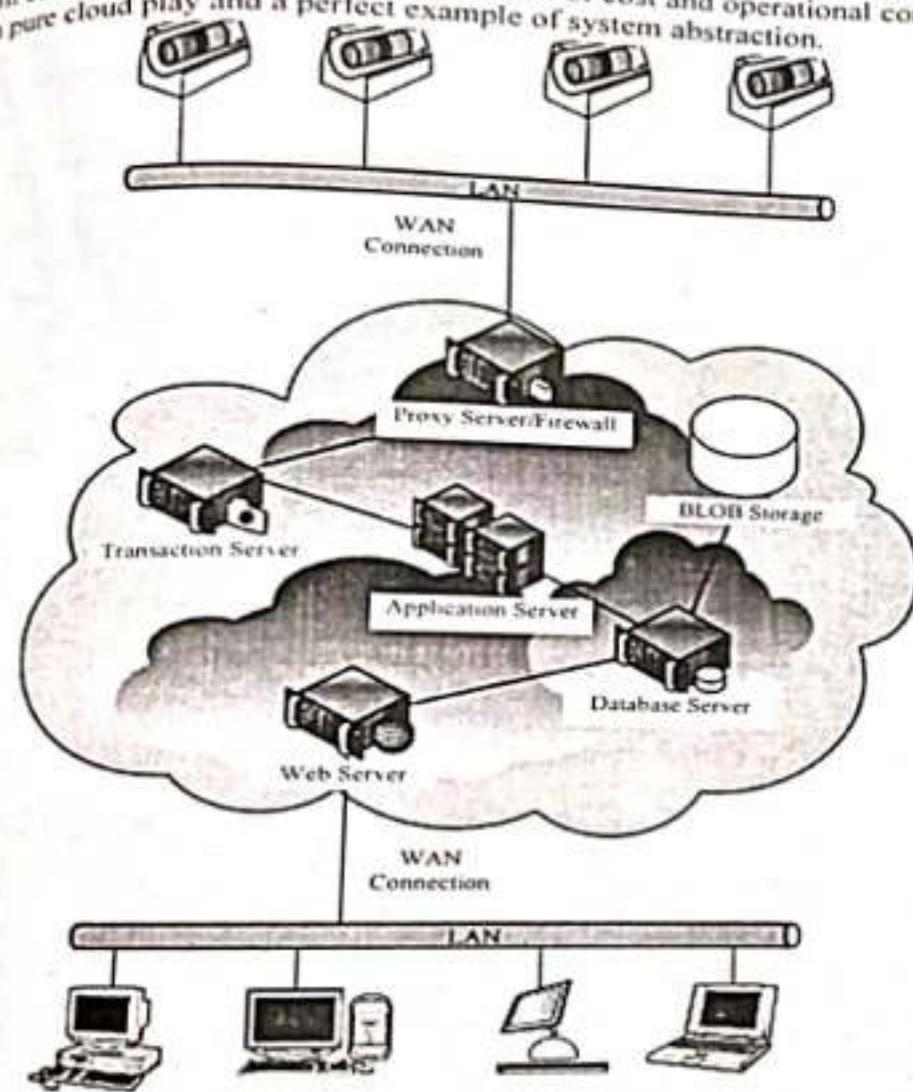
#### **Answer:**

Let us consider a service that does medical imaging.

- In the past, this service created patient scans and then rendered the image on a local computer.
- After the image was rendered, it was posted to the hospital LAN and made available to the people who read the scans.
- When the people reading the scans were outside the hospital, across the country, or around the world, those people would have to log into the hospital server via VPN to download the file.
- The scanning service decided to eliminate infrastructure and streamline the process. The service began its redeployment by first moving the stored images off the hospital's LAN and onto shared storage in the cloud. This feature eliminated the need to maintain a great deal of managed storage locally.
- As the service began to outsource the reading of scans to other countries, it enabled a content delivery network feature that the cloud service provider had. CDN (Content Delivery Network) placed copies of recently used and created scans in locations that were closer to the readers and made the system faster. The second stage in the redeployment was to eliminate the local processing associated with the scanning machines themselves. Most of the time the scanning machine was operating, it was collecting data, and an economic analysis revealed that it was significantly cheaper to process the files in the cloud.
- In the new system, shown in Figure below, the files are created locally and transmitted to the cloud. Virtual machines are provisioned to process the scans.
- The system leverages a message queuing server to create a steady stream of execution for the application server to process. At times of peak load, the system creates new machine instances to handle the load.
- As the application server completes the scan processing, it notifies the message queue, records the result in a database, and displays it on a Web page on a Web server, all of which are in the cloud.
- This new system results in greater system efficiencies because the system is always processing at its optimum load. The rendered scans are available from anywhere viewed inside a browser.
- Also, because the system is scalable, the scanning service can expand to other sites and bring on new capacity to handle additional load. As the service loses sites, it can also release resources as well.

