CSCI 5409 Cloud Computing
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Week 3 – Lecture 1 (Sep 18, 2023)

Introduction to Cloud Computing – Goals, Benefits, Risks and Challenges

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Housekeeping and Feedback

- Start recording
- I will provide treats to top 3 Kahoot players on every Friday

Contents

Objectives

- Cloud goals & benefits
  - We need to know why we're going to take all of this effort to learn about cloud computing
- Cloud risks & challenges
  - We need to be aware of the complexities and challenges presented by cloud computing and how to mitigate those risks

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Cloud Goals and Benefits

1. Reduced Investment and Proportional Costs
2. Increased Scalability
3. Increased Availability and Reliability
4. Regular Updates

Cloud Computing Benefits

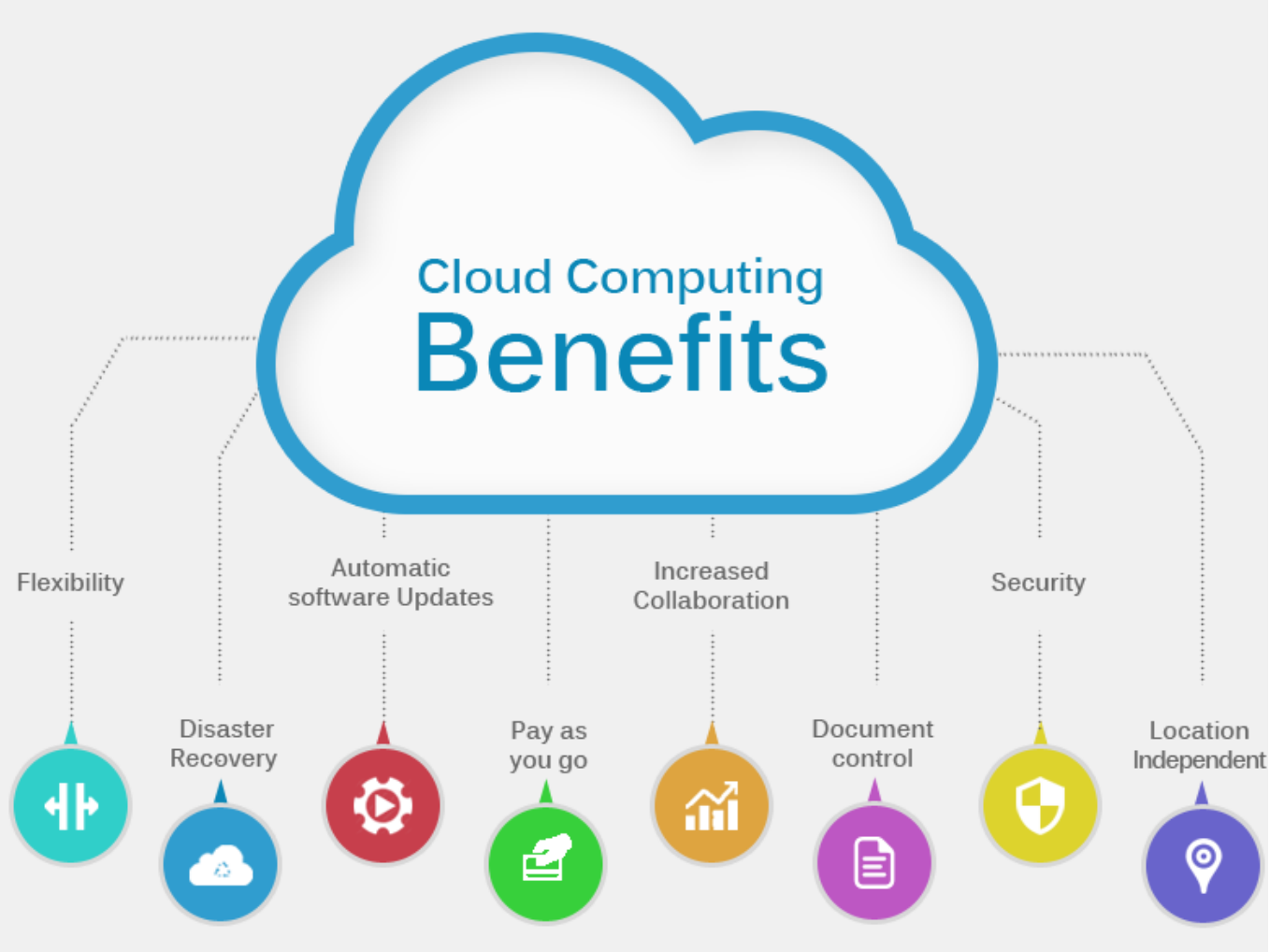


Figure from https://i.pinimg.com/originals/68/76/96/6876968 2f198af4a77b1102f5f647258.png

