

1.

(i) Let n represent the number of employees in the organization who are going to purchase the software.

Let p be the initial licensing fee of the software. In the given problem the value of p is \$12000

Let c be the support ratio coefficient which is given as 0.4

Let m be the number of years.

We have to find the year where the cumulative support expense equals that of the initial licensing fee.

In a mathematical equation, it can be represented as

$$np(1 + mc) - np = np$$

where $np(1 + mc) - np$ is the cumulative support expense and np is the initial licensing fee.

$$np(1 + mc - 1) = np$$

$$m * c = 1$$

$$m * 0.4 = 1$$

Therefore $m = 1 / 0.4$ which is equal to 2.5 year

(ii) We have to find the year where the initial cost of the software will become 5% of the overall expenditure.

In a mathematical equation, it can be represented as

$$np = 0.05 * np * (1 + mc)$$

$$1 / 0.05 = 1 + mc$$

$$20 = 1 + mc$$

$$19 = m * c$$

$$19 / 0.4 = m$$

$$m = 47.5 \text{ years}$$

In 47.5 years the initial cost of the software would become 5 % of the overall expenditure.

2.

(i) SaaS: Software as a Service (Saas) allows the user to access or connect to the cloud-based applications via the internet. In this model, the user will not be installing the application on his hardware. So the cost of infrastructure and software licensing is saved. Instead, the user will pay a monthly or annual subscription fee to access the applications. Users can access the applications via multiple systems such as phones, tablets, personal computers, or smart tv.

Examples of SaaS:

a. Google Docs Suite: It is a web-based office suite that is offered by Google. It contains multiple applications such as Google Docs, Google Sheets, Google Sites, etc. All the applications of Google Docs Editor allow the user to create and edit online while collaborating with the other users in real-time. It is similar to a traditional Microsoft Office but the only difference is that the user will not be purchasing the licensing for the software and install in his hardware. Another advantage of Google Docs Editor is that it is free to use i.e. the user has to pay only for the device for accessing the application.

b. Netflix: Netflix is an American streaming service and a production company. They offer films, television shows through distribution deals or their productions. Netflix is considered to be a SaaS company because it allows the user to use their services such as watching videos. They run a subscription-based model i.e. the user pays a fixed amount of money either monthly or annually.

c. Zoom: It is a cloud-based conferencing tool that allows the users or organizations to interact with each other virtually. Zoom allows various modes of communication such as audio, video, text, or all of the above. Users can set up a video conference with up to 500 participants. It allows the user to share their computer screen so that the user can coordinate with other users at ease and distribute the information easily. Users can attend meetings via web browser or application.

(ii) PaaS: Platform as a Service (PaaS) is a model where the third-party cloud providers deliver the user with hardware and software tools to use over the internet. PaaS allows you to avoid the expense and complexity of buying and managing software licenses, hardware infrastructure, and middleware. It is designed to support complete application web cycles such as creation, testing, deployment, management, and up-gradation.

Example of PaaS

a. Heroku: It is a cloud-based platform as a service that supports several programming languages such as Java, PHP, Python, Node.js, Ruby, etc. Developers use Heroku to deploy, manage and scale applications. Heroku handles more than 60 billion requests every day. Heroku runs your applications inside the smart containers called dynos. Dynos are isolated, virtualized Linux containers that are designed to execute the command based on a user-specified command. Applications running inside the dynos will scale automatically if the demand for the resource from the user is more.

b. Google App Engine: It is a fully managed serverless application platform with simple administration that allows the developer to quickly build and deploy applications using popular languages or using their language runtimes and frameworks. Developers focus more on writing the code rather than the underlying infrastructure. App Engine handles the work of uploading the code and running it on Google Cloud. It seamlessly scales from zero to millions as your application becomes popular and the organization has to pay only what the user uses. Developers can host different versions of their applications either for testing or incremental development future rollouts.

c. Elastic Beanstalk: It is one of the most popular PaaS running on the software market. It is an easy-to-use service for deploying and scaling web applications and developers can develop applications using Java, .NET, PHP, Docker, etc. The developer has to simply upload the code and Elastic Beanstalk will handle the deployment, load balancing, auto-scaling, and other aspects. Developers are not charged to deploy their applications. They are charged only for the resources which are created to support the application. Elastic Beanstalk has various components such as Application, Application version, Environment, Environment tiers.

