

CSCI 5409 Adv. Topics in Cloud Computing – Fall, 2023
Week 12 – Lecture 1 (Nov 20, 2023)

Business Considerations in Cloud Computing

Dr. Lu Yang
Faculty of Computer Science
Dalhousie University
luyang@dal.ca

Housekeeping and Feedback

- Start recording
- Start working on the term project. Ask Purvesh and Rahul questions.
- CPC and SAA voucher request spreadsheet is up. The deadline to sign up is Dec 4.
- Final:
9:30-11:30am, Dec 8
Goldberg Building room 127 (CS auditorium)

Objectives

- Identify and calculate up-front, on-going and additional business costs in cloud computing as well as the metrics for choosing and evaluating cloud services
- Understand service-level agreements and the service quality metrics used to audit cloud computing service performance

Contents

Section 1. Business Cost Metrics

Section 2. Cloud Usage Cost Metrics



1

Business Cost Metrics

You may not be interested in business topics...

- But you need to be:
 - The architectural decisions you make when designing software in the cloud have the potential to significantly affect the cost of running the infrastructure to support it
 - Therefore, **cost** must be a component of your system requirements and constraints
 - You have learned that experimentation is an excellent approach to evaluating new advances in cloud computing
 - Therefore, integrating business and budget concerns with development plans is critical to an organization that wants to remain competitive



[Image] Falling asleep at your desk?

<https://mumbaimirror.indiatimes.com/others/health-lifestyle/falling-asleep-at-your-desk/articleshow/74271770.cms>

Business Cost Metrics

"Common metrics used to evaluate the estimated costs and business value of leasing cloud-based IT resources when compared to the purchase of on-premise IT resources." – Cloud Computing (T. Erl, Z. Mahmoud, R. Puttini, 2013)

Up-Front and On-Going Costs

- "Up-front costs are associated with the initial investments that organizations need to make in order to fund the IT resources they intend to use. This includes both the costs associated with obtaining the IT resources, as well as expenses required to deploy and administer them." [1]
 - Purchasing equipment is expensive, especially in Canada with high taxes and environmental fees on electronic equipment
 - Leasing equipment from a cloud provider tends to be much less expensive
- "On-going costs represent the expenses required by an organization to run and maintain the IT resources it uses." [1]
 - Licensing fees - \$\$\$
 - Labour - \$\$\$
 - Electricity - \$\$
 - Bandwidth - \$\$
 - Insurance - \$

[1] Cloud Computing (T. Erl, Z. Mahmoud, R. Puttini, 2013) pg. 380 - 381

Additional Costs

- **Cost of Capital:** Making your initial purchase of the hardware required to host a modern webapp on-premise may require a loan, or investment, cost of capital is the cost of raising these funds
- **Sunk Costs:** These are costs already paid for existing IT resources, a strong motivator to remain on-premise for as long as possible
- **Integration Costs:** These are the costs required to transition from on-premise to in the cloud, another motivator to remaining on-premise
- **Locked-in Costs:** Once you transition to the cloud you will build your systems specifically for one provider or another, this cost represents the cost of transferring (altering your architecture, from one cloud provider to another)




2

Cloud Usage Cost Metrics



Cloud Usage Cost Metrics

Metrics for calculating costs associated with
cloud-based IT resource usage



Negotiation

- We should first understand that most modern cloud providers are open to negotiation!
- Why might that be?



Network Usage

- The cost of transferring data over a network connection
- Separately measured in bytes: inbound traffic and outbound traffic
 - Usually there are inbound and outbound rate differences
See: <https://aws.amazon.com/ec2/pricing/on-demand/>
- Often there are tiers, e.g.:
 - 1GB free, \$0.001/GB up to 10TB, then \$0.002/GB
- This includes:
 - Traffic between your organization and the cloud (provisioning, image and code deployments, etc.)
 - Traffic between your services in the cloud and your customers