## CLOUD COMPUTING

When it is decided that the scans need to be converted into a different format, this can be done in a central location and doesn't need to be rolled out to the computers attached to individual scan systems. Infrastructure, storage, and the queuing system all come together to eliminate a great deal of cost and operational complexity. This is a pure cloud play and a perfect example of system abstraction.



11. What is cloud bursting?

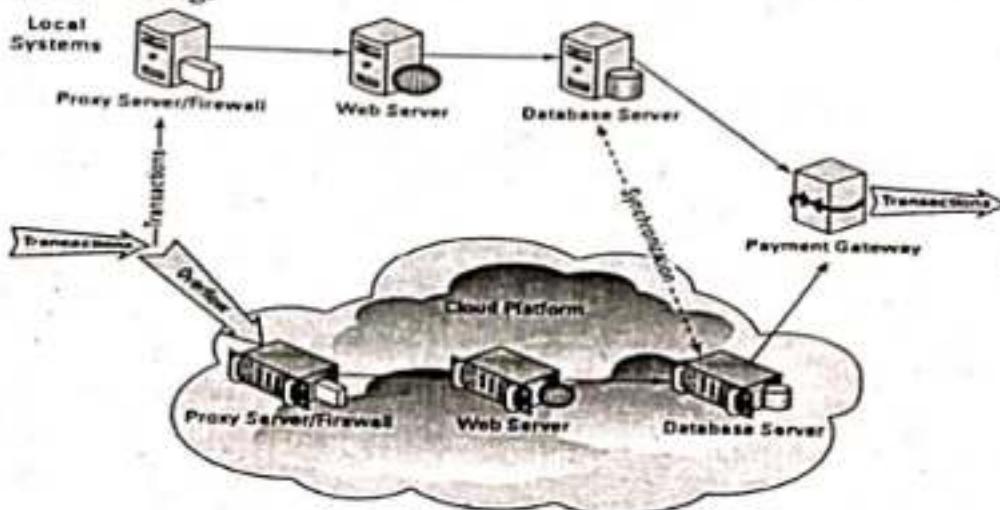
Answer:

Usually, cloud deployments are hybrid applications which mean a part of the application is on a local system, and part is in the cloud. There are many reasons why this is

[MODEL QUESTION]

## POPULAR PUBLICATIONS

desirable, but one of the most common reasons is that the cloud can serve as excess capacity at times of high volume. This type of hybrid has been called *cloud bursting*. Examples of systems where there is high volume over short periods of time are transaction processing systems such as reservations systems. In a reservation system, there is a certain low level of background transactions occurring at any time. At certain times, events trigger high demand. If the system builds infrastructure to accommodate peak demand, then that infrastructure is wasted. Most systems built to perform cloud bursting have a simple underlying design: clone the local system in the cloud. Often, there may be little activity in the cloud portion of the system, but when the activity grows, the copy of the system in the cloud picks up the extra activity and, when necessary, provisions extra resources. Figure below shows a simple reservations system set up for cloud bursting.



### 12. What is the definition for cloud storage?

**Answer:**

Cloud storage is a repository of data in a cloud that may be accessed by web based API's. Based on the need, the company can choose either block storage devices or file storage devices. A block storage device exposes its storage to clients as raw storage that can be partitioned to create volumes. It is up to the operating system to create and manage the file system; from the standpoint of the storage device, data is transferred in blocks. The alternative type of storage is a file server, most often in the form of a Network Attached Storage (NAS) device. NAS exposes its storage to clients in the form of files, maintaining its own file system. Block storage devices offer faster data transfers, but impose additional overhead on clients. File-oriented storage devices are generally slower (with the exception of large file-streaming applications), but require less overhead from attached clients.