Application: It is a folder that holds all the codebase, application configuration files to support the application when you deploy the application via Elastic Beanstalk.

Application Version: It resembles a folder that stores a collection of components such as environment, versions, and environment configuration.

Environment: Only the current version of the application is executed in the environment. Elastic Beanstalk offers multiple environments. If the developer wants to run a new version of the application, then they must create a new environment in the Elastic Beanstalk and execute the new version.

Environment Tier: There are two types of environment tiers. If the application servers HTTP requests, then it runs on the webserver environment tier, and if the application runs a background task and it servers HTTP requests then it runs on the worker environment tier.

(iii)IaaS: Infrastructure as a Service (IaaS) is a cloud computing service that provides storage, networking, virtualization, and computational resources on-demand and on a pay-as-you-go basis. The consumer does not manage or control the underlying cloud infrastructure but manages the operating systems, middleware, and application.

Examples of IaaS

a. Amazon Elastic Cloud Compute (EC2): It is one of the best examples of IaaS. Amazon EC2 instance is a virtual server that allows the user to run the applications on the AWS infrastructure. Amazon gives various types of EC2 instances along with different types of storage, memory, computation power, etc according to the needs of the user. There are predefined amazon machine images (AMI) that are provided by Amazon to create the instances. They are configured with the operating system and other software which determines the user operating system environment.

b. OpenStack: OpenStack is a free open source cloud platform that allows the user to access virtual servers and other server resources. Users can manage the hardware, storage, and networking resources either through the command line or a web-based dashboard. Open stack performs horizontal scaling, unlike AWS which performs vertical scaling. Horizontal scaling means that you scale your system by adding more machines into your pool of resources whereas in vertical scaling you scale the system by adding more memory and computation power to the existing system.

c. Google Compute Engine: It is a component of the Google cloud platform that runs google search engine, youtube, and other services. Developers can use this service to store and compute the data. It can be accessed via command line, REST API, or developers console.

References:

https://en.wikipedia.org/wiki/Google_Workspace

<https://www.heroku.com/dynos>

<https://cloud.google.com/appengine>

<https://aws.amazon.com/elasticbeanstalk>

<https://www.hava.io/blog/what-is-aws-elastic-beanstalk>

<https://azure.microsoft.com/en-us/overview/what-is-iaas/#overview>

<https://www.rackspace.com/library/what-is-openstack>

3.

I agree with the definition provided in the textbook and the web.

Cloud bursting is an application deployment technology in which an application that is running in the private cloud gets burst into the public cloud if the demand for computation resources gets proliferated. The advantage of cloud bursting is that the organization pays only for the extra computational resources when they are used. Once the on-demand spike gets declines, the application and resources get released from the public cloud, and the data and application are moved back to the private cloud. There are multiple ways to trigger the cloud bursting either automatically when the demand is high or manually when the organization raises a request. The organization has to take care of the security, policies while implementing the cloud bursting technique. Critical Applications or data are not recommended for cloud bursting because that data will be transitioned in the public cloud.

Benefits of Cloud Bursting:

Cost: Organization has to pay only for the additional resources which will be used during a sudden spike. Once the demands get a decline, resources will be released.

Business Continuity: Organisation does not need downtime to transfer the application or data into the public during sudden demand. The application will burst into the public cloud automatically without interrupting the users.

Disadvantages of Cloud Bursting:

Security: Since the organization's data is moved is to the public cloud during cloud bursting there is a higher chance of data breach.

Networking: Sometimes the organization finds it difficult to create a low latency and higher bandwidth connection between the private and the public cloud.

4.

Shadow IT is the use of IT-related software or hardware by a department or an individual without the knowledge of an IT department or security team in the organization. Shadow IT can contain cloud services (SaaS, PaaS, IaaS), applications, or collaboration tools (Zoom, WebEx). Users have become more comfortable uploading the company's data and using cloud services without informing the IT department.