regions
same service
different prices

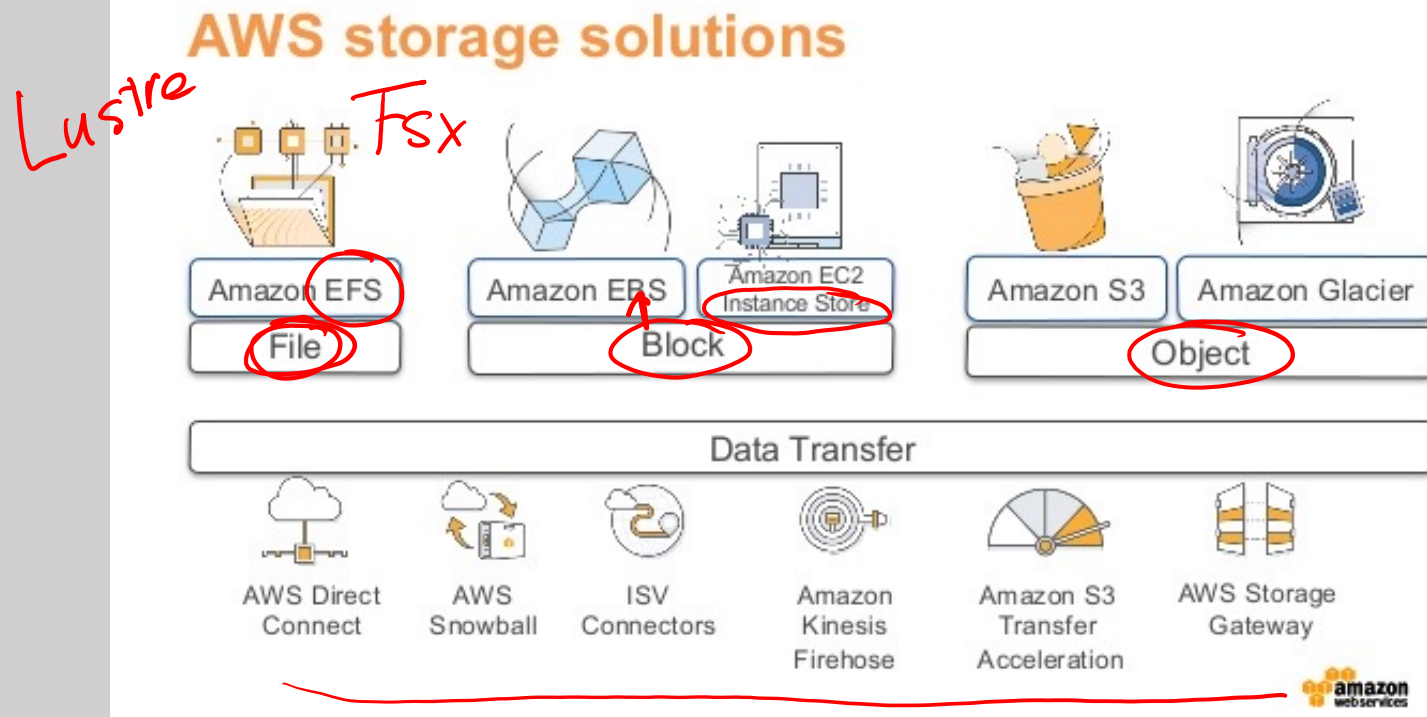
Internet

Server Usage

- The cost of provisioning a virtual server on a physical server
- Measured in hours of execution at a specific physical resource configuration
- Cost determined by several factors:
 - Number of virtual CPUs
 - Amount of memory
 - Amount of storage
 - Operating system license
 - Region
- It's clear that server usage decisions must be evaluated in various architectural configurations

Pricing Model	Constraints	Cost
<u>On-Demand</u>	Most expensive due to the cloud provider's inability to plan physical resource allocation needs	\$\$\$
<u>Reserved Instances</u>	Provide significant discount (<u>up to 72%</u>) because they allow the cloud provider to plan. Lock your organization into lengthy <u>1- or 3-year</u> terms to get the highest discount	\$\$
<u>Dedicated Hosts</u> (a physical server dedicated entirely to you!)	Reduce costs by allowing you to use your existing server-bound software license (Windows, SQL Server, SUSE Linux Enterprise Server, etc.), requires you to need enough compute to warrant an entire server, all your eggs are in one basket	\$\$
<u>Spot Instances</u>	A company of AWS's scale will always have spare computing capacity available. That's where Spot Instances come in. They're up to <u>90% cheaper</u> because you're occupying this spare capacity that's otherwise just losing money. 5%	\$

