



The advantages of cloud computing over traditional IT infrastructure and services

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Abstract

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<p>This report is a research-type thesis that aims to study the benefits of cloud computing over traditional IT infrastructure. The research is conducted with a qualitative approach and the research methods are literature review and case studies.</p> <p>The report consists of an introduction where the topic, the research background, theoretical framework as well as aims and objectives are presented. In addition to the introduction, the theoretical basis is discussed in the second chapter covering topics and key concepts such as cloud computing definition, cloud evolution, cloud deployment models and most popular cloud providers.</p> <p>After this, the two chosen case studies are analysed. The case studies I chose for this thesis are Netflix and Airbnb and these are presented because I wanted to have real-world examples of transitioning to cloud. The case studies were analysed to examine why and how companies chose to change their old IT infrastructure and migrate to cloud. Lastly, the results and the findings based on the research are presented as well as tips for companies before and after the migration to cloud.</p> <p>This research has four main objectives which are examine the impact of cloud computing on business operations, collect information from companies that migrated to cloud successfully, analyse the gathered data and draw conclusions and provide recommendations for a safe migration process.</p> <p>The key findings of the study are the increased scalability and flexibility cloud technology offers to companies as well as cost savings compared to tradition IT infrastructure. In addition, cloud technology offers more reliability and availability, because the resources are provided by the cloud service provider, which gives more freedom to businesses.</p> <p>The report ends with a discussion section where the findings of the study are compared with how businesses used to run before and after cloud technology. Also, the difference in the cost between these two infrastructures as well as the moves the cloud providers have made to enhance security in cloud. Lastly, recommendations for companies thinking to transition to cloud are provided.</p>
Key words Cloud computing advantages, traditional IT infrastructure, service models, deployment models, virtualization

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1 Introduction

This research-type bachelor's thesis aims to explore the benefits of cloud computing over the traditional IT infrastructure. I will achieve this by using different research methods in order to gather the information I need.

Nowadays, we live in a world where technological evolution is rapidly increasing, new things and ideas are entering everyday life with new terminologies, which people need to know and sometimes interact with. One of these terms is cloud computing. This thesis will focus on the positive impact of cloud technology on business operations and performance by examining the existing literature and analyzing two case studies.

1.1 Research Background

Cloud technology has become an increasingly well-known solution for companies and as a result, it has brought significant positive changes by replacing old approaches with more efficient and effective ways.

With traditional IT infrastructure businesses had to invest their money in hardware, software and own or rent a physical space for their IT infrastructure. These upfront charges can often be an obstacle for small and medium businesses, making it difficult for them to survive and compete with other businesses in the market. Also, in order to keep everything running smoothly and ensure proper system function, maintenance and upgrades are necessary. But this requires specialized staff and additional hardware, which can further increase expenses.

The adoption of cloud computing by companies improves their daily operations and reduces costs. This cloud-based solution drives companies to increase their efficiency and productivity rapidly due to the high flexibility and scalability that it offers. However, the fact that all these benefits are well-known to the public, there are still concerns about the potential risks that may arise from this 'new' technology, particularly in terms of data security. That's why it's important for companies to understand the significance of cloud computing to benefit from it.

1.2 Aims and Objectives

The main goal of this research thesis is to explore the impact of cloud technology on companies that have migrated to the cloud and to provide detailed information about the benefits of this adoption over traditional IT infrastructure and services. The objectives of this thesis are listed below:

- To examine the existing literature on cloud computing and its impact on business operations, considering the advantages and disadvantages of cloud computing.
- To select two companies that have transitioned to the cloud and collect information about their experience.
- To analyze the data gathered from the case studies and examine the impact of cloud technology on various areas of the companies' operations.
- To draw conclusions and provide recommendations for companies considering migrating to the cloud.

1.3 Theoretical framework

The theoretical framework will examine various aspects of cloud computing such as its models, services, providers, advantages and disadvantages related to traditional IT infrastructure. This analysis will highlight the strengths and the weaknesses of both choices. Also, the theoretical framework will explore how cloud computing has totally transformed business operations and why companies should adopt cloud technology instead of staying in traditional IT infrastructure approach. This thesis will be based on a review of existing literature in cloud computing adoption and examining two case studies of successful cloud adoption companies (Netflix and Airbnb).

In this thesis, I will examine the literature on cloud computing in order to present the challenges, risks and the benefits that are offered. Moreover, I will identify the business factors that are most enhanced through cloud adoption. On the other hand, case studies provide real-world examples of successful cloud adoption and offer valuable insights into why a company should move to cloud, how to overcome challenges during transition and what are the benefits from this after all.

1.4 Methods

In this chapter, I will explain how I am going to conduct my research in finding the advantages of cloud computing over traditional IT infrastructure and why I chose this specific approach. By doing this, I aim to achieve the objectives of my thesis.

The research will be conducted with the qualitative approach. The research will consist of two main components, the first will be a review of existing literature on cloud computing and the second will be case studies of two companies that have successfully transitioned to cloud. For the literature review, I will search for existing studies over the Internet from various technology websites. Also, I will pick two companies with different focus and business models that have migrated to the cloud and collect data from external resources such as articles and industry reports, to gain a broader

perspective from real-world examples about the benefits of the transition from traditional IT infrastructure to the cloud.

After collecting the data from literature review and case studies, the data will be analysed by using qualitative technique through content analysis. I will examine written material over the Internet so that I can extract conclusions about the benefits of cloud computing over the traditional IT infrastructure. In my analysis, there will be comparisons in how business operates before and after cloud adoption, also I will include some graphs and images to help me support my analysis with visuals.

1.5 Structure of the thesis

This research type thesis is divided into five chapters. The first chapter introduces the topic, including the research background, theoretical framework, the methodology, the aim and the objectives of the thesis. The second chapter of this thesis presents a review of the current literature on cloud computing, covering topics such as its definition, evolution of the cloud, the cloud services, cloud deployment models, most popular cloud providers and challenges. Moreover, this chapter makes a comparison between the advantages and disadvantages of cloud computing and traditional IT infrastructure and explores the impact on various aspects of business operations.

The third chapter will present the case studies of the companies (Netflix and Airbnb) that have successfully migrated to cloud computing. By analysing the experiences of these companies, the thesis will be able to extract information about the transition from on-premises infrastructure to cloud and the impact of cloud technology on business operations.

In the fourth chapter, there will be the results of data analysis presented and finally the last chapter will provide a summary of the research findings. Also, in the last chapter there will be some recommendations for companies in order to migrate to the cloud with safety.

2 Literature review

This thesis will discover the benefits of cloud computing over the traditional IT infrastructure with the help of the existing literature and exploring some case studies. The literature review is taken from existing information and articles from the Internet.

