

Introduction to Cloud Computing (CS 524)

(Homework 1)

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Course Section: **CS 524-A**

Homework 1.1 –

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?

Solution 1.1 –

Cumulative support expense (CSE) when it would be equal to the initial licensing fee,

$$CSE = p * c * m$$

where, " p " is an initial licensing fee per user,
" c " is a support ratio coefficient, and
" m " is the number of years

Let, $CSE = p$

Then, $p = p * c * m$

$$c * m = 1$$

$$m = 1 / c$$

$$m = 1 / 0.40$$

$$m = 2.5 \text{ years}$$

given in the question
substituting the value of CSE in the above formula
cancelling " p " from both sides
equation derived
substituting the value of " c "

The initial cost of software when it becomes 5% of the overall expenditure,

$$\text{Initial Cost, } IC = n * p$$

where, " n " is the number of employees, and
" p " is an initial licensing fee per user

$$\text{Overall Expenditure, } OE = n * p (1 + m * c)$$

where, " n " is the number of employees,
" p " is an initial licensing fee per user,
" m " is the number of years, and
" c " is a support ratio coefficient

Let, $IC = 5\% \text{ of } OE$

ImPLY, $IC = 0.05 * OE$

$$n * p = 0.05 * n * p (1 + m * 0.40)$$

$$0.05 * (1 + m * 0.40) = 1$$

$$(1 + m * 0.40) = 1 / 0.05$$

$$(1 + m * 0.40) = 20$$

$$m * 0.40 = 20 - 1 = 19$$

$$m = 19 / 0.40$$

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

given in the question
substituting the values in the formula
cancelling " $n * p$ " from both sides

Answer: Cumulative support expense would be equal to the initial licensing fee in **2.5 years** and the initial cost of software would become 5% of the overall expenditure in **47.5 years**.

Homework 1.2 –

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 difference between the definitions.

Solution 1.2 –

Cloud Bursting is an application deployment model in which application runs on a private cloud. Whenever the private cloud or data center exploit its resources and need additional computing capacities (like computing power, memory size, storage, etc.) during the higher bandwidth demand. The running application bursts into a public cloud to meet such peak demands.

As per my web research, **Yes**, I think Cloud Busting relates to Hybrid Clouds.

Hybrid cloud is a combination of public and private cloud infrastructures which are bounded together by standardized technologies. In sudden spike in the workload or in any situation when a private cloud exhausts its computing resources and to handle such critical conditions, it is advisable to burst in the public cloud to utilize the available resources for higher performance. This cloud busting phenomenon saves the capital expenditure on buying and maintaining more servers for such temporary scenarios. For this advanced feature of hybrid cloud the private cloud users have to pay only for extra computing resource whenever needed.

In other words, Cloud Busting is a Hybrid Cloud technique which assists an organization in the expansion of its computing capacities whenever required along with maximum utilization of the existing resources.

(References: <http://searchcloudcomputing.techtarget.com/>)

Homework 1.3 –

What are the essential differences between the *public* and *private* cloud that have made CIOs worry about the 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.

Solution 1.3 –

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.hhs.gov/hipaa>, <http://searchdatamanagement.techtarget.com/definition/HIPAA>, https://en.wikipedia.org/wiki/Sarbanes-Oxley_Act, <http://www.investopedia.com/terms/s/sarbanesoxleyact.asp>)

Homework 1.4 –

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?

Solution 1.4 –

At the time when Facebook purchased *Instagram*, Instagram had 11 employees managing 30 million customers. Facebook paid \$1 billion in cash and stocks. Since then in two years, the company generated one billion dollars in value. The company generated such value because there was no capital expense required, no physical servers needed to be procured and maintained, no technicians paid to administer them, and so on but just little or no upfront investment in people or infrastructure.

(References: Cloud Computing: Business Trends and Technologies)

Homework 1.5 –

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.

Solution 1.5 –

Amazon Elastic Cloud Computing is a web service that provides resizable compute capacity in the cloud. It provides with complete control of computing resources and allows to quickly scaling capacity, both up and down, as computing requirements change.

Amazon Elastic Cloud Computing provides IaaS service model more closely than PaaS 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.

But now it is becoming more of PaaS or can be considered as mixture of both IaaS and PaaS. The key distinguishing feature between an IaaS and PaaS is the type of service offered. In IaaS, customers typically work with virtual machines that they configure themselves whereas in PaaS, customers takes the responsibility and work with services created and maintained by the providers.

