

CS 524 Introduction to Cloud Computing

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Homework 1

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- 1) Using the formulae for the first software business model, find the year where the cumulative support expense equals that of the initial licensing fee p , where $p = \$12,000$ per user, and $c = 0.40$. In how many years will the initial cost of software becomes 5% of the overall expenditure?

Sol: $CSE = P * C * M$

Cumulative support expense (CSE), P is licensing fee per user, C is radio coefficient, M is number of years

Let, $CSE = P$ (When CSE equals to that of the initial licensing fee)

$$P = P * C * M$$

$$1 = C * M$$

$$1 = 0.40 * M \quad (C = 0.40)$$

$$M = 1/0.40$$

$$M = 2.5$$

$$IC = N * P$$

Initial Cost (IC), N is number of employees, P is licensing fee per user

$$OE = N * P (1 + M * C)$$

Overall Expenditure (OE), N is number of employees, P is licensing fee per user, C is radio coefficient, M is number of years

Let, $IC = 5\% \text{ of } OE$ (When the initial cost of software becomes 5% of the overall expenditure)

$$IC = 0.05 * OE$$

$$N * P = 0.05 * N * P (1 + M * C)$$

$$1 = 0.05(1 + M * 0.40) \quad (C = 0.40)$$

$$1/0.05 = 1 + M * 0.40$$

$$20 = 1 + M * 0.40$$

$$M * 0.40 = 19$$

$$M = 19/0.40$$

$$M = 47.5$$

Cumulative support expense equals that of the initial licensing fee in 2.5 years and the initial cost of software becomes 5% of the overall expenditure in 47.5 years.

- 2) In the definition of Hybrid Cloud, a term "Cloud bursting" is mentioned. Search the Web for its definitions. Do these definitions agree? If so, provide what you think is the best definition (you can rephrase it as you see fit). If not, explain the differences between the definitions.

Sol: Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and bursts into a public cloud when the demand for computing capacity spikes. The advantage of such a hybrid cloud deployment is that an organization only pays for extra compute resources when they are needed.

Hybrid cloud is a cloud computing environment that uses a mix of on-premises, private cloud and third-party, 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.

So According to my research Cloud bursting is a Hybrid Cloud Techniques that allows organization to increase computing capacity whenever required.

(References: <https://searchcloudcomputing.techtarget.com/definition/cloud-bursting>,
<https://searchcloudcomputing.techtarget.com/definition/hybrid-cloud>)

- 3) What are the essential differences between the public and private cloud that have made CIOs worry about legal consequences of Shadow IT? Read the original text of the US Government acts mentioned in the text (HIPAA and SOX) and summarize each in one paragraph.

Sol: In a Public Cloud scenario, each department in an organization has members accessing the cloud to meet their own requirements. There is no intervention of the IT department. Once the department has an approved budget, it is up to them as to what technology they use. They no more need approvals from the IT department or the CIO. Everything is available and accessible over a Public Cloud. Hence Shadow IT cannot be stopped easily in case of a Public Cloud. Whereas in a Private Cloud setup, everything is monitored and needs a formal approval from the IT department. The resources over the Private Cloud are monitored and cannot be accessed with permissions. The departments and the employees need to stick to the rules and regulations laid down by their IT departments while accessing the resources over the cloud. Hence Shadow It can easily be battled in the case of a Private Cloud. HIPAA stands for Health Insurance Portability and Accountability Act.

HIPAA was introduced to provide the data privacy and security provisions for safeguarding of medical information. HIPAA preserves the rights and provide protections to the individual's medical records and health plans, whether electronic, written or oral. The rule establishes national standards for the security of electronic protected health information. The security rule specifies a series of administrative, technical, and physical security to assure the integrity, availability and confidentiality of electronic protected health information.

SOX stands for Sarbanes Oxley Act and also known as "Public Company Accounting Reform and Investor Protection Act" and "Corporate and Auditing Accountability and Responsibility Act". SOX was introduced to protect investors from the possibility of fraudulent accounting activities by corporations. The SOX Act mandated strict reforms to improve financial disclosures from corporations and prevent accounting fraud.