2.1 Introduction to Cloud Computing

Cloud computing is a technology that enables users to access different computer resources such as storage, servers, databases over the Internet. This way resources and services are quickly provided to users without any complexity.

The concept of cloud computing dates back to 1960s, but it wasn't introduced as a service until 2006 from AWS and later from Google, IBM and Microsoft. It's worth saying that Salesforce was actually the first company to use cloud computing, but in a different way than Amazon. While Amazon used the cloud as a platform, Salesforce on the other hand, used it for cloud-based software delivery. (Biswas s.a)

The main idea of cloud computing is instead of purchasing and setting up the resources on your own, you have the option to borrow this service from cloud providers such as Amazon or Azure and use them according to your needs, this way the cost is much lower, because you avoid paying more for the staff and space for the equipment.

Cloud computing can be considered as a revolutionary technology, that has totally changed the way businesses operate. Cloud computing is the on-demand delivery of IT resources over the Internet with pay-as-you-go -pricing. Rather than purchasing, owning, and managing physical data centers and servers, cloud technology provides services such as computing power, storage and databases. (AWS a s.a) All data and information are saved by cloud providers in data centers located in different regions all over the world. Cloud computing has become popular due to its ability to offer flexibility, scalability and cost-effectiveness.

All these services and benefits of cloud computing couldn't be achieved without the help of virtualization. The whole idea of cloud computing is about creating resources over the Internet and virtualization plays a crucial role in this. Virtualization is a technology that simulates hardware functionality in virtual version. So, all this is based on the concept of a virtual machine that runs on a physical computing platform which is controlled by a hypervisor. A hypervisor or Virtual Machine Monitor helps to create virtual machines by separating the operating system from the physical hardware and then emulate hardware such as CPU, memory and RAM to those Virtual Machines. (Mercier 2021)



Figure 1. What is Cloud Computing. (Knight 2021)

According to NIST which stands for National Institute of Standards and Technology, there are five important characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. (Reciprocity 2 December 2021) Those characteristics will be further described below:

- **On-demand self-service:** Users can allocate computing resources like servers or databases on their own according to their needs without any interaction with the service provider.
- **Broad network access:** All computing resources can be easily accessed from any location at preferable times and from any personal device connected to the Internet.
- **Resource pooling:** The data distribution is provided with the multi-tenancy model to multiple users. This way computing resources are used from several users dynamically depending on the demand.
- **Rapid elasticity:** Elasticity is about how quickly and flexible computing power can be. Users can have immediately limitless resources and can scale up or down to meet the desired level at any time.
- **Measured service:** Cloud services control the resource usage of all users and after the calculations can provide details about the prices and resources used so far in the form of reports. This service provides transparency and better control of their costs for the users.

2.1.1 Cloud Services

Cloud computing has also evolved over the years and there are two main categories that can be divided. The first category is the type of service that is offered and the second is the deployment

models that are available. The Figure 2 below, presents the cloud Shared Responsibility Model. This model shows the exact duties of the cloud provider and the customer in each service.

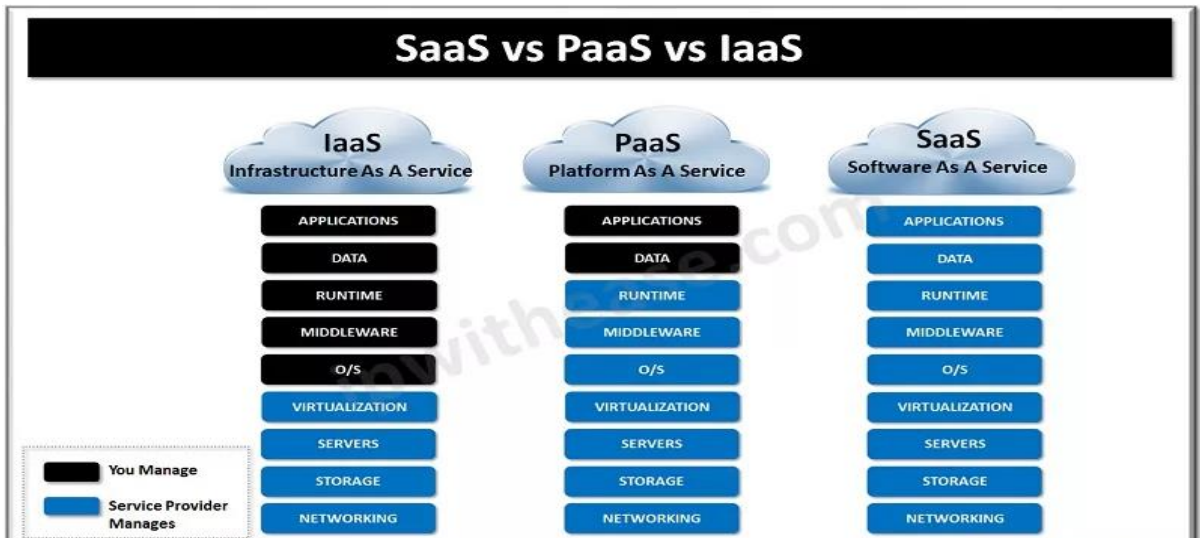


Figure 2. SaaS vs PaaS vs IaaS: Understand the difference. (Bhardwaj s.a)

The three main types of cloud computing services are Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Each of these service models offers different levels of management of the cloud infrastructure.

Infrastructure as a Service (IaaS)

This model offers the fundamental building of computing infrastructure such as computing power, networking, and storage resources. Users have no rights to control the used cloud infrastructure but they are able to execute and develop their own software, have control over the operating systems, manage the applications that have been deployed and storage media. Two examples of IaaS are Amazon Web Services and Microsoft Azure.

Platform-as-a-Service (PaaS)

This service provides a platform where users can deploy and create applications with any programming language and tools. User is not managing any cloud infrastructure, servers or operating systems, but user is responsible for the control of applications and data. Developers find this type of service ideal because they prefer to focus on coding and application development rather than spending time and effort on provisioning and maintaining their own platforms before starting to code. Some PaaS services are GitHub, Docker and Kubernetes.

Software-as-a-Service (SaaS)

In this model the user can rent the software instead of purchasing it. The cloud provider is responsible for any update and maintenance of the software. All services are available to users over the Internet and there is no need to install or spend users' physical resources because everything is set up on cloud provider servers. Some SaaS services are Dropbox, Zoom and Netflix.

2.1.2 Cloud Deployment Models

All these cloud services can be available in different users of various cloud deployment models such as private or public cloud. Cloud deployment models are public cloud, private cloud, hybrid cloud and community cloud. Although these cloud deployments models have some differences between them, they all rely on similar technologies and share fundamentals principles of cloud computing.

