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FACULTY OF COMPUTING
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Chapter 8
Cloud Computing

Technology and Information Systems

Learning Objectives

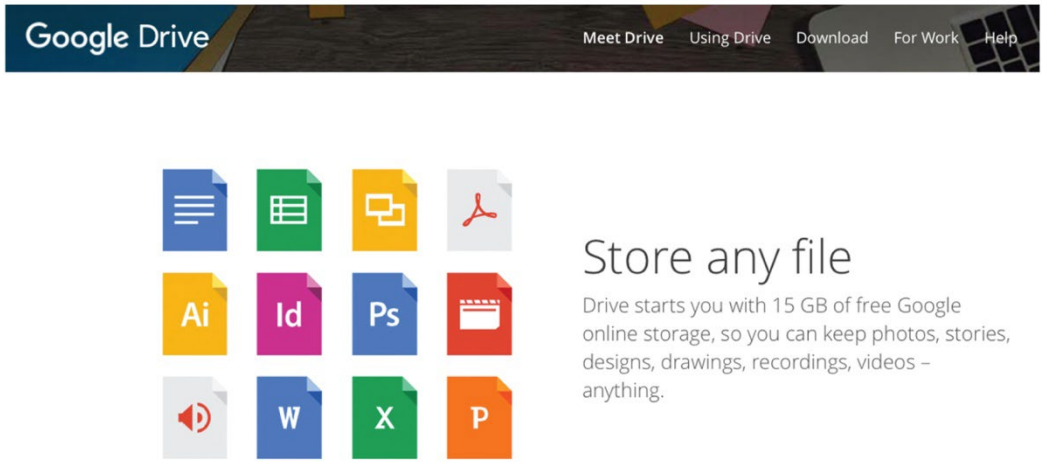
By the end of this lecture, you will be able to understand:

1. The basic concepts of cloud computing
2. The basic cloud service models
3. The cloud computing deployment models
4. Advantages of cloud computing
5. Challenges of cloud computing
6. Top 10 Cloud Service Providers in 2023

Cloud Storage

The Internet acts as a “cloud” of servers

- Applications provided as a service rather than a product
- Supplied by servers that provide cloud storage or online storage



Cloud Computing Defined

Cloud computing is the **on-demand** delivery of compute power, database, storage, applications, and other IT resources **via the internet** with **pay-as-you-go** pricing.

Infrastructure as Software

Cloud computing enables you to **stop thinking of your infrastructure as hardware**, and instead **think of (and use) it as software.**

Traditional Computing Model

- Infrastructure as hardware
- Hardware solutions:
  - Require space, staff, physical security, planning, capital expenditure
  - Have a long hardware procurement cycle
  - Require you to provision capacity by guessing theoretical maximum peaks

Cloud Computing Model

- Infrastructure as software
- Software solutions:
  - Are flexible
  - Can change more quickly, easily, and cost-effectively than hardware solutions
  - Eliminate the undifferentiated heavy-lifting tasks

Cloud Service Models

IaaS
(infrastructure as a service)

PaaS
(platform as a service)

SaaS
(software as a service)

More control
over IT resources

Less control
over IT resources

Cloud Service Models

There are three main cloud service models. Each model represents a different part of the cloud computing stack and gives you a different level of control over your IT resources:

1. Infrastructure as a service (IaaS)
2. Platform as a service (PaaS)
3. Software as a service (SaaS)

Cloud Service Models - IaaS

Infrastructure as a service (IaaS)

- Services in this category are the basic building blocks for cloud IT and typically provide you with access to networking features, computers (virtual or on dedicated hardware), and data storage space.
- IaaS provides you with the highest level of flexibility and management control over your IT resources.
- It is the most similar to existing IT resources that many IT departments and developers are familiar with today

Cloud Service Models - PaaS

Platform as a service (PaaS)

- Services in this category reduce the need for you to manage the underlying infrastructure (usually hardware and operating systems) and enable you to focus on the deployment and management of your applications.