[MODEL QUESTION]

## QUESTION 2014

### Group - A

#### (Multiple Choice Type Questions)

1. Choose the correct alternatives for the following.
- i) Amazon Web Services is which type of cloud computing distribution model?
- a) software as a service
  - b) infrastructure as a service
  - c) platform as a service
  - d) identity as a service
- ii) What is the name of the Rackspace cloud service?
- a) cloud on-demand
  - b) cloud servers
  - c) EC2
  - d) Google cloud
- iii) What is the name of the organization helping to foster security standards for cloud computing?
- a) cloud security standards working
  - b) cloud security alliance
  - c) cloud security watchdog
  - d) security in the cloud alliance
- iv) What is Cloud Foundry?
- a) a factory that produces cloud components
  - b) VMware-led open source PaaS
  - c) an industry wide PaaS initiative
  - d) VMware-led closed source PaaS
- v) Which of the following isn't an advantage of cloud?
- a) no worries about running out of storage
  - b) easier to maintain a cloud network
  - c) immediate access to computing resources
  - d) paying only for what you use
- vi) Which company recently shut the doors on its storage service?
- a) hitachi data systems
  - b) savvis
  - c) iron mountain
  - d) Symantec
- vii) Which of these service is not platform as a service?
- a) Force.com
  - b) Microsoft azure
  - c) Amazon EC2
  - d) Joyent
- viii) What feature does not belong in a private cloud?
- a) metered billing
  - b) self-service portal
  - c) dial-home support
  - d) rapid elasticity
- ix) What is private cloud?
- a) a standard cloud service offered via the Internet
  - b) a cloud architecture maintained within an enterprise data center
  - c) a cloud service inaccessible to anyone but the cultural elite
  - d) none of these
- x) Which Amazon cloud product recently experienced a massive outage?
- a) simple DB
  - b) EBS
  - c) S3
  - d) cloud front

## **POPULAR PUBLICATIONS**

- xi) What is the number one concern about cloud computing?  
a) too expensive      ✓b) security concerns      c) too many platforms      d) accessibility
- xii) Which is not a major cloud computing platform?  
a) Google 101      ✓b) IBM Deep blue      c) Microsoft AZURE      d) Amazon EC2

### **Group – B**

#### **(Short Answer Type Questions)**

2. What are the advantages and disadvantages of cloud computing?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 1.**

3. How does cloud computing differ from grid computation and pervasive computation?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 2.**

4. What is the difference between scalability and elasticity?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 3.**

5. Explain NIST model with diagram.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 4.**

6. What are the behavioral factors relating to cloud adoption?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 5.**

### **Group – C**

#### **(Long Answer Type Questions)**

7. a) Explain characteristics of Amazon Cloud.

b) Compare with diagram Type I Hypervisor and Type II Hypervisor?

c) Describe VMotion, Distributed Resource Scheduler (DRS) and vNetwork Distributed Switch (DVS)?

See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 1.**

8. a) Explain previously Jericho Forum's Cloud Cube model with diagram.

b) Briefly explain deployment models for cloud computing?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 6.**

9. What is IaaS? Mention the characteristics of IaaS. Explain modern implementation of SaaS using SOA components. Previously explain protocol Stack for a SOA architecture with diagram.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 7.**

10. a) Describe briefly with suitable diagram life cycle management of cloud service.

b) Draw the diagram of CSA cloud reference model with security boundaries.

See Topic: **MODULE NO. 3, Short & Long Answer Type Question No. 1.**

11 Write the short notes any three of the following:

- a) Google Cloud
- b) Chromium OS
- c) IaaS
- d) Windows AZURE service
- e) Hybrid Cloud

- a) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(a).
- b) See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 24(a).
- c) See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 24(b).
- d) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(b).
- e) See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 24(c).