Public Cloud: It is also called the multi-tenant model that allows the user to use the cloud computing services provided by the third party vendors either free or sold on demand which allows the customers to pay for the storage, memory, or networking when they use.

Multi-tenant means multiple users are using the same software or hardware simultaneously but one user cannot access the other user data. If the company uses the public cloud for its operation and business activities, there is a high chance of security and data breaches.

Private Cloud: It is also called the single-tenant model that allows only the organization to access the cloud computing services through the internet or dedicated network. The private cloud provides all the facilities of the public cloud. In addition, it also delivers a high level of security and privacy to make sure that sensitive data is not accessible to third-party providers. The Organization IT department is responsible for managing the private cloud. With the help of the private cloud, IT Department and security will be able to track down the users who are using the shadow resources. There are two types of Private Cloud: in-house and Virtual Private Cloud. In-house private cloud allows the organization to access all the facilities of cloud computing. The only difference will be is that the infrastructure, software tools, and applications will be running in the company data center. They are managed by the company IT Department. In Virtual Private Cloud (VPC), the cloud providers allocate dedicated resources to the organization. These resources are not shared with any other users outside of the organization. VPC can be managed by third-party cloud providers or by the organization's IT Department.

The Health insurance Portability and Accountability (HIPAA) Act prohibits health care providers and healthcare businesses from disclosing protected information to anyone other than the patients and the patient's authorized representative without their consent. It does not prohibit the patients from sharing their health information with family members or other individuals not a part of a covered entity. Covered Entities contain doctor's offices, hospitals, health care providers, etc. Patients must also not disclose the information to the business associates that provide the services to the covered entity.

SOX stands for Sarbanes-Oxley Act which was passed to increase accountability in the financial sector and to protect the investors from fraudulent financial activities by corporations. The law helps ensure public companies engage in non-deceptive business accounting practices. Maintaining and encrypting sensitive customer data and financial information can help companies become SOX-compliant. Private companies aren't required to follow all of the provisions of the SOX law.

References:

https://en.wikipedia.org/wiki/Health_Insurance_Portability_and_Accountability_Act
https://en.wikipedia.org/wiki/Sarbanes%E2%80%93Oxley_Act

5.

Instagram is a social media application that allows the user to share photos or videos. Users can browse other users' content and view the trending content. Instagram had only 11 employees and they were managing 30 million customers. Facebook bought Instagram for \$1 billion in April 2012. Instagram didn't purchase any of the infrastructures and they were using AWS cloud services. Out of the 11 employees, only 3 employees were managing the Amazon cloud. There were no capital expenses which was required, no physical server, and no technician to administer them. With this strategy, Instagram was able to generate \$1 billion in two years. Most of the expense Instagram used was during customer acquisition and retention. Cloud used to take care of all of the incoming traffic and scale automatically if the number of users gets increased without crashing the server.

Resources: Cloud Computing business trends and technologies by Igor Faynberg, Hui-Lan Lu, Dor Skuler

6.

Amazon Elastic Computer Cloud (EC2) is an IaaS that provides virtual servers called EC2 instances which are used for computation purposes. EC2 aims to make the life of the developer easier by providing secure and resizable compute capacity in the cloud. This will allow the developer to focus on application development and deployment rather than the infrastructure and other aspects.

Features of EC2:

a. Elastic Load Balancing: Developers can balance network traffic with the Elastic Load Balancing (ELB) service, which includes the Application Load Balancer and Network Load Balancer.

b. Management and Configuration: Admin can monitor and manage cloud resources via AWS Config. This tool allows the IT team to avoid improper configuration and needlessly expensive cloud resource deployments.

c. Amazon Simple Storage Service (S3): It provides scalable object storage for data backup, collection, and analytics. An IT professional stores data and files as S3 objects -- which can range up to 5 GB -- inside [S3 buckets](#) to keep them organized.

d. Amazon Virtual Private Cloud: This allows the user to control a virtual network and to use an isolated section of the AWS cloud. AWS automatically provisions new resources within a VPC for extra protection.

e. Amazon relational database: It provides a relational database such as PostgreSQL, MySQL, MariaDB, etc to AWS users. Administrators can easily replicate or migrate their existing database to Amazon RDS. AWS also offers a NoSQL database.

f. Multiple Locations: Amazon allows the developers to run the EC2 instances in multiple geographic locations.

g. Amazon Elastic Block Storage: It is Amazon's block-level storage solution used with the EC2 cloud service to store persistent data. This means that the data is kept on the AWS EBS servers even when the EC2 instances are shut down

h. Security: The developer can secure login information for his instance using key pairs. AWS stores the public key and the developer stores the private key.