Cloud Service Models - SaaS

Software as a service (SaaS)

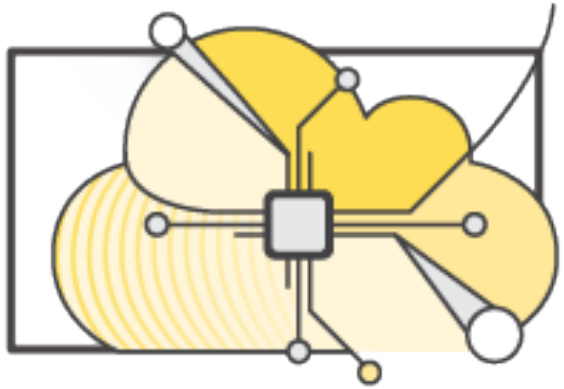
- Services in this category provide you with a completed product that the service provider runs and manages.
- In most cases, *software as a service* refers to end-user applications.
- With a SaaS offering, you do not have to think about how the service is maintained or how the underlying infrastructure is managed.
- You need to think only about how you plan to use that particular piece of software.

Cloud Service Models - SaaS

Software as a service (SaaS)

- A common example of a SaaS application is web-based email, where you can send and receive email without managing feature additions to the email product or maintaining the servers and operating systems that the email program runs on.

Cloud Computing Deployment Models



Cloud

Hybrid

On-premises (private cloud)

Cloud Computing Deployment Models

There are three main cloud computing deployment models, which represent the cloud environments that your applications can be deployed in:

1. Cloud
2. Hybrid
3. On-premises

Cloud Computing Deployment Models - Cloud

Cloud

- A cloud-based application is fully deployed in the cloud, and all parts of the application run in the cloud.

- Applications in the cloud have either been created in the cloud or have been migrated from an existing infrastructure to take advantage of the benefits of cloud computing.

- Cloud-based applications can be built on low-level infrastructure pieces or they can use higher-level services that provide abstraction from the management, architecting, and scaling requirements of core infrastructure

Cloud Computing Deployment Models - Hybrid

Hybrid

- A hybrid deployment is a way to connect infrastructure and applications between cloud-based resources and existing resources that are not located in the cloud.

- The most common method of hybrid deployment is between the cloud and existing on-premises infrastructure.

- This model enables an organization to extend and grow their infrastructure into the cloud while connecting cloud resources to internal systems

Cloud Computing Deployment Models – On-premises

On-premises

- Deploying resources on-premises, using virtualization and resource management tools, is sometimes called *private cloud*.

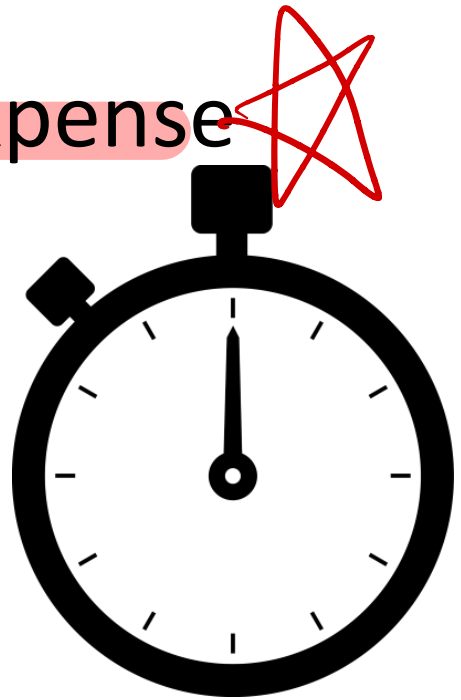
- While on-premises deployment does not provide many of the benefits of cloud computing, it is sometimes sought for its ability to provide dedicated resources.