## QUESTION 2015

### Group - A

#### (Multiple Choice Type Questions)

- i Choose the correct alternatives for the following:  
 i) Which of the following factors should a company consider before implementing cloud computing systems?  
     a) user satisfaction  
     b) potential cost reduction  
     c) information sensitivity  
     ✓ d) all of these
- ii Which of the following is perceived as the number one concern about cloud computing?  
     a) complex accessibility  
     b) too expensive  
     c) high latency  
     ✓ d) information security
- iii Which of the following techniques is vital for creating cloud computing environments?  
     ✓ a) virtualization     b) personalization     c) localization     d) all of these
- iv Which of the following is not a cloud computing service/solution?  
     a) Amazon EC2     b) Google GAE     ✓ c) IBM Deep Blue     d) Microsoft Azure
- v Which is the correct combination of cloud service provider and cloud-based service?  
     ✓ a) Google and AWS  
     c) IBM and Azure  
     b) Intuit and Quick Books Online  
     d) Microsoft and GWT
- vi Geographic distribution of data across a cloud service provider's network is perceived as a major issue for many organizations because it:  
     a) makes data recovery harder  
     c) complicates regulatory compliance  
     b) adds more latency  
     ✓ d) raises security concerns
- vii Which of the following can cloud computing replace?  
     a) corporate data centers  
     c) costly software upgrade  
     b) expensive computer hardware  
     ✓ d) all of these

## **POPULAR PUBLICATIONS**

- viii) Amazon EC2 is which type of cloud computing model?  
a) compliance as a service   ✓ b) infrastructure as a service  
c) platform as a service    d) software as a service
- ix) Which of the following widely used services is built on cloud-computing technology?  
a) Gmail    b) Twitter    c) YouTube    ✓ d) all of these
- x) Which of the following programming language did Google include for development around App Engine?  
a) C++    b) Java    ✓ c) SQL    d) Visual Basic

### **Group - B**

#### **(Short Answer Type Questions)**

2. Clean-and-Green Energy, a power generation and distribution company, has decided to deploy cloud-based solutions for two crucial customer-facing systems, namely,

- (i) Real-time Load Management
- (ii) Online Consumer Billing

Discuss, in brief, the advantages / disadvantages of both systems with cloud environment.

**See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 8.**

3. Explain, in brief, what 'multi-tenancy' is in the context of SaaS. Mention three significant characteristics of a typical SaaS solution.

**See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 9.**

4. a) What is virtualization?

b) Compare Process-level and System-level virtualization with respect to technique and virtualization model.

**See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 2.**

5. Describe Cloud Security Model as defined by Cloud Security Alliance.

**See Topic: MODULE NO. 3, Short & Long Answer Type Question No. 2.**

6. a) What are the benefits of Google AdWords to the advertisers? What is 'CPC' in context of AdWords?

b) What are the functions of Google Analytics? How does it work for the user?

**See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 3.**

### **Group - C**

#### **(Long Answer Type Questions)**

7. With respect to the NIST Reference Model of Cloud Computing, explain the following with suitable schematic and examples:

- i) Essential Characteristics
- ii) Service Models
- iii) Deployment Models.

**See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 10.**

8. a) Discuss three main advantages and two major disadvantages of cloud computing with suitable examples.

b) Describe key parameters used in a typical Cloud Service Level Agreement.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 12.**

9. Explain the concept of IaaS and SaaS. Use suitable examples and/or appropriate schematic diagrams to help establish your understanding.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 11.**

10. a) Virtualization in the context of IaaS.

b) Benefits of Virtualization.

c) Differences between 'full virtualization' and 'Para-virtualization'.

d) Amazon Machine Images (AMI) use both types of virtualization, namely, Hardware Virtual Machine (HVM) as well as Para-virtualization (PV). Mention the respective situations in which AMI's can use PV or HVM.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 4.**

11. a) Describe key features of Amazon Elastic Component Cloud (EC2).

b) What are the differences between Amazon Simple Storage Service (S3) and Elastic Block Storage (EBS)?

c) What is Google APIs? Mention broad categories of Google APIs with suitable examples. Name any two programming language environments that are compatible with Google API.

d) What does Google App Engine do? Mention any two services provided by it.