References:

<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/concepts.html>

<http://aws.amazon.com/ec2>

7.

In the current year, we can use the same strategy which was used by Instagram to implement Zing Media Interactive. We will hire a few people probably 3 or 4 employees who know how to develop the application and who know how to use AWS cloud Environment. We will spin a couple of EC2 instances so that the developers will focus on the application rather than the infrastructure. Once the application is completed we will deploy that application in the Amazon EC2 instance. If there is higher user demand, ELB (Elastic Load Balance) will come into the picture which will divert the traffic to the new EC2 instance without any downtime of the application. Once the demand for the application gets reduced we can release the additional EC2 instances either manually or automatically. We can use Amazon Simple Storage Service (S3) or Amazon relational database (ADS) to store the radio songs or advertisements. ADS can also be used to store the user information which will make the I/O for the application faster.

References: Cloud Computing business trends and technologies by Igor Faynberg, Hui-Lan Lu, Dor Skuler

8.

When the application is deployed in the cloud provider's hardware, the developer automatically relinquishes control to the physical infrastructure. Because of that, developers are not sure whether an application is getting enough computational power or not from the cloud providers. It cannot be verified with a fine granularity that an application is getting enough resources if it is deployed in the cloud. This problem comes into the picture if the application is constantly using memory and processor and the application is not getting enough resources.

To overcome this problem, CPU Pinning was introduced.

CPU Pinning makes sure that a user will get CPU time from a specific CPU or set of CPUs that are pinned. Intel has provided an API that allows the user or cloud providers to pin X amount of CPUs. Let us take an example that a machine has 10 cores out of which 6 cores are needed to be pinned for a user application. These six cores are reserved for the user application and no other processes in the machine can access these six cores. This will allow the user to get a performance gain in his application.

9.

Amazon Compute Service Level Agreement is a policy governing the use of products and services such as Elastic Compute Cloud (EC2), Elastic Block Storage (EBS), Elastic Container Service (ECS), Fargate, between the users or organization and Amazon cloud providers. There are two types of service level agreements provided by Amazon.

Region level SLA:

If there are multiple instances running in the two or more AZs in the same region or different regions, AWS makes reasonable efforts with a monthly uptime percentage of at least 99.99%, during any monthly billing cycle. 52 minutes and 35 seconds will be the bound of downtime in a year.

Instance level SLA:

For each individual Amazon EC2 instance (single instance), AWS makes reasonable efforts with a Monthly Uptime Percentage of at least 99.5%, during any monthly billing cycle. 1 day 19 hours 49 minutes and 44 seconds will be the bound of downtime in a year.

References:

https://aws.amazon.com/compute/sla/?did=sla_card&trk=sla_card

<https://uptime.is/>

10.

Telecom-grade refers to a hardware or software component that is extremely reliable, well tested, and proven in its capabilities. Telecom-grade systems are tested and engineered to meet high availability standards, and provide very fast fault recovery through redundancy. Telecom-grade hardware is specifically designed for running telecommunications networks. They are designed in such a way that they can live in a network for more than 15 years. Also, they provide 99.999% function time which is equivalent to 5 minutes of downtime in a year.

AT&T, BT, CenturyLink, China Mobile, Colt, Deutsche Telekom, KDDI, NTT, Orange, Telecom Italia, Telefonica, Telstra, and Verizon were the ETSI NFV Industry Specifications Group founders.

Potential Examples for the use of NFV are listed below:

- a. Traffic Analysis of the internet packets coming and going out of the network.
- b. Service Assurance: Can be used to test and diagnose the network.
- c. Security: Firewalls, virus scanners, intrusion detection system, DDOS protection system, and spam detection.
- d. Application optimization: Can be used to set up the load balancer so that the strong urge for the network can be avoided