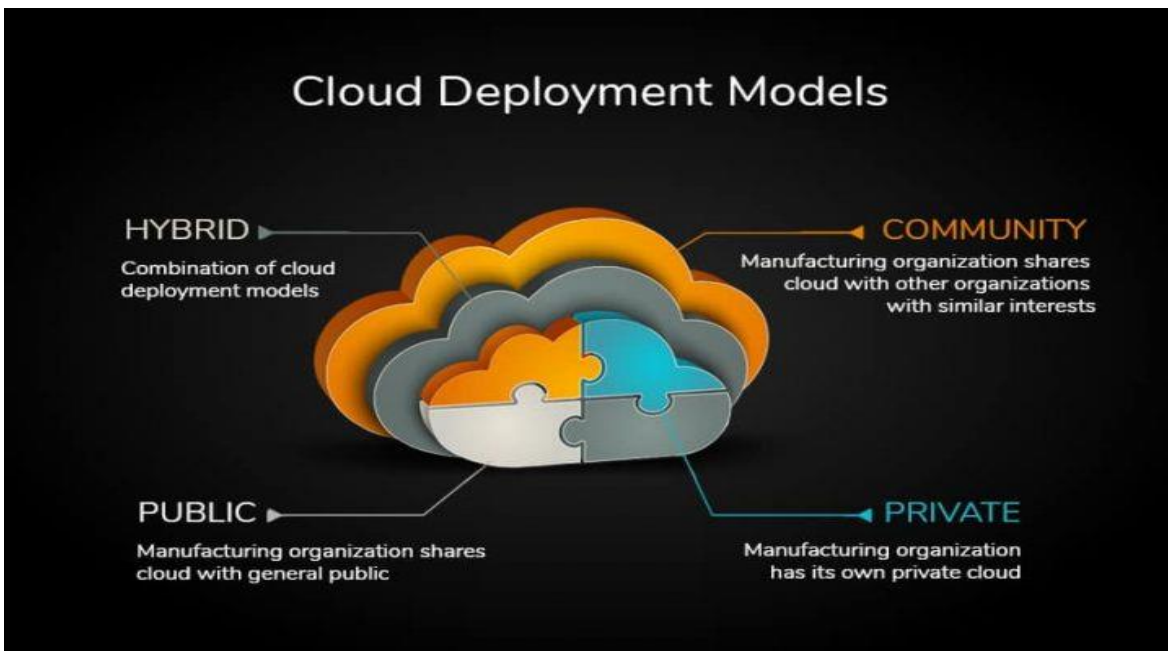


Figure 3. Cloud Deployment Models. (Turningcloud 21 January 2021)

Private Cloud: This deployment model, also known as corporate or internal model, is used by specific companies to provide cloud services within their own infrastructure. In this model all the equipment and resources are stored on-premises. Unlike the public cloud, under this model companies have the control and the power to manage their own systems according to their needs. Private cloud is mostly used by big companies because it offers customization and control. Also, in this model only authorized staff of the company is allowed to access data. On the other hand, private cloud is not cheap because it requires hardware and maintenance from the owning company.

Public Cloud: Public cloud is available from third-party providers over the Internet for both companies and individuals offering computing services, storage and deployment environments among other features. Public cloud is the most used deployment model due to its affordability, accessibility from everywhere and their lack of obligation for users to check hardware or set up networks and infrastructures, cloud provider is responsible for maintenance and every problem that arises. However, this model creates some concerns to users about where their data is stored, and it's true that security risks are high due to vulnerabilities.

Community Cloud: This model is like private cloud, but it's not owned by one company but from many with similar backgrounds and needs. Companies share their resources and infrastructure to utilize the community cloud. With this approach, the cost is divided and makes this model more affordable than using private cloud. Additionally, the collaboration between companies is enhanced because all the data are shared within the community cloud. However, the high demand from companies may occur problems with storage and bandwidth capacity.

Hybrid Cloud: This model is a mixed computing environment where private and public clouds are combined. It is ideal for companies with a wide variety of needs because it transfers data between other clouds according to their needs. For instance, if an application needs high scalability and flexibility it can benefit from public cloud. However, if this application needs to store sensitive data it can utilize the private cloud. This model offers flexibility and control, but it also needs maintenance and sometimes the implementation can be challenging.

2.1.3 Cloud Providers

Due to the rapid growth of cloud computing the number of cloud service providers has increased. Each provider offers a variety of services to users, while some of them are offering specific services targeting specific industries. The top three cloud providers that are holding together more than 60% of cloud computing market share are AWS, Azure and Google Cloud (Susic 2023). Below, is an introduction to these major cloud providers and their services.



Figure 4. Comparing the top 3: Google Cloud, AWS & Microsoft Azure. (Clouve 26 November 2020)

AWS: In 2006, Amazon launched a cloud computing platform known as Amazon Web Services. This platform managed over the years to dominate the cloud computing world by offering a wide variety of services. AWS is known for its high availability and reliability due to AWS global network of data centres and multiple availability zones and regions that are provided. Also, AWS gives emphasis on security and offers a variety of security features to ensure data is fully protected. Some of the offered cloud services are Elastic Cloud (EC2), Virtual Private Network (VPC) and Simple Storage Service(S3). EC2 provides computing power to create virtual machines, VPC creates a totally isolated virtual network inside the infrastructure and S3 which is an object storage service where users can store and retrieve their data.

Azure: This cloud computing platform was launched by Microsoft in 2010. It offers a wide range of cloud services like AWS, but it comes second in market share. However, this provider has more availability zones and regions located worldwide compared to AWS. (Pareek 2022) Some Azure cloud services are Azure Virtual Machine, Azure Blob and Azure VNet. The first one is used to provision virtual servers, Azure Blob is an object storage service and the last one is for creating an isolated network to run inside the virtual server.

Google Cloud Platform: Although this provider was launched before Azure it didn't have the same impact on cloud computing like AWS and Azure. The number of services that are available in Google Cloud is less than the other two providers. Some Google Cloud services are Google Compute Engine, Google Cloud Storage and Virtual Private Cloud.

There is not a straight answer to the question which cloud provider is the best, because every company has specific needs and requirements. It's important to consider beforehand, which provider

offers the most suitable services that are meeting the company's needs. Companies usually prioritize factors like pricing, security features, support and technical expertise needed.

2.2 Challenges and risks of cloud computing

There are both positive and negative aspects in cloud computing. Although the advantages are more than the disadvantages, it's important to point out the disadvantages, because this will help the users to understand how exactly cloud technology works and what is being offered, before migrating to the cloud.