Cloud Storage Device Usage (1/3)



Cloud Storage Device Usage (2/3)

Data Temperature

Hot

- Access Frequency – High
- Storage Cost – Higher
- Access Cost – Lower

Hot data is being actively worked on. It is being actively contributed to via new ingests, updates, and transformations. Both reads and writes tend to be single-item. Items tend to be small. Speed of access is essential. Hot data tends to be high-Velocity and low-Volume.

Warm

- Access Frequency – Medium high
- Storage Cost – Medium
- Access Cost – Medium

Warm data is still being actively accessed, but less frequently than Hot data. Often, items can be as small as in Hot workloads, but updated and read in sets. Speed of access, while important, is not as crucial as with Hot data. Warm data is more balanced across Velocity and Volume dimensions.

Cold

- Access Frequency – Low
- Storage Cost – Low
- Access Cost – High

Cold data still needs to be accessed occasionally, but updates to this data are rare and reads can tolerate higher latency. Items tend to be large (tens of hundreds of MB or GB). Items are usually written and read individually. High durability and low cost are essential. Cold data tends to be high-Volume and low-Velocity.

Frozen

- Access Frequency – Lowest
- Storage Cost – Lowest
- Access Cost – Highest

Frozen data needs to be preserved for business continuity, archival, or regulatory reasons, but is not being actively worked on. While new data is regularly added to this data store, existing data is never updated. Reads are extremely infrequent (known as “write once, read never”) and can tolerate very high latency. Frozen data tends to be extremely high-Volume and extremely low-Velocity.

Cloud Storage Device Usage (3/3)

- Costs are based on:
 1. Storing the data (wide range, \$/month per GB):
 - Cheap if infrequently accessed (<https://aws.amazon.com/s3/glacier/>)
 - More expensive the more responsive (faster read/write) or frequent access
 - Your choices here affect the rates of the next two costs
 2. Data moves in and out of the cloud :
 - Most cloud providers allow you to input your data for free (ingress), but will charge large network fees to move your data out of the cloud elsewhere (egress)
 - This means cloud providers cover the cost of inbound data from the public internet
 - AWS doesn't charge for data transferred within regions between its services
 - Transferring from one region to another has a fee
 3. Requests and retrievals (\$0.00# per 1000):
 - Cloud providers charge for requests to their various storage services (e.g. S3, DynamoDB, etc.)
 - This covers their cost of running servers to handle the requests

Demo

<https://www.youtube.com/watch?v=JWz4eCczCkQ>

Cloud Service Usage

- In a Software-as-a-Service (SaaS) environment service usage is a significant cost
 - For example, Dalhousie and Microsoft for Office 365
- Other delivery models will use cloud provider services in various ways
- Costs can be based on:
 - Duration of application use
 - Number of individual user licenses
 - Number of transactions
 - Amount of infrastructure usage
- Your organization must make choices that balance flexibility and availability with cost

Example:

<https://docs.aws.amazon.com/whitepapers/latest/how-aws-pricing-works/amazon-ec2-cost-breakdown.html>

Monitoring

- Most metrics highlighted are based on usage at various rates
- We therefore require a system to monitor that usage so that we can be sure we're billed correctly
- These monitoring services are usually implemented by the cloud provider:
 - AWS Cost Explorer (Monitoring costs and usage)
<https://aws.amazon.com/aws-cost-management/aws-cost-explorer/>
 - AWS Budgets (Set budgets, thresholds and actions that respond to thresholds)
<https://docs.aws.amazon.com/awsaccountbilling/latest/aboutv2/billing-what-is.html>

The background of the image is a stylized world map divided into four quadrants by a vertical and a horizontal line. The top-left quadrant is red, the top-right is blue, the bottom-left is yellow, and the bottom-right is green. The word "Kahoot!" is written in a large, white, bold, sans-serif font across the center of the image, spanning across all four quadrants.

Kahoot!