See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 5.**

12. Write short notes on any three of the following:

a) Amazon AWS

b) Cloud Cube Model of Cloud Computing

c) Google GWT

d) Microsoft SQL Azure

e) Virtual Machine Monitor (VMM).

a) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(c).**

b) See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 24(d).**

c) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(d).**

d) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(e).**

e) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(f).**

## QUESTION 2016

### **Group - A**

#### **(Multiple Choice Type Questions)**

1. Choose the correct alternatives for any ten of the following:

i) Which one is not a PaaS Service?

a) Windows Azure

✓ c) Salesforce

b) Google App Engine

d) Oracle Database as a Service

## **POPULAR PUBLICATIONS**

- i) DCOM, RMI, COBRA are different forms of  
✓ a) RPC                        b) IPC                        c) SOA                        d) Web Services
- ii) Which are valid dimensions of cloud cube?  
a) Service, Deployment                        b) Ownership, Sourcing  
c) Security Boundary, Portability              ✓ d) Physical Location of the data, Platform
- iv) What are the technologies that played a vital role in cloud computing?  
a) Mainframe  
✓ b) Utility Computing, Grid Computing, API  
c) Web 2.0, Virtualization, Service oriented Computing  
d) Database, Super computers
- v) An example of high performance cluster file system is  
a) vMotion                        ✓ b) VMFS                        c) DVS                            d) NTFS
- vi) What is the expansion of WSDL expands to  
a) Web Security Description of WSDL expands to  
✓ b) Web Service Description Language  
c) Web Solution Description Language  
d) Web Service Differentiation Language
- vii) Which one is not a second level attribute of Storage attribute?  
a) Query                        b) Non-Relational                        ✓ c) Data Access                        d) Replication
- viii) Which one of the following options is true with respect to cloud computing?  
a) Hardware should be composable  
b) Software should be composable  
c) Both Hardware and Software should be composable  
✓ d) Both Hardware and Software are not required to be composable
- ix) Which one is not a valid category of Google API?  
a) Ads and AdSense                        b) AJAX                                c) Google Gears                        ✓ d) Geo
- x) Different message passing topologies in SOA are respectively Circular, Network, Star and  
✓ a) Stove and Pipe    b) Hub and Spoke                        c) Mesh                                d) Hierarchical
- xi) Which one of the following providers provides Compliance as a Service (CaaS)?  
a) IBM                                b) HP                                        c) Microsoft                            ✓ d) Google
- xii) Which one of the following large vendors does not have an IT Management software as a service?  
a) IBM                                ✓ b) HP                                        c) Microsoft                                d) Google

- xiii) Which one of the following service models is closest to traditional hosting?  
a) SaaS                      ✓ b) PaaS

**Group - B**

(Short Answer Type Questions)

2. Define cloud computing. Explain different service models of cloud with example.  
See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 13.

3. A small sized enterprise is contemplating an email solution for their employees. What are the reasons you would suggest a cloud computing solution or a traditional solution?  
See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 14.

4. What is a hypervisor? Explain the types of hypervisor. Explain what is meant by Identity as a service.

1<sup>st</sup> & 2<sup>nd</sup> Part: See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 1(b).  
3<sup>rd</sup> Part: See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 7(1<sup>st</sup> Part).

5. What are the two different kinds of cloud service offerings by Google? What is disintermediation?

1<sup>st</sup> Part: See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 15.  
2<sup>nd</sup> Part: See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 6.

6. What are typical features of an ESB? What are the different types of catalogue services?

See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 2.

7. What are the different factors to be considered while choosing a database for AWS?

See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 7.

**Group - C**

(Long Answer Type Questions)

8. a) Write a brief note on cloud ecosystem along with examples.

- b) Explain Amazone EC2 service characteristics.

a) See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 16.

b) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 8(a).

9. a) Explain cloud computing security architecture.

- b) What is dark web? Write down the difference between deep web and dark web. Explain the concept of Google Ad words.

a) See Topic: MODULE NO. 3, Short & Long Answer Type Question No. 2.

b) 1<sup>st</sup> Part: See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 8(b).

2<sup>nd</sup> Part: See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 3(a).