The main potential risks that someone can face in cloud computing are security, network connectivity, vendor lock-in, limited control and cost. These challenges will be discussed further below.

Security: Although security is a top-priority and cloud providers apply multiple security layers, customers may think that saving their sensitive data in a third-party servers might be risky. According to a survey almost 98% of companies that use cloud computing have faced at least one data breach from 2020 to 2022. (Yachin 1 July 2021)

Network: Cloud technology is reliant on virtualization technology, which requires Internet to access virtual resources. As a result, when the internet is not available or the connection is weak, cloud computing can't provide any services due to high dependency on the Internet.

Vendor lock-in: This is a common challenge that many businesses face, as it's not that simple to move from your current cloud provider to a different cloud provider in the future. As businesses grow, their needs and requirements are changing. In some cases, their current cloud provider may not be able to support the new requirements. This results in the customer finding the best possible solution from another cloud provider. However, here is the tricky part, because transitioning from one cloud provider to another can present compatibility challenges.

Limited control: Except for the private cloud, all other deployment models are completely managed by cloud providers. The customer can't monitor their own cloud infrastructure and this situation leads to customers having no control over their data.

Cost: To benefit from cloud computing the customer should have a pre-defined plan that outlines the company's strategy for what it specifically needs before moving to the cloud. Since cloud technology is something new to the customer their lack of experience and insufficient knowledge may lead to unexpected costs.

All the above possible risks may happen at some point, but all cloud providers are evolving day by day to mitigate these risks as much as possible. Also, from the customer's perspective everything

should be clear regarding their cloud service needs. For example, the exact amount of storage needed, the configuration of security settings, service monitoring or any other concerns must be addressed before signing the contract with the provider. With this way customer enhance the possibility to avoid any hidden costs and use cloud services smoothly.

2.3 Comparison of cloud computing over traditional IT infrastructure

Figure 5 helps to understand the different levels of responsibility when it comes to manage an IT infrastructure and can help companies to decide which approach is most suitable for their needs.

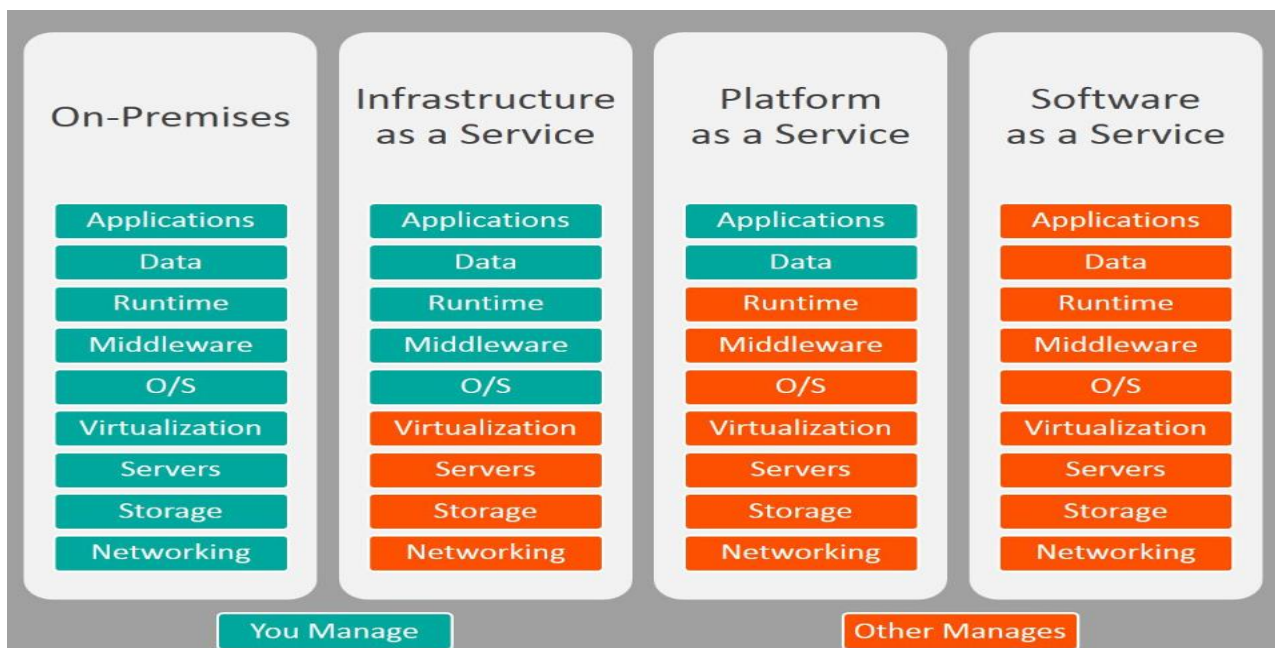


Figure 5. SaaS vs PaaS vs IaaS: What's The Difference & How To Choose. (Bmc 15 June 2019)

2.3.1 Traditional IT infrastructure

Before exploring the advantages of cloud computing, it's important to understand how businesses used to operate with the traditional IT infrastructure before the advent of cloud computing.

In traditional IT infrastructure all the equipment is kept in an on-premises environment and businesses have complete control over their infrastructure. The business owner is responsible for buying, maintaining and upgrading the hardware of the infrastructure, as well as providing a dedicated space for establishing the data centre, where physical servers and data will be stored. It is easier to ensure that only authorized staff have access to sensitive data, because all data is stored only within the company. In addition, the business is responsible for purchasing licences for the software and updating it when necessary.

However, the cost of the equipment, maintenance expenses and hiring new staff for the smooth operation of the infrastructure, require a significant amount of money to ensure the high performance of the servers and the resiliency in the infrastructure. Also, there is a possibility in the future that the needs and requirements will change and with the existing infrastructure the business may not be able to operate successfully. As a result, more expenses are arising for the business to expand the existing infrastructure by purchasing more equipment and hiring additional staff to manage it. This high risk with the additional investments can cause problems for the business because the existing equipment at some point in the future will cause a depreciation of investments. A key characteristic that is missing from traditional IT infrastructure is the ability to scale up or down resources to meet the new business needs. Without this feature businesses are doomed to spend a huge amount of money to survive in the new market demands.

2.3.2 Cloud computing

According to a survey 94% of enterprises use cloud services and by 2025 there will be an estimated 175 zettabytes of stored data on the cloud. This high percentage has significantly increased the last years due to the COVID-19 pandemic and the need for remote work. (Flynn 2022) Let's now examine the different possibilities cloud computing offers compared to traditional IT approaches.

The sustainability of a company is related with profit. Therefore, one of the top priorities is to minimize expenses. Cloud computing gives an opportunity for companies to use various cloud services from third-party companies without the need to buy and manage their own equipment and create on-premises data centers. Maintenance also, is fully supported by the cloud provider for both hardware and software. In this case, the costs are significantly lower because the company pays the cloud services (computing power, storage, etc.) on demand.