- In most cases, this deployment model is the same as legacy IT infrastructure, but it might also use application management and virtualization technologies to increase resource utilization

Advantages of Cloud Computing

1. Trade capital expense for variable expense

Data center investment based on forecast



Pay only for the amount you consume

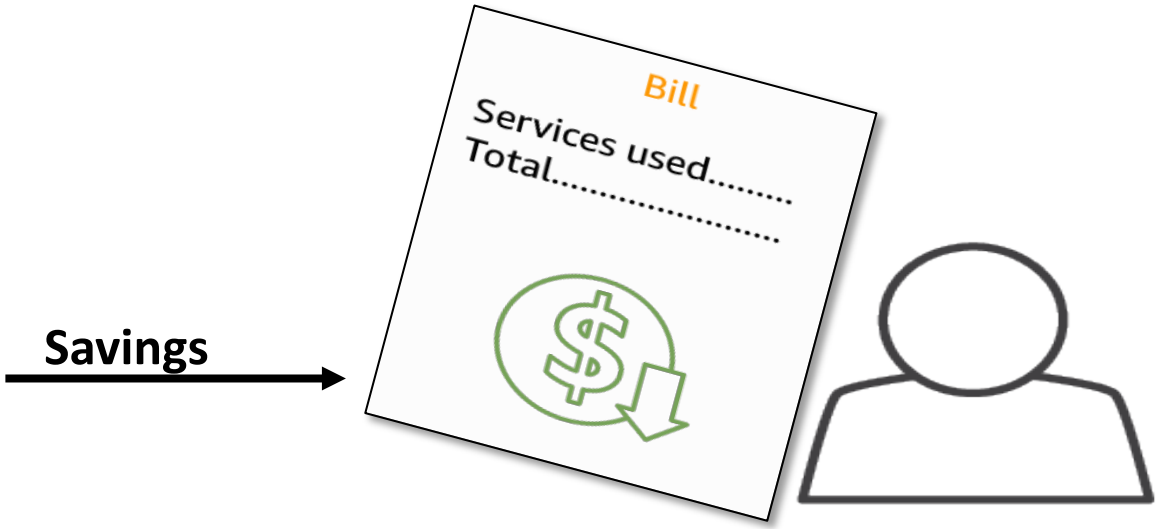
Advantages of Cloud Computing

2. Massive economies of scale

Because of aggregate usage from all customers, AWS can achieve higher economies of scale and pass savings on to customers.