(References: <https://www.dhcs.ca.gov/formsandpubs/laws/hipaa/Pages/1.00WhatIsHIPAA.aspx>,
https://en.wikipedia.org/wiki/Sarbanes%E2%80%93Oxley_Act,
<https://searchhealthit.techtarget.com/definition/HIPAA>)

- 4) Consider the case of the Instagram as described in the textbook. How many employees and customers did it have at the time of the purchase by Facebook? How much did Facebook pay for it? What was the value that the purchased business has generated in the first two years, and what were the factors that enabled generating this value?

Sol: Instagram had 11 employees and 30 million customers when Facebook acquired Instagram. Facebook Paid One Billion Dollar in Cash and Stocks to Instagram. It generated One Billion Dollar in Value in two year's because it had no capital expense required, no physical servers and maintenance, no technicians to administer them, just little upfront investment in cloud infrastructure helped Facebook to eliminate huge efforts and costs and gain huge profits.

5) Familiarize yourself with the description of the Amazon Elastic Cloud Computing (<http://aws.amazon.com/ec2/>). What kind of a service model does it provide (i.e., SaaS, PaaS, IaaS, or a combination of these)? Please list the features that support your answer.

Sol: Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides secure, resizable compute capacity in the cloud. It is designed to make web-scale cloud computing easier for developers. Amazon EC2's simple web service interface allows you to obtain and configure capacity with minimal friction. It provides you with complete control of your computing resources and lets you run on Amazon's proven computing environment.

Amazon Elastic Cloud Computing provides IaaS service model because of the following reasons:

- Distributed Services – Like in IaaS, the resources are distributed like servers, storage, network, operating systems, etc. It provides the user with very strong working environment by combining all these resources. The client need not to purchase any of these but can have full control to use and deploy these resources.
- Elastic Scaling – The web service manages the resources more efficiently for high performance. Means, the resources capacity can be scaled both up and down according to the requirement. If there is a high demand of the resources, the web service scales up the resources quickly to fulfill the demand and vice versa.
- Complete Control – Amazon EC2 provides the complete computing control to customer. Like in IaaS, user have the control processing, storage, networks and other fundamental computing resources and the user is allowed to deploy and run arbitrary software, which can include operating systems. The user does not have to manage the underlying cloud infrastructure but has control over the resources.
- Multiple Users – Like IaaS, Amazon EC2 allows multiple users means all the computing resources (like computing power, memory size, etc.), servers or storages, maintaining the privacy and security, and other instances are available to many users at the same time. This feature allows the economical use of the resources.
- Varied Pricing – The price of using the resources in an IaaS is not fixed. The customer has to pay depending upon the usage. There are no minimum charges; the prices are varied according to the use of the resources. This leads to controlled expenditure whenever the services are not in demand. This makes it well suited for workloads that are temporary, experimental or changes unexpectedly.

EC2 provides scalable infrastructure for companies who want to host cloud-based applications. EC2 users do not own the physical servers; AWS provides virtual servers.

(References: <https://aws.amazon.com/ec2/>,

<https://aws.amazon.com/types-of-cloud-computing/>,
<https://www.bigcommerce.com/blog/saas-vs-paas-vs-iaas/#the-three-types-of-cloud-computing-service-models-explained>,
<https://aws.amazon.com/application-hosting/benefits/>)

- 6) Read the article on Fog Computing provided in the lecture. Familiarize yourself with the OpenFog Consortium (www.openfogconsortium.org) and answer the following questions: a. How many members does the consortium have? b. What is the definition (one sentence) of Fog computing according to the consortium? c. What is the goal of the consortium?

Sol: A) OpenFog Consortium merged with Industrial Internet Consortium (IIC) Consortium and have 258 Members in total.
B) A horizontal, system-level architecture that distributes computing, storage, control and networking functions closer to the users along a cloud-to-thing continuum.
C) The goal of the OpenFog Consortium is to increase the number of market segments (use cases) for fog computing, and its business value. OpenFog will create test-beds to adapt the high-level architecture to these market segments. These testbeds will also provide opportunities for FogFests (plug fests) to help drive component level interoperability and accelerate time to market.