Another feature that does not exist in traditional IT infrastructure is the unlimited storage space and the availability of cloud computing resources. Depending on the workload a company can scale up or down cloud resources easily. This feature provides more flexibility, because resources can meet the needs of the company without installing any physical infrastructure. After fulfilling their requirements, the company can release the cloud resources and continue according to the new needs.

Moreover, another important benefit in cloud computing is the accessibility. Multiple users can use cloud services from their devices with internet connectivity and access files that are saved online in data centers. This feature is quite important nowadays due to the increased number of people working from home.

Also, with cloud computing is easy to retrieve backup data from the cloud. All businesses have a storage plan for backups, where they keep copies of their data. In cloud computing disaster recovery solution is often based within the data center of the cloud provider, which is designed to meet security and compliance needs of businesses. In traditional IT infrastucure disaster recovery solutions are often located in a different physical location from the company's primary data center. This choice will definetely cost the company more money and also the risk of losing data makes using cloud method better solution.

Of course, security and safety has become a primary concern in cloud computing, because data leak is something everyone wants to avoid. Many businesses are skeptical to store their data on third parties' servers rather than having their data on their premises. Some businesses could use the hybrid model to store their data on premises and at the same time use cloud resources from cloud providers.

Cloud providers are aware of the hesitation of companies to move to cloud because of the security issues and that's why the shared responsibility model is used. This model is a security framework that defines the responsibilities between the customer and the cloud provider to provide security to the cloud environment. The cloud provider is responsible for the security 'of' the cloud and the customer for the security 'in' the cloud.

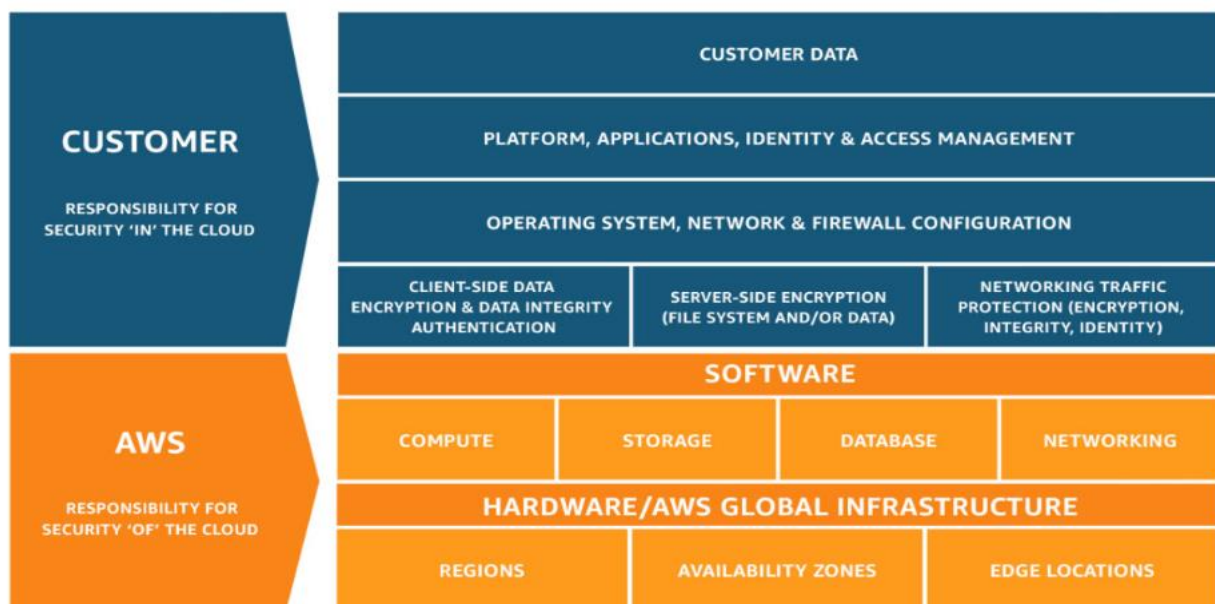


Figure 6. Shared Responsibility Model. (AWS b s.a)

Also, cloud providers have taken several other actions to address security such as:

- **Security tools and features:** Firewalls, access controls, monitoring security and encryption.
- **Continuous improvement:** Cloud providers are always enhancing their security measures, adopting new security technologies and conducting regular vulnerability and penetration testing.
- **Compliance certifications:** Cloud providers frequently take on compliance certifications to showcase their commitment to security and privacy regulations. Some of these certificates are ISO 27001, SOC 2 and HIPPA. (Algosec s.a)

3 Case studies

With this research method, I will gain detailed information and insights about the benefits of cloud computing over traditional IT infrastructure and services. I chose two real-world examples for the case studies. These are Netflix and Airbnb.

3.1 Case study Netflix

Netflix is the first company I will analyse in terms of why and how it transitioned from using traditional IT infrastructure to adopting cloud computing services, as well as the benefits they gained from this choice.

Netflix is a Software as a Service (SaaS) entertainment company that was founded in 1997 and primarily focuses on streaming movies and TV-series online. This streaming platform is the most popular among others streaming services, and it is available in over 190 countries and has millions of subscribers worldwide.

Back in 1997, Netflix operated differently from what it does now. Instead of offering streaming services, the only way customers could request DVDs was by choosing from an online catalog on Netflix's website and DVDs were delivered to customers by mail. In the early years, Netflix used a pay-per-use billing plan, but later they launched other billing models. In 2007, Netflix introduced the online-streaming service as an additional option for renting DVDs, which completely transformed the concept of entertainment and the way of watching movies in such direct way and even today it's very popular. In Figure 7, we can see the first website of Netflix. This allows us to compare it with the current user interface and observe how navigation has become easier and more user-friendly over the years.

Try Netflix for FREE Today!

Rent all the DVD movies you want.
For 20 bucks a month. No late fees.

 World's Largest Selection	 FREE & FAST HOME DELIVERY	 NO LATE FEES	 Free Shipping!
Super Selection! Create a list online of all the movies you want to see	Free & Fast Home Delivery The movies you select arrive via first-class mail in 2-4 days.	No Due Dates or Late Fees Keep each DVD as long as you want. Have up to 3 movies on hand.	Free Shipping! Return one DVD in its prepaid envelope and get another DVD from your list.

\$19.95 PER MONTH

One Flat Fee!
 It's just 20 bucks a month. There are no late fees, no hidden charges, no commitments. If you have any questions, call 1-888-638-3549.