AWS Cloud

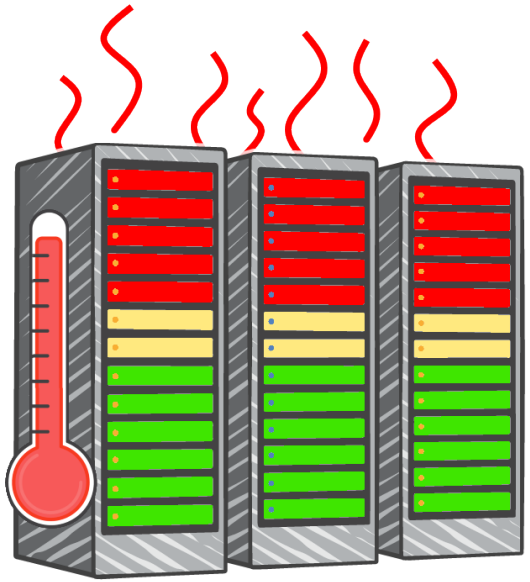
Economies of scale



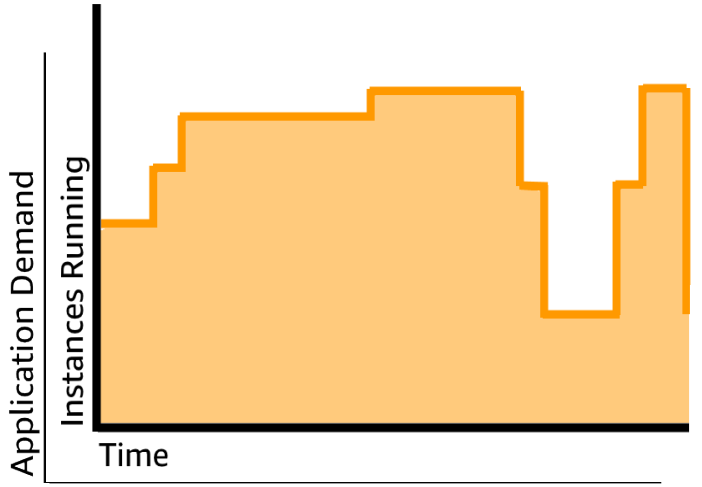
Advantages of Cloud Computing

3. Stop guessing capacity

Overestimated server capacity



Underestimated server capacity

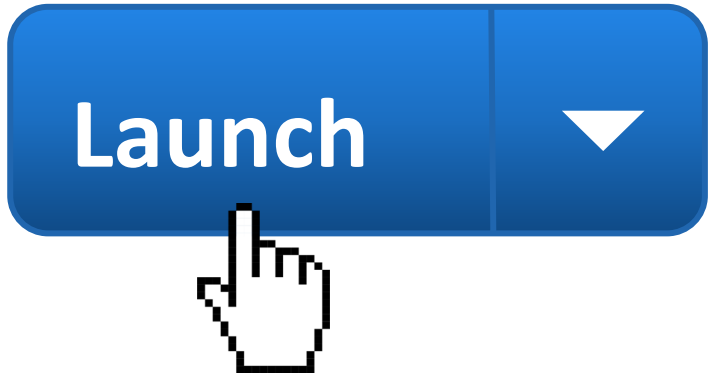


Scaling on demand

Advantages of Cloud Computing

4. Increase speed and agility

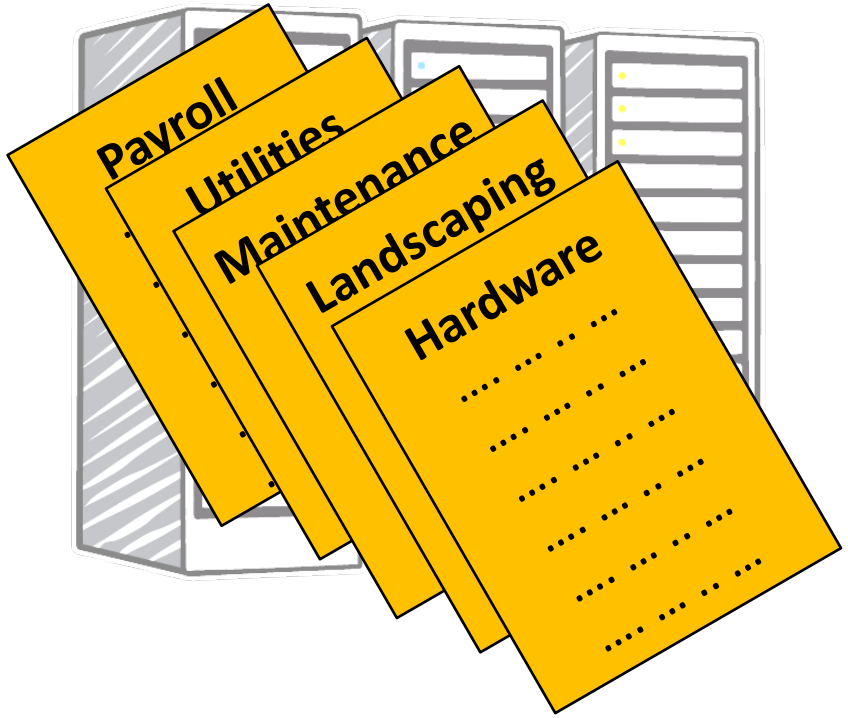
Weeks between wanting resources and having resources



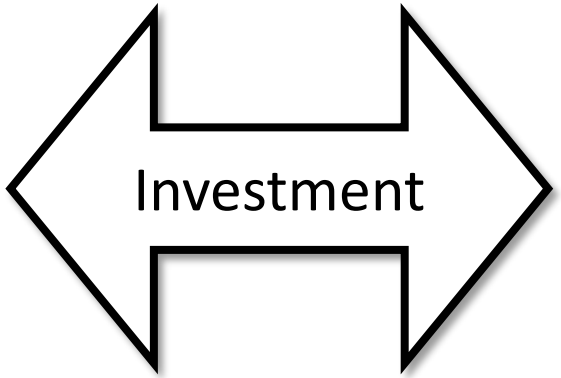
Minutes between wanting resources and having resources