(References: Cloud Computing: Business Trends and Technologies, <https://aws.amazon.com/ec2/>, <https://starthq.com/blog/saas-101-iaas-paas-saas-and-cloud-computing>)

Homework 1.6 –

Repeat the same exercise as above for the following *Amazon* services:

- a. *SimpleDB*, and
- b. *Simple Storage Service (S3)*

Solution 1.6 –

- a. SimpleDB – Amazon Simple Database Service also known as value data store and provides PaaS, it is highly available and flexible non relational or No SQL database service provided by Amazon. This database allows the user to focus even more on the core features of their application. It provides read and write scalability.
 - Scalable: It is scalable and can be streamlined according to use. The service allows quickly adding or accessing data according to the need.
 - Inexpensive: SimpleDB is quite inexpensive and the user pays only for the resources that are actually consumed.
 - Simple to Use: It is simple to use and avoids the complexity often unused database operations.

- b. Simple Storage Service (S3) – Amazon Simple Storage Service (S3) is object storage with a simple web service interface to store and retrieve any amount of data from anywhere on the web. It is designed to deliver durability, and scale past trillions of objects worldwide. Simple Storage Service is an example of Infrastructure as a Service (IaaS).
- Storage and Hosting: Simple Storage Service (S3) provides a very durable storage capacity for variety of data. It is the primary storage for cloud native applications. The user can store their data in the cloud and make use of the scalability feature of S3 by increasing the usage as and when the need increases.
 - Website Hosting: Simple Storage Service (S3) can be used to host an entire website for a low cost. S3 is a highly available storage system which can be scaled according to the need.
 - Backup and Recovery: Simple Storage Service (S3) offers a robust disaster recovery solution to provide a high level of data protection for the user.
 - Data Analytics: A large variety of data or data lake can be stored in the simple storage service and can be used as big data object store.

(References: https://en.wikipedia.org/wiki/Amazon_SimpleDB, <http://searchaws.techtarget.com/definition/Amazon-Simple-Database-Service-SimpleDB>, <https://aws.amazon.com/simpliedb/>, <https://aws.amazon.com/s3/>)

Homework 1.7 –

Consider the example of *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.

Solution 1.7 –

If I have to launch the services like *Zing Interactive Media* today using Amazon EC2. I would avoid:

- a. To Lease a “cage” or buying a server or rent T1 lines.
- b. Renting space on a hosting site
- c. Instead of anticipating a peak use amount and preparation and develop a redundancy schema for the service. I would scale up or down my resources according to demands.
- d. Instead of requesting for a purchase of new hardware like servers, network gears, cages. I will save cost of buying such hardware.
- e. Instead of hiring an IT team of networking experts, system administrators, database administrators, and so on to maintain the setup. I would hire few developers for building a robust and scalable application.

(References: Cloud Computing: Business Trends and Technologies)

Homework 1.8 –

Explain what *CPU pinning* is and how *Intel* supports it with API.

Solution 1.8 –

CPU pinning is the ability to run specific virtual machine’s CPU on specific physical CPU in a specific host. Means, *CPU pinning* is the technique of binding and unbinding of a process or a thread to a CPU or multiple CPUs, so that the said thread process or thread runs on a specified CPU only. This is the modified version of scheduling algorithm in symmetric multiprocessing operating system.

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: Cloud Computing: Business Trends and Technologies, <https://www.ovirt.org/documentation/sla/cpu-pinning/>, <https://01.org/openstack/blogs/stephenfin/2015/smarter-cpu-pinning>)

Homework 1.9 –

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

Solution 1.9 –

Amazon EC2 Service Level Agreement (SLA) is a policy governing the use of Amazon Elastic Compute Cloud. Amazon makes an effort to make Amazon EC2 available for with a Monthly Uptime Percentage for at least 99.95% during a monthly billing cycle. In any case if Amazon does not meet the Service Commitments, the customer is eligible to receive Service Credit calculated as a percentage of the total charges paid by the customer.

- Monthly Uptime Percentage is calculated by subtracting from 100% the percentage of minutes during the month for which Amazon Services was in the state of "Unavailability".
- Monthly Uptime Percentage is less than 99.95% but equal to or greater than 99.0% and the Service Credit Percentage is 10%. This means that for a downtime of less than 1% and more than 0.05%, the Service Credit Percentage will be 10%.
- If Monthly Uptime Percentage is less than 99%, then the Service Credit Percentage is 30%. This means that for a downtime less than 1%, the Service Credit Percentage will be 30%.

The bound on the downtime in a year is 0.5% is about 4.38 hours or 263 minutes.

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

Homework 1.10 –

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)

Solution 1.10 –

"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.

To overcome this problem, seven of the world's leading telecom network operators joined together to create a set of standards for the advancement of virtualizing network services. On 12th October 2012, the representatives of 13 network operators from all over the world released a White Paper outlining the benefits and challenges. Sooner 52 other network operators including telecom equipment, IT vendors, technology consultants formed the ETSI NFV Industry Specification Group.

The NFV is expected to act in the following areas:

- a. Operational improvements
- b. Cost reductions
- c. Streamlining high touch processes
- d. Reduction of development time
- e. Reduction of replacement costs
- f. Reduction of equipment costs

(References: Cloud Computing: Business Trends and Technologies)