Reduced Investment and Proportional Costs

- All companies that require equipment must debate whether to buy or lease, cloud computing is the lease option
  1. Buying:
     - High up-front cost
     - You own it, and have full control over it, and are subject to its failures
     - You must maintain it
  2. Leasing:
     - Higher long-term cost
     - You do not own it, and therefore have no → limited control over it other than what the owner provides
     - You are protected from failures and benefit from updates
     - Maintenance free

IaaS

- Cloud provider business model is built on economy of scale [1]
  - Mass-acquisition of IT resources
  - Us-east-1, Amazon's primary region, is in Virginia close to internet backbone[2], reducing bandwidth costs and latency
  - Cost savings are passed on to consumers

1. Cloud Computing (T. Erl, Z. Mahmood, R.Puttini), ch 3.3
2. https://www.theatlantic.com/technology/archive/2016/01/amazon-web-services-data-center/423147

Increased Scalability

- On-demand access to pay-as-you-go computing resources on a short-term basis, resources are essentially "unlimited"[1]
- Ability to add or remove resources at a fine-grained level, e.g. single gigabyte increments, options not available when provisioning your own hardware

1. Cloud Computing (T. Erl, Z. Mahmood, R.Puttini), ch 3.3

Increased Availability and Reliability

- The average cost of downtime across all industries has historically been about $5,600 per minute, but recent studies have shown this cost has grown to about $9,000 per minute.[1]
- Abstraction of the infrastructure allows us to avoid locking ourselves into specific devices or locations, cloud resources can be moved if needed
- AWS has services with 9's of uptime: 99.999999%, a number almost impossible to achieve on your own equipment, achieved through:
  - Geographically diverse data centers, the closer it is to you the faster you get it (reliability and availability)
  - Apocalypse safe infrastructure (reliability)
  - Redundancy, data is replicated all over the world, in case of failure automated processes move traffic away from affected areas (reliability)
  - Advanced network attached storage (NAS) solution [2] (availability)

11 9s
S3

1. https://www.pingdom.com/outages/average-cost-of-downtime-per-industry/#:~:text=The%20average%20cost%20of%20downtime,to%20about%20%249%2C000%20per%20minute
2. https://aws.amazon.com/marketplace/solutions/infrastructure-software/high-availability

Regular Updates (1/2)

- Updating your own stuff:
  - **You** must stay on top of the latest and greatest hardware and software
  - **You** are responsible for monitoring security / bug updates, and accountable for the failure to do so

1. Broadcast downtime to your stakeholders
2. Someone stays up late and swaps stuff out
3. Bring it back up, test
4. Switchover

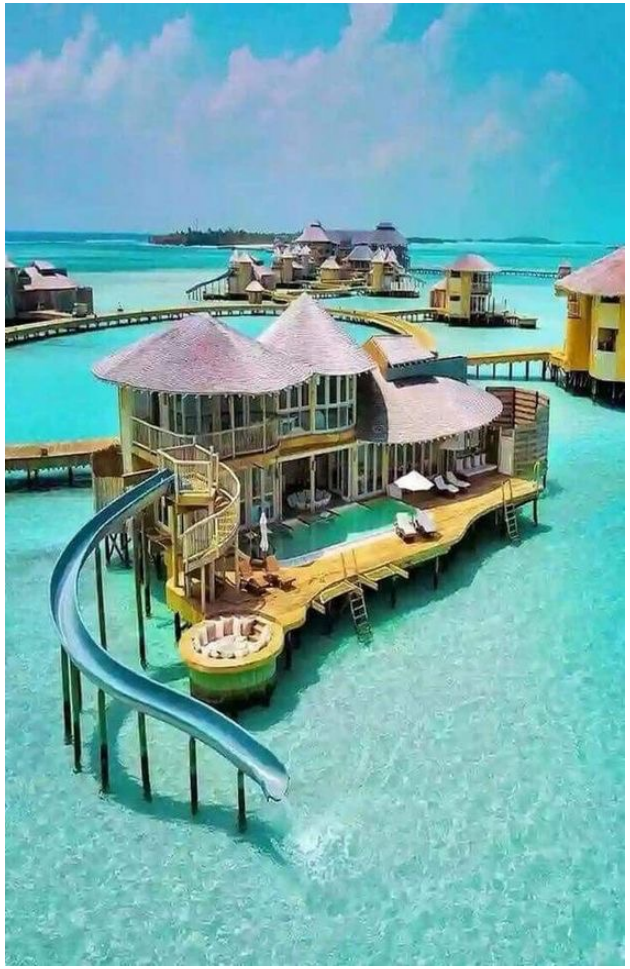
If you haven't done this, it's not much fun and a source of many horrible panic-filled evenings. Failures here often result in job loss.