Figure 7. Screenshot of the 2002 Netflix user interface. (hAhA Innovations 01 February 2021, min. 0:05-0:16)

This revolutionary change in the way of watching movies was positively received by people and the number of new customers increased rapidly. This happened because the new streaming service was more convenient and flexible instead of waiting for the DVD to arrive by mail. This sudden increase in customers, the simultaneous use of online streaming service and the initial DVD delivery service by mail led to technical problems. In 2008, a significant incident occurred in Netflix's database, which caused Netflix to be unable to ship any DVDs for three days. This event became a turning point for Netflix, leading them to reconsider their business operations and IT infrastructures and move away from vertically scaled single points of failure, such as relational databases in Netflix datacenter and move to highly reliable and horizontally scalable distributed systems in the cloud. (Izrailevsky, Vlaovic, Meshenberg 2016)

The cloud provider that was chosen by Netflix was AWS as it was the first company to offer such services. The reason why this cloud provider was selected by Netflix is that it met all requirements and conditions that Netflix had set in order to address the problems that existed while using traditional IT infrastructure. During the transition, Netflix had to maintain the initial infrastructure to ensure that the migration would not disrupt any of their services and the customers wouldn't face big delays or downtime experiences in their streaming service, which might lead to customer dissatisfaction.

By 2015, most of the applications and other IT resources have moved to the cloud successfully. However, the billing infrastructure service and customer and employee data management needed a secure and durable cloud path because it's a complex process that requires additionally planning to avoid potential risks such as data loss or performance problems. Finally, in 2016 Netflix shut down the last data center and the migration to the cloud officially finished. (Izrailevsky, Vlaovic, Meshenberg 2016)

Simultaneously with the cloud migration process, the number of new members rapidly increased, leading to its current position as the best online streaming service globally. In Figure 8, we can see the growth of streaming hours and how it increased over the years. Netflix was able to implement its revolutionary ideas and new features in their online streaming service with great success and they recognize that this success was only possible after moving from their traditional IT infrastructure to the cloud, because otherwise it would be too expensive and time-consuming to develop the needed infrastructure for implementing new features and that choice could lead to unpredicted negative results.



Figure 8. Monthly streaming hours during the migration process. (Izrailevsky, Vlaovic, Meshenberg 2016)

So, how does cloud computing differ and what does it offer that traditional IT infrastructure couldn't? The answer to this question is that cloud technology offered Netflix a virtually dynamic networking environment with numerous capabilities. This large cloud ecosystem consists of inter-dependent components (applications) that are constantly communicating with each other over the Internet.

In this environment Netflix has access to hardware, software and various tools that enable it to use servers, data storage, databases and different tools for data analysis and processing. However, the fact that Netflix relies a lot on Amazon's cloud infrastructure doesn't mean that Netflix doesn't have its own development teams and continuously makes improvements independently. For example, Netflix uses their purpose-built tools for big data processing and analytics and video processing and transcoding to meet specific needs. These tools are customized and integrated with AWS services. (Ajeenkya 2020)

Netflix has preferred the hybrid cloud model because it offers better control over the IT infrastructure. With this model, Netflix can choose the IT infrastructure in which each task is distributed

based on specific requirements. This capability helps to ensure the smooth running of all business operations. For example, if there is a task where there is a high volume of traffic then Netflix will take advantage of the scalability of cloud computing and utilize AWS's computing power to handle the increased load. On the other hand, if there is a task where sensitive data must be stored then traditional IT infrastructure is a better choice.

After adopting the hybrid cloud model, Netflix has moved most of its infrastructure and resources to the cloud but still utilizes on-premises resources for better control over the IT infrastructure. Below are some of the cloud services that support Netflix's business operations.

AWS has Amazon Elastic Compute Cloud (EC2) service, where Netflix can launch and manage virtual machines (instances) and configure the needed parameters like CPU, storage, memory, etc. Those instances are launched on demand and Netflix only pays for the used resources. This resizable computing capacity is beneficial for Netflix because it can be adjusted according to varying demands of Netflix workload.

Another important AWS cloud service that Netflix uses is Simple Storage Service (S3). With S3 Netflix can store and retrieve data anytime without any delays. In this cloud storage solution Netflix stores its big library of movies and TV shows, user data and other content. This cloud service is crucial for Netflix, because the massive amount of stored data is continuously growing in line with Netflix's goals and with the help of S3 everything is easily accessible with reasonable pay-as-you go prices.

Some of the AWS databases are Amazon Relational Database Service (RDS) and Amazon DynamoDB. Both databases serve different purposes of Netflix operations. RDS is used for storing structured data that requires a relational database schema and DynamoDB is a NoSQL database that manages unstructured data like Scalar, Multi-valued and Document. (Patra 15 September 2022)



Figure 9. Some of the AWS cloud services. (Optisolbusiness 2020)

Most of the cloud services run inside the Virtual Private Cloud (VPC). Netflix uses this service to establish a virtual network inside the cloud environment and deploy its resources. Every resource inside this network is isolated and secured from outside threats. With VPC, Netflix can control network traffic and create subnets and security groups to enhance the safety of its resources.

Of course, there are many other cloud services and tools from AWS that can enhance various aspects of Netflix operations. For example, some AWS tools gather data based on customer behavior and personal interests. This raw data is analyzed using various machine learning and data processing tools to extract valuable insights and customer's preferences. This way Netflix can use this information to improve their strategy and boost their business operations.

All in all, Netflix's digital transformation was a complete success thanks to AWS advanced cloud resources and capabilities. All the limitations of traditional IT infrastructure, such as having to manage many physical servers and large data centers, have been transformed into an easy-to-manage virtual network. The next chapter will provide a detailed analysis of the results offered by cloud services to Netflix's business operations.

3.2 Case study Airbnb

The next case study will provide valuable information about why Airbnb chose to transition to cloud and what benefits it gained and goals it achieved. I chose to conduct this second case study analysis to support my findings because it will further highlight the advantages of cloud technology and will show how companies meet their requirements and growth fast.

Airbnb is a leading online marketplace for short-term homestays and it was founded in 2008 and has left a significant impact on the hospitality industry. It has changed the way people travel by offering affordable alternatives to traditional accommodation options. The idea behind Airbnb is to provide a platform for people to rent out their homes or extra spaces to travellers who are looking for a cheaper and unique lodging experience than staying in the hotel.