10. a) What is an Amazone EC2 instance? Explain the process of launching an Amazone EC2 instance.

- b) Explain the protocol stack for Service oriented Architecture (SOA) with a neat diagram.

## POPULAR PUBLICATIONS

- a) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 9.
- b) See Topic: MODULE NO. 4, Short & Long Answer Type Question No. 4.

11. What are the different components used in Amazon AWS?

See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 10.

12. What is the difference between traditional data centres and cloud?

See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17.

## QUESTION 2017

### **Group - A**

#### **(Multiple Choice Type Questions)**

1. Choose the correct alternatives for any ten of the following:
  - i) What can cloud computing replace?
    - a) Corporate data centers
    - b) Expensive personal computer hardware
    - c) Expensive software upgrades
    - d) All of these
  - ii) What is the number one concern about cloud computing at present?
    - a) Too expensive
    - b) Security concerns
    - c) Too many platforms
    - d) Accessibility
  - iii) Which of these companies is not yet a leader in cloud computing?
    - a) Google
    - b) Amazon
    - c) Blackboard
    - d) Microsoft
  - iv) Which one of these is not a cloud computing pricing model?
    - a) Free
    - b) Pay Per Use
    - c) Subscription
    - d) ladder
    - e) Perpetual License
  - v) Which of one of these is not a major type of cloud computing usage?
    - a) Hardware as a Service
    - b) Platform as a Service
    - c) Software as a Service
    - d) Infrastructure as a Service
  - vi) Which one of these is not a major cloud computing service?
    - a) Google GWT
    - b) IBM Deep Blue
    - c) Microsoft Azure
    - d) Amazon EC2
  - vii) Which of these should a company consider before implementing cloud computing technologies?
    - a) User satisfaction
    - b) Potential cost reduction
    - c) Information sensitivity
    - d) All of these
  - viii) Which of these widely used services is built on cloud-computing technology?
    - a) Twitter
    - b) Skype
    - c) Gmail
    - d) YouTube
    - e) All of these

- (i) Which one of these techniques is vital for creating cloud-computing centers?  
✓ a) Virtualization      b) Transubstantiation      c) Cannibalization      d) Insubordination
- (ii) Which one of these is not considered as Platform as a Service?  
a) Force.com      b) Microsoft Azure      c) Amazon EC2      ✓ d) IBM Smart Cloud
- (iii) An internal cloud is  
a) An overhanging threat  
b) A career risk for a CIO  
✓ c) A cloud that sits behind a corporate firewall  
d) The group of knowledge workers who use a social network for water-cooler gossip
- (iv) Point out the correct combination of cloud service provider and their cloud-based service  
✓ a) Amazon and EC2      b) IBM and Azure  
c) Google and Cloudburst      d) Microsoft and GWT

**Group - B****(Short Answer Type Questions)**

2 Explain the different Cloud Service Models used with examples of products using these service models. Discuss the business benefits involved in cloud architecture.

1<sup>st</sup> Part: See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 10(ii).**

2<sup>nd</sup> Part: See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 18.**

3 Discuss the detail with diagram(s) the Cloud Cube model.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 6(a).**

4 For infrastructure as a service also known as IaaS, mention the resources that are provided by it. Explain the various reasons which are causing more and more data centers to migrate to the cloud.

See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 11.**

5 Define Hypervisor in cloud computing and their types. Discuss Hypervisor Baseline functions.

See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 12.**

**Group - C****(Long Answer Type Questions)**

6 What are the essential characteristics of the different service models and the various deployment models as per the NIST Reference Model of Cloud Computing? Describe with suitable examples.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 10(iii).**

7 Compare the three service models of Cloud Computing, using suitable examples and explanations.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 10(iii)**

## **POPULAR PUBLICATIONS**

8. What is Software-as-a-Service (SaaS) and what are the main characteristics of a SaaS solution? Describe through a schematic diagram and necessary explanations how XML and SOA are used to implement an Open SaaS environment.

1<sup>st</sup> part: See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 9.**

2<sup>nd</sup> part: See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 7.**

9. What is Identity-as a Service (IDaaS), and what are its core functions? Describe how user identity is authenticated and resource authorization is enforced in a typical IDaaS scenario.