(References: https://en.wikipedia.org/wiki/OpenFog_Consortium,
https://en.wikipedia.org/wiki/Industrial_Internet_Consortium,
https://www.iiconsortium.org/pdf/OpenFog_Reference_Architecture_2_09_17.pdf)

- 7) Consider the example of the Zing Interactive Media and explain how you would launch the same service today using Amazon EC2. Specifically list the steps (and costs) you would avoid by doing so.

Sol: If we have to launch Zing Interactive Media using Amazon EC2, we can avoid following cost:

- 1) Buying servers or Renting T1 Lines
- 2) Renting or Buying Space for hosting servers
- 3) Avoid implementing server for peak usage that go redundant most of the times.
- 4) Hiring an IT team of networking experts, system administrators, database administrators to maintain the server
- 5) Paying high electricity and other usage bills
- 6) Avoid any maintenance costs.

- 8) Explain what CPU pinning is and how Intel supports it with API.

Sol: Processor affinity, or CPU pinning or "cache affinity", enables the binding and unbinding of a process or a thread to a central processing unit (CPU) or a range of CPUs, so that the process or thread will execute only on the designated CPU or CPUs rather than any CPU. This can be viewed as a modification of the native central queue scheduling algorithm in a symmetric multiprocessing operating system. Each item in the queue has a tag indicating its kin processor. At the time of resource allocation, each task is allocated to its kin processor in preference to others.

Intel is providing API that allows the host to guarantee a certain percentage of the CPU to a given virtual machine. This capability, affected by assigning a virtual machine to a given processor or a range of processes is exposed via the hypervisor and the Cloud provider's systems, and it can be consumed by the application.

(References: https://en.wikipedia.org/wiki/Processor_affinity)

- 9) Study the Amazon EC2 SLA. What service commitment (in percentage) does it guarantee? What is the bound on the downtime in a year?

Sol: Amazon Compute Service Level Agreement (this "SLA") is a policy governing the use Amazon Elastic Compute Cloud (Amazon EC2) and applies separately to each account using the Included Services. AWS will use commercially reasonable efforts to make the Included Services each available for each AWS region with a Monthly Uptime Percentage of at least 99.99%, in each case during any monthly billing cycle (the "Service Commitment"). In the event any of the Included Services do not meet the Service Commitment, you will be eligible to receive a Service Credit as described below.

Service Credits are calculated as a percentage of the total charges paid by you (excluding one-time payments such as upfront payments made for Reserved Instances) for the individual Included Service in the affected AWS region for the monthly billing cycle in which the Unavailability occurred in accordance with the schedule below.

Monthly Uptime Percentage	Service Credit Percentage
Less than 99.99% but equal to or greater than 99.0%	10%
Less than 99.0% but equal to or greater than 95.0%	30%
Less than 95.0%	100%

The bound on the downtime in a year is atmost 876 hours

(References: <https://aws.amazon.com/compute/sla/>)

- 10) What is the "telecom-grade" service commitment? Who were the ETSI NFV Industry Specifications Group founders? List the areas where the NFV is expected to act. (Optional recommended reading: the ETSI NFV White Papers.)

Sol: "Telecom Grade" service commitment means the hardware is specifically engineered for running in telecommunications network, designed to live in network for over 15 years, functional 99.999% of time(with only 5mins downtime per year). But all these features come with high cost of installation and maintenance. Solving the issues required a new operational model that reduces costs and speeds up the introduction of new services for growth.

ETSI NFV Industry Specifications Group founders were Specifications Group founder are AT&T, BT, Deutsche Telekom, Orange, Telecom Italia, Telefonica, and Verizon.

Areas where the NFV is expected to act:

- Switching elements: BNG, CG-NAT, routers.
- Mobile network nodes: HLR/HSS, MME, SGSN, GGSN/PDN-GW, RNC, Node B, eNode B.
- Functions contained in home routers and set top boxes to create virtualised home environments.
- Tunnelling gateway elements: IPSec/SSL VPN gateways.
- Traffic analysis: DPI, QoE measurement.
- Service Assurance, SLA monitoring, Test and Diagnostics.
- NGN signalling: SBCs, IMS.
- Converged and network-wide functions: AAA servers, policy control and charging platforms.
- Application-level optimisation: CDNs, Cache Servers, Load Balancers, Application Accelerators.
- Security functions: Firewalls, virus scanners, intrusion detection systems, spam protection.