"I see the computer system is down again."

Figures from: Cloud Computing (T. Erl, Z. Mahmood, R. Puttini)

Regular Updates (2/2)

- Benefitting from cloud provider updates:
  - Cloud providers constantly competing to deliver the latest and greatest new infrastructure and services
  - Your focus shifts to **your** product, not the infrastructure needed to deliver your product, a potential advantage over competitors but at minimum a way to stay on par with competitors
  - Your products benefit from silent upgrades with zero downtime



Figures from: Cloud Computing (T. Erl, Z. Mahmood, R. Puttini)

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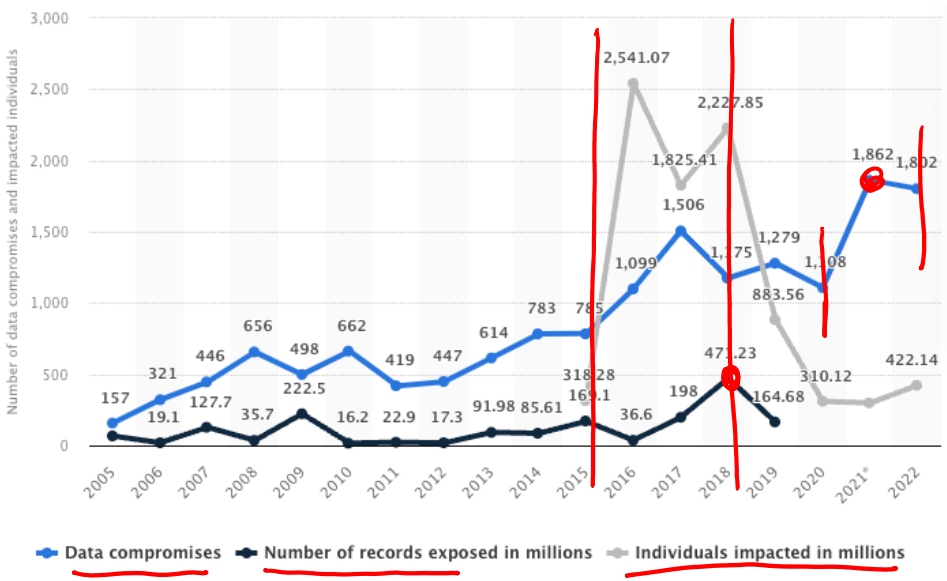
Risks and Challenges

1. Increased Security Vulnerabilities and Reduced Operational Governance Control
2. Limited Portability
3. Multi-Regional Compliance and Legal Issues
4. Ethical Issues

Risks

Annual number of data compromises and individuals impacted in the United States from 2005 to 2022

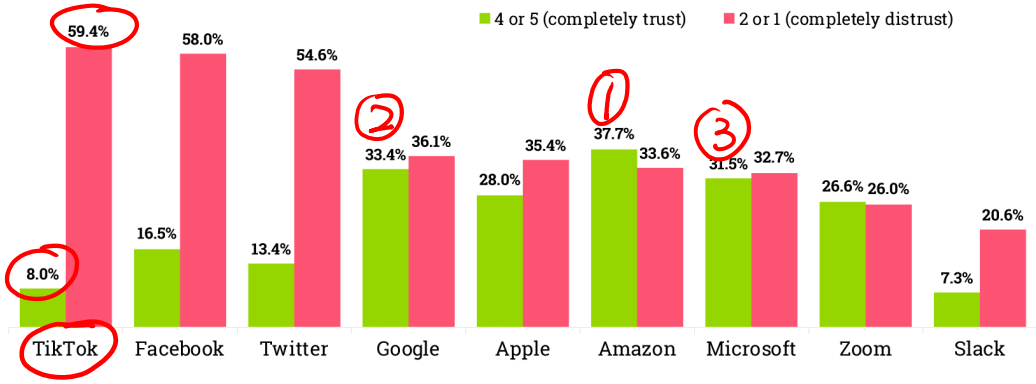


https://www.statista.com/statistics/273550/data-breaches-recorded-in-the-united-states-by-number-of-breaches-and-records-exposed/

Trust in Tech Companies with Consumer Data

marketing charts

"On a scale from 1 to 5 where 1 is completely distrust and 5 is completely trust, please indicate how much you trust each organization or entity below to collect and use your personal information/data."



Published on MarketingCharts.com in December 2021 | Data Source: The Center for Growth and Opportunity (CGO) / YouGov

Based on an August survey of 1,000 US adults (18+) | Chart excludes responses for "3" and for "never heard of / don't know"

https://www.statista.com/statistics/273550/data-breaches-recorded-in-the-united-states-by-number-of-breaches-and-records-exposed/

Increased Security Vulnerabilities and Reduced Operational Governance Control

- Multitenancy means overlapping trust boundaries, a problem you do not have with your own equipment
  - Can the cloud provider meet the security requirements of both consumers?
- Your data leaving your premises means increased risk, no matter what you do responsibility for protecting the data is now shared with your cloud provider
- You have relinquished control; do you trust your provider?
  - Are they maintaining their service level agreements?
  - Are they using 3rd parties too? Do you know?