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 24(b).**

10. a) Write short notes on the following:

- a) Amazon EC2
- b) Google API
- c) SQL Azure

a) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(g).**

b) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(h).**

c) See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 17(e).**

11. What is virtualization and why has it gained prominence in the context of Cloud Computing? What are the major components and the characteristics of a virtualized environment? Explain with suitable examples.

See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 13.**

## **QUESTION 2018**

### **Group - A**

#### **(Multiple Choice Type Questions)**

1. Choose the correct alternatives for each of the following:

i) What is private cloud?

- a) A standard cloud service offered via the Internet
- b) A cloud architecture maintained within enterprise data center
- ✓ c) A cloud service inaccessible to anyone but the cultural elite
- d) None of the above

ii) What is server virtualization?

- a) It's a problem that crops with cloud computing when servers go offline
- b) It's a method of modeling a cloud computing network before you actually build it so that it works properly
- ✓ c) It's partitioning a normal server so that it behaves as if it's multiple servers
- d) None of the above

iii) What does CAAS stand for?

- a) Computing as a service
- c) Connection as a service
- b) Compliance as a service
- ✓ d) None of these

- v) Which of the following is essential concept related to Cloud?  
 a) Reliability      b) Productivity       c) Abstraction      d) All of these
- vi) Which of the following cloud concept is related to pooling and sharing of resources?  
 a) Polymorphism    b) Abstraction       c) Virtualization      d) None of these
- vii) Which of the following is a Virtual Machine Technology now owned by Oracle that can be run on various operating systems?  
 a) V machines       b) VirtualBox      c) ThoughtPolice      d) none of these
- viii) Rackspace Cloud Service is an example of  
 a) IaaS      b) SaaS      c) PaaS      d) All of these
- ix) The componentized nature of SaaS solutions enables many solutions to support a feature called  
 a) workspace      b) workloads       c) mashups      d) All of these
- x) Which of the following is provided by Identity as a Service?  
 a) Identity governance      b) Provisioning       c) Risk and event monitoring      d) All of these
- xii) The technology used to distribute service resources is referred to as  
 a) load performing      b) load scheduling       c) load balancing      d) All of the mentioned

**Group - B****(Short Answer Type Questions)**

2 What is Cloud Computing? What are the advantages and limitations of cloud computing?  
 See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 20.**

3 What is Hypervisor? What are the types of Hypervisor? Write about identity as a service?

1<sup>st</sup> & 2<sup>nd</sup> Part: See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 1(b).**

3<sup>rd</sup> Part: See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 7.**

4 What is Virtualization? Write about Load Balancing

See Topic: **MODULE NO. 2, Short & Long Answer Type Question No. 14.**

5 What are the difference between Private Cloud and Public Cloud?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 21.**

6 What are the differences between Vertical Scalability and Horizontal Scalability?

See Topic: **MODULE NO. 1, Short & Long Answer Type Question No. 22.**

## **POPULAR PUBLICATIONS**

### **Group - C**

#### **(Long Answer Type Questions)**

7. a) Write about VMware's vSphere Cloud Computing Infrastructure Model?  
b) What are the advantages of Virtualizations?

**See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 15(a) & (b).**

8. What are the concepts about IaaS, PaaS and SaaS? Explain each with appropriate schematic diagram with example.

**See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 23.**

9. a) What is Life Cycle of Cloud Computing? Explain.

- b) Write about NIST Model.

a) See Topic: MODULE NO. 3, Short & Long Answer Type Question No. 1(a).

b) See Topic: MODULE NO. 1, Short & Long Answer Type Question No. 4.

10. What is Eucalyptus? Explain the Eucalyptus architecture with diagram. Write about Walrus Storage controller, Vmware Broker.

**See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 16.**

11. Write short notes on the following:

- a) EC2
- b) Windows Azure Service
- c) Amazon AWS
- d) P2V, D2C
- e) Virtual Machine

a) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(g).

b) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(b).

c) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(c).

d) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(i).

e) See Topic: MODULE NO. 2, Short & Long Answer Type Question No. 17(j).