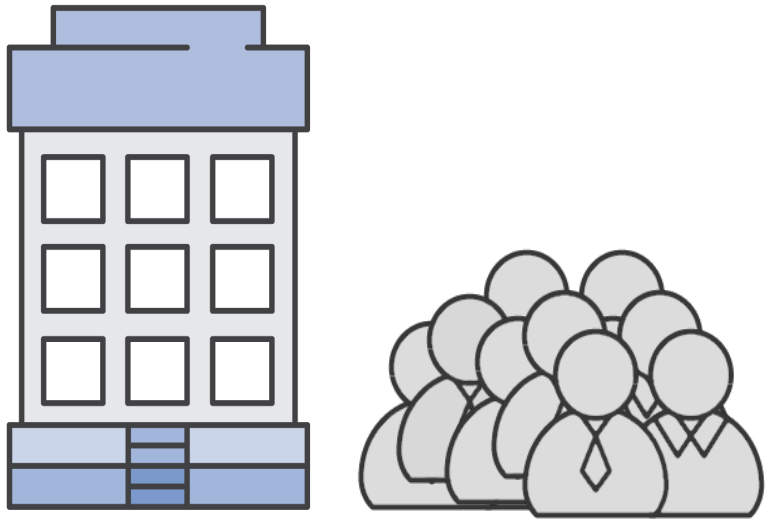
Advantages of Cloud Computing

5. Stop spending money on running and maintaining data centers



Running data centers

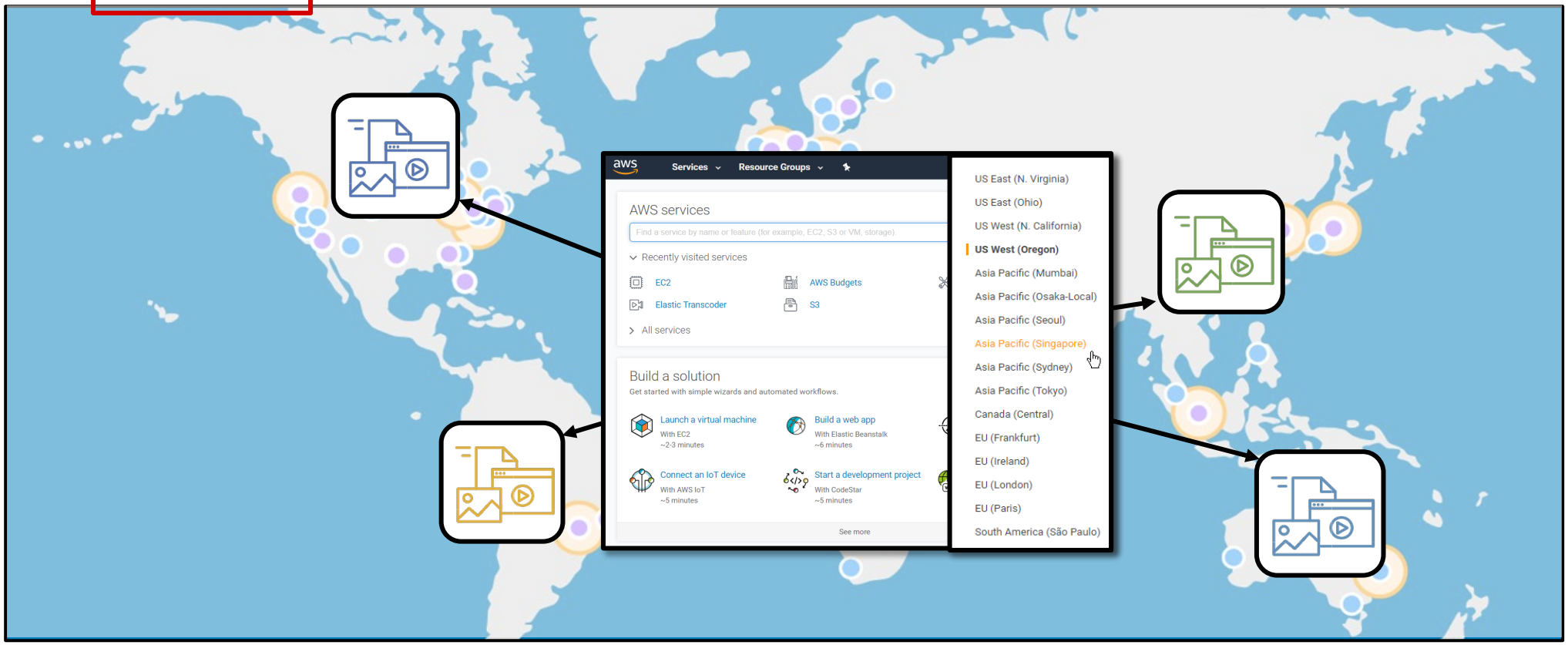




Business and customers

Advantages of Cloud Computing

6. Go global in minutes



Challenges of Cloud Computing

- Policy and organizational issues
- Technical issues
- Legal issues

Source: M'rhaoaurh I., Okar C., Namir A., and Chafiq N., "Challenges of cloud computing use: A systematic literature review", *In the Proceedings of MATEC Web of Conferences 200 (IWTSCE'18), 00007*, 201

Challenges of Cloud Computing- Policy and organizational Issues

- **Policy and organizational issues**: These are business-related IT issues that companies may confront when considering cloud computing service providers.
  1. Lock-in vendor
  2. Loss of governance
  3. Compliance challenges
  4. Supply chain failure

Source: M'rhaoaurh I., Okar C., Namir A., and Chafiq N., "Challenges of cloud computing use: A systematic literature review", *In the Proceedings of MATEC Web of Conferences 200 (IWTSCE'18), 00007*, 201

Challenges of Cloud Computing- Technical Issues