This concept was widely embraced because it was beneficial for both hosts and travelers. On one hand, hosts were able to earn some money without much effort, and on the other hand travelers enjoyed greater flexibility in their travel plans. After having a significant increase in demand from customers, Airbnb wanted to add new ideas and experiences in their business plan. That was the time when some service administration challenges emerged with Airbnb's original provider. After that, it was obvious that something should change in the company, as the projects were not progressing as planned and there was a growing need to use more resources. Until then, Airbnb was using self-management servers as well as some third-party cloud providers for their services. With the increased demand of the needed resources, managing various systems became complex. In

2008, Airbnb made the decision to migrate nearly all of its cloud computing functions to AWS. It's worth noting that during the migration process of the MySQL database to Amazon RDS there was only 15 minutes of downtime. (Gupta 2020)

After making this transition, Airbnb used Amazon EC2 instances to support their business needs and meet the increased demand. In 2015, Airbnb had around five thousand EC2 instances running on AWS, with the majority of them being reserved instances (AWS pricing model to reserve EC2 instances in advance with discount) for cost effective reasons. However, only 1500 of those instances were dedicated to running web-facing applications and the remaining 3500 instances were utilized for various kinds of analytics and machine learning algorithms to support the company's operation. Of course, as Airbnb expands, those numbers will increase accordingly to meet the new requirements. (Prickett Morgan 2015) To ensure the proper distribution of traffic among the instances Airbnb used AWS Elastic Load Balancing to achieve efficient traffic management. With this service the stability of cloud computing infrastructure is ensured by preventing unexpected overloads on any instance.

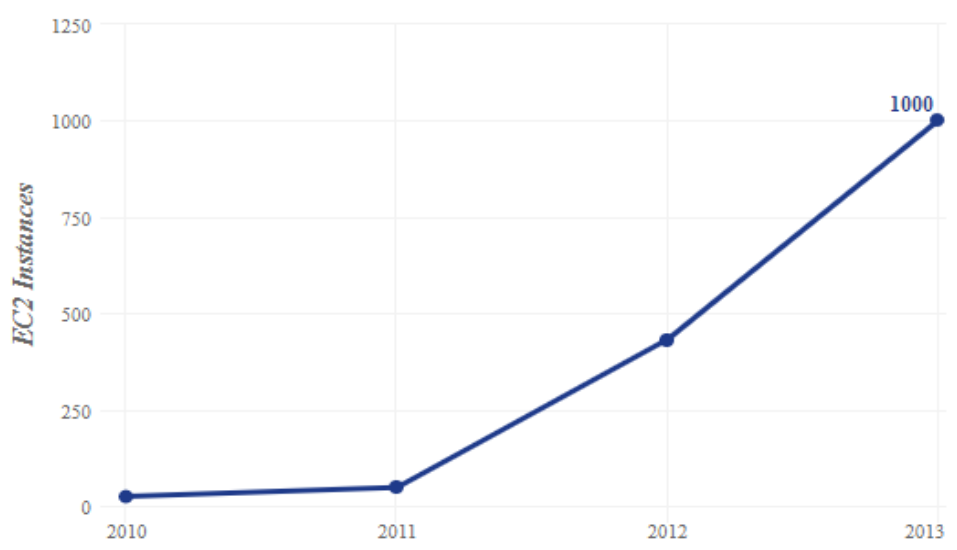


Figure 10. Number of used EC2 Instances until 2013. (Amazon Web Services 09 January 2014, min. 1:57-1:58)

During the cloud migration, Airbnb made the decision to use AWS Relational Database Service (RDS) instead of continuing to manage their own MySQL database. RDS was chosen due to its ability to simplify many of the time-consuming, administrative tasks that are typically required in database management. A variety of data related to Airbnb's business operations is stored in RDS such as user data, booking data and operational data. In order to increase the automation of database replication and enhance the durability of data Airbnb uses Multi Availability zone. With the

use of (Multi-AZ), AWS ensures that in case of a failure in the primary database, there is an available standby database in a different availability zone and avoids which helps to prevent data loss. All these complex procedures can be managed with just a few clicks through a graphical user interface, the AWS Management console. In addition, AWS provides the Command Line Interface or APIs for those who prefer to manage resources programmatically. (AWS c)

Airbnb was required to analyze large volumes of data daily, extracted from high-resolution images of lodging locations. To process this large amount of data effectively, Airbnb used the Amazon Elastic MapReduce solution, which provided a range of tools and frameworks for analysis. All this data is saved in AWS S3 service, which is a scalable and secure data storage solution. (AWS c) In Figures 10 and 11 we can see how the number of resources has increased after the cloud migration. More instances and storing space are needed to meet the demand after the significant growth of Airbnb.

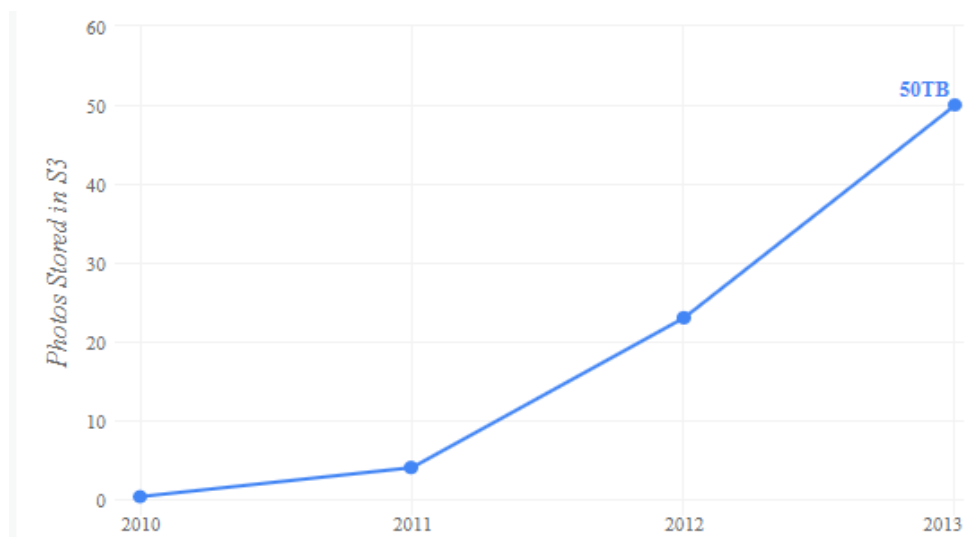


Figure 11. Size of the photos stored in S3 until 2013. (Amazon Web Services 09 January 2014, min. 2:06-2:08)

All these services can be supervised from Airbnb by using the Amazon CloudWatch service. This monitoring service collects metrics, log files, set alarms and helps Airbnb to manage AWS resources in a more effective way. It provides the performance status updates for running resources and applications, allowing Airbnb's engineers to proactively respond to issues. Of course, most of the AWS resources that Airbnb uses are hosted in an isolated virtual environment (VPC). This environment provides better control over network traffic and ensures the safety of the cloud infrastructure.