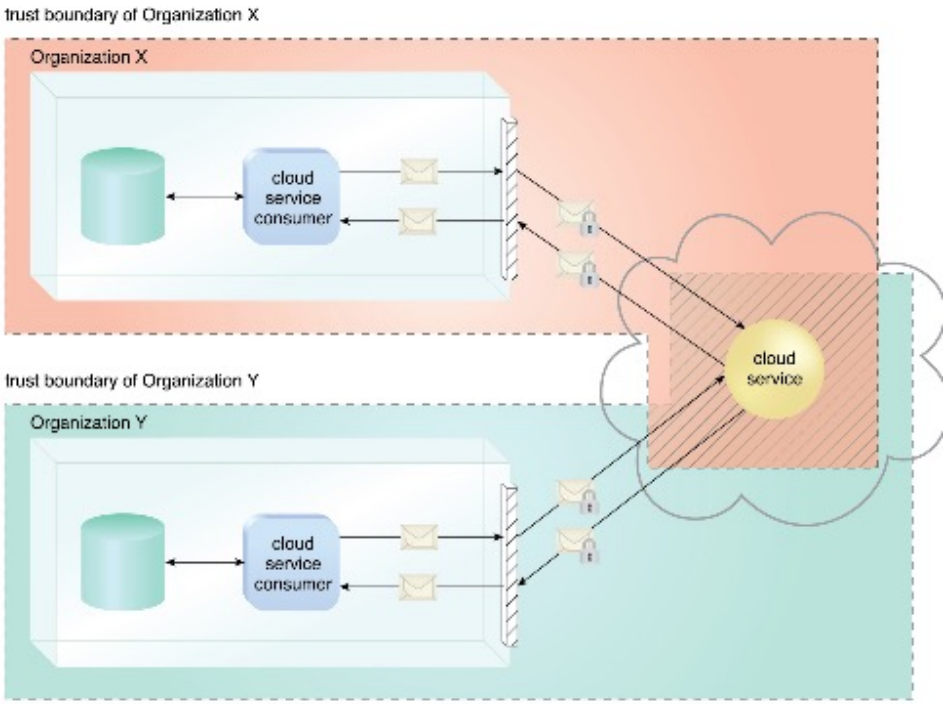


Figure from Cloud Computing (T. Erl, Z. Mahmood, R.Puttini).

Limited Portability

- Lack of industry standards in cloud provider services locked
  - Cloud providers have financial incentive to make this difficult
  - These companies are so big they can bully governments that would try to regulate consumer protections
- Oh boy do we ever have an awesome example of this:

This year cloud practitioners saw a new term enter our parlance: "de-platforming". Parler rightly kicked off AWS services, and struggling to relocate. There's much they could have done to make this easier, but this must have many organizations suddenly waking up in alarm about the risks of limited portability... What happened to the data? Could they retrieve it even or were they locked out? An incredible historic moment in cloud computing.

Multi-Regional Compliance and Legal Issues

- Cloud providers establish data centers in affordable or convenient geographical locations
  - Reading fine print of service level agreements often reveals that legal disputes are resolved in countries that are highly favorable to cloud providers
- This poses serious legal concerns for cloud consumers:
  - Data privacy
  - Data storage and retention regulations
    - Examples: UK requires data belonging to UK citizens to be kept within the UK, Canadian government organizations cannot use services that store data outside of Canada
  - Accessibility and disclosure of data, some governments require disclosure to government agencies
    - Example: data stored in the US is subject to the US Patriot Act

Ethical Issues

- Difficult to monitor cloud providers for adherence to service level agreements, they control the tools that measure this
- Multiple hands problem [1]:
  - When breaches happen, who is responsible? The responsibility is shared 50/50, but this is difficult for the end customer to determine in which half the problem lies
- Environmental impacts:
  - Global emissions from cloud computing range from 2.5% to 3.7% of all global greenhouse gas emissions, thereby exceeding emissions from commercial flights (about 2.4%) and other existential activities that fuel our global economy[2].
  - Would we be better off without efficient/green data centers? Good topic for a research grad students…

1. https://www.mdpi.com/2504-3900/1/3/166/pdf
2. https://www.climatiq.io/blog/measure-greenhouse-gas-emissions-carbon-data-centres-cloud-computing#:~:text=Global%20emissions%20from%20cloud%20computing,that%20fuel%20our%20global%20economy.


Kahoot!