- **Technical issues**: These issues for the most part are well understood as part of resilient challenges of cloud computing adoption and continue to form a major obstacle to the availability and use of this technology. They are specified by the failures associated with the technologies and services furnished by the Cloud service vendor.
  1. Malicious insiders
  2. Shared technology
  3. Encryption
  4. Multi-tenancy

Source: M'rhaoaurh I., Okar C., Namir A., and Chafiq N., "Challenges of cloud computing use: A systematic literature review", *In the Proceedings of MATEC Web of Conferences 200 (IWTSCE'18), 00007*, 201

Challenges of Cloud Computing- Technical Issues

5. Resource and service management
6. Service level agreement (SLA)
7. Denial of service (DOS)
8. Insecure interfaces and APIs
9. Data loss or leakage
10. Integrity

Source: M'rhaoaurh I., Okar C., Namir A., and Chafiq N., "Challenges of cloud computing use: A systematic literature review", *In the Proceedings of MATEC Web of Conferences 200 (IWTSCE'18), 00007*, 201

Challenges of Cloud Computing- Technical Issues

11. Natural disaster
12. Availability
13. Loss of backups
14. Data transfer bottlenecks
15. Interoperability

Source: M'rhaoaurh I., Okar C., Namir A., and Chafiq N., "Challenges of cloud computing use: A systematic literature review", *In the Proceedings of MATEC Web of Conferences 200 (IWTSCE'18), 00007*, 201