Although, Airbnb used many cloud computing services and had a significant growth in their business, in 2021 there was a report saying that a few years earlier the cost of AWS services was quite high which had a negative impact on the company's revenue. After this, Airbnb tried to implement suitable measures to decrease AWS costs. Their initial challenge was about the proper use of S3 service because of the huge pricing. They decided to use S3 Glacier in addition to S3 due to the infrequent access needs of some of their data. This low-cost storage service is designed for data archiving and long-term backup storage. Next, Airbnb used AWS Savings Plans which is a pricing model that can save up to 72% on their computing power usage. Under this model, customers agree to use a consistent amount of computing power for a certain period in order to get the discounted rate according to their level of commitment. To further reduce costs, Airbnb engineers decided to move from their old monolithic service architecture and adopt microservices architecture that utilizes Kubernetes and use containers as a deployment mechanism, because of their standardized environment and scalability. Kubernetes is an open-source container orchestration platform for automating, managing and scaling containerized applications. The strategy that Airbnb's engineers wanted to implement with Kubernetes didn't work as well as expected, so they created the Kubernetes Cluster Autoscaler tool. This tool solved the scaling issues in clusters by ensuring that resources can meet demand at any time. With the above actions Airbnb reduced its AWS costs by 63.5 million within 9 months. (The Stack 2022)

Overall, despite the challenges Airbnb faced, the journey to cloud computing can be considered successful as the significant growth experienced is mainly attributed to the hybrid cloud model used for their business operations. Next, I will examine the outcomes of Airbnb's choice to move from traditional IT infrastructure to cloud computing.

4 Results

My analysis, which involved examining literature on cloud computing and traditional IT infrastructure, as well as gaining insights from exploring the cloud journeys of two successful companies, has produced informative results of how crucial cloud adoption is for companies. In Figures 12 and 13 we can observe how the number of Netflix subscribers has increased and how the revenue of Airbnb has grown after their cloud transition.

Scalability

By combining my two research approaches I found that cloud computing's provision of scalability is a critical factor for the growth and transformation of any company. A company with traditional IT infrastructure is possible to encounter issues when handling traffic because the demand is not always constant and can vary. Netflix's and Airbnb's huge development was linked with the high level of scalability that cloud technology provides, as both had access to limitless virtually cloud computing resources for implementing their plans and strategies without worrying about handling increased traffic or system crashes.

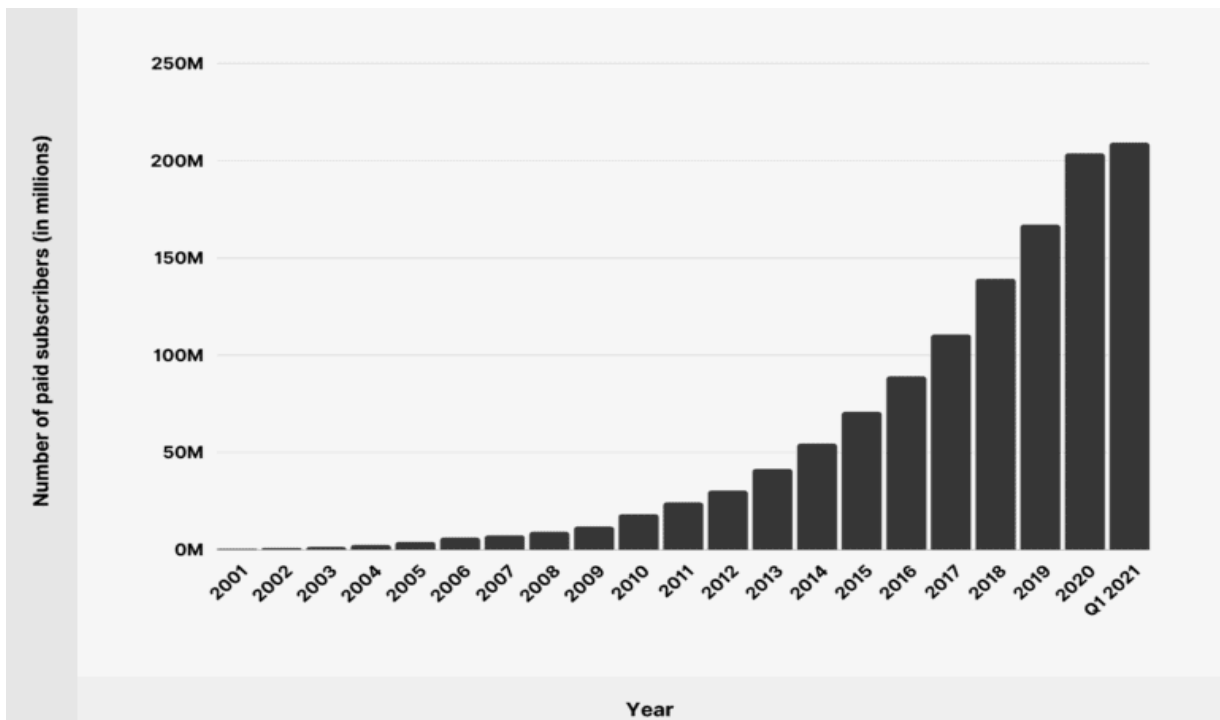


Figure 12. Number of Netflix subscribers over the years. (Dean a 2021)

Flexibility and Accessibility

Flexibility is another advantage of cloud computing that is closely related with scalability. With flexibility there is a freedom to make changes and adjustments quickly, it allows companies to use different type of resources and experiment with new tools and services. In my case studies, I observed that both Netflix and Airbnb utilized services from their on-premises infrastructure and cloud provider to bring the best possible solution. This combination of using different tools and services together can be considered as a high level of flexibility. Accessibility also helped Netflix and Airbnb, whose employees are spread out across many different locations, by allowing remote work and enhancing their collaboration. Accessing cloud resources over the Internet allows for dynamic communication which helps in better understanding of customer needs and drives to success.

Cost Savings

Companies relying on traditional IT infrastructure require upfront costs to expand and implement their future plans. This can be challenging for a company to balance the need for implementing new plans while also installing and maintaining data centers. Netflix and Airbnb used the hybrid cloud model because they wanted to combine the advantages of both infrastructures to optimize their IT operations. From cloud computing perspective, where companies pay on-demand for resources, both Netflix and Airbnb utilized computing power and storage resources (saving large volume of data) because they wanted to have high availability and flexibility, while also taking advantage of useful tools and features that are offered by the cloud provider. The traditional IT infrastructure is useful for innovation purposes such creating specific tools and applications that meet company's exact requirements and then both infrastructures tools are utilized together and offer higher efficiency. Also, in Airbnb's case study we observed how many possible cloud solutions were available to reduce costs and address issues of