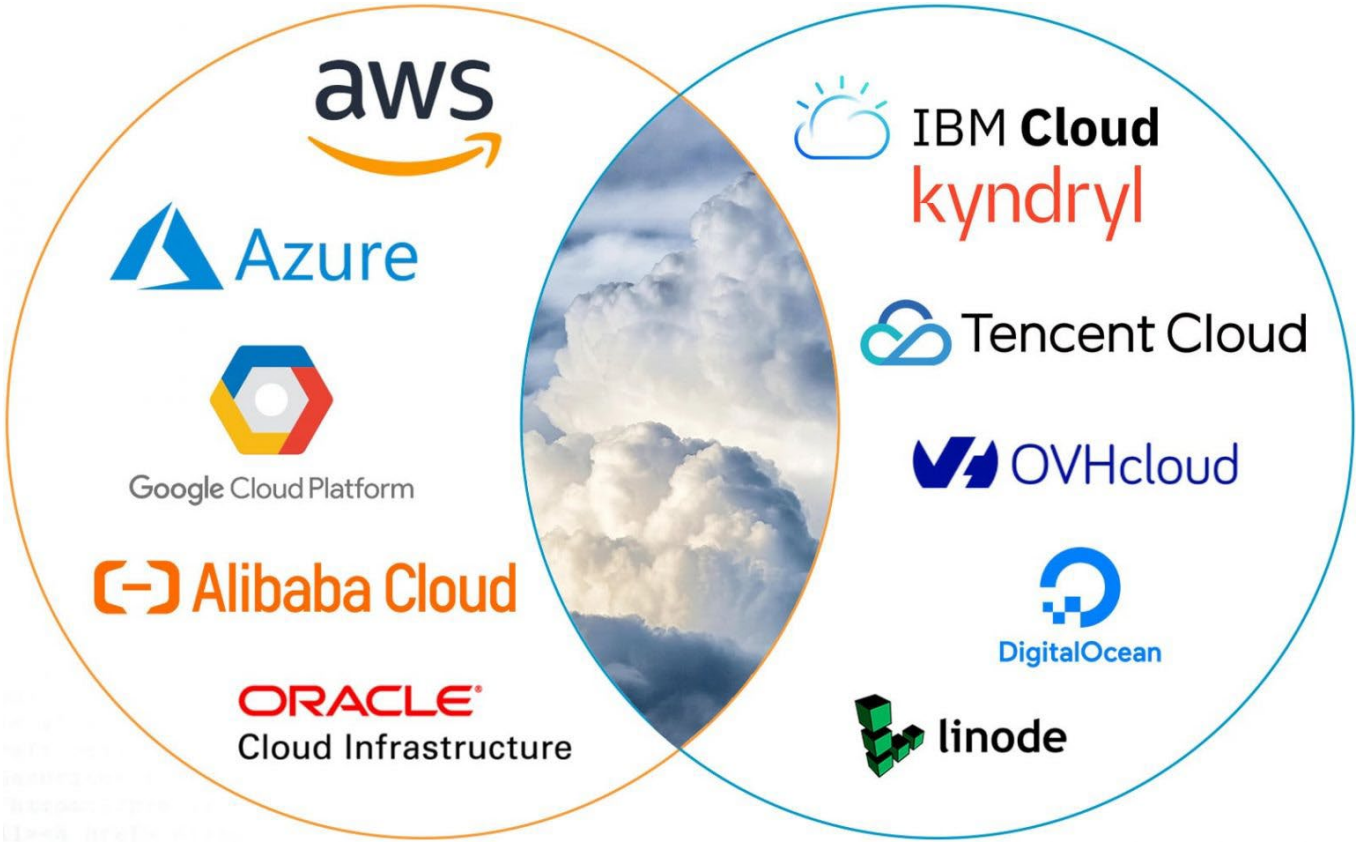
Challenges of Cloud Computing- Legal Issues

- **Legal issues**: These consist of the IT-related issues that are legal in nature, and can also have a negative impact on companies using cloud computing services.

1. Legal jurisdiction
2. Data privacy and protection
3. Licensing risk
4. Subpoena and e-discovery

Source: M'rhaoaurh I., Okar C., Namir A., and Chafiq N., "Challenges of cloud computing use: A systematic literature review", *In the Proceedings of MATEC Web of Conferences 200 (IWTSCE'18), 00007*, 201

Top 10 Cloud Service Providers in 2023



Source:
https://dgtlinfra.com/top-cloud-service-providers/

Top 10 Cloud Service Providers in 2022

#	Cloud Service Provider	Regions	Availability Zones
1	Amazon Web Services (AWS)	32	102
2	Microsoft Azure	62	120
3	Google Cloud Platform (GCP)	39	118
4	Alibaba Cloud	30	89
5	Oracle Cloud	46	56
6	IBM Cloud (Kyndryl)	10	30
7	Tencent Cloud	21	65
8	OVHcloud	17	37
9	DigitalOcean	9	15
10	Linode (Akamai)	20	20

Source: https://dgtlinfra.com/top-10-cloud-service-providers-2022

Microsoft Azure

- Microsoft Corporation's Intelligent Cloud segment contains Azure, the second largest cloud service provider globally.

- Through Microsoft Azure, the company delivers a consistent hybrid cloud experience, developer productivity, artificial intelligence (AI) capabilities, and security & compliance.

Source: https://dgtlinfra.com/top-10-cloud-service-providers-2022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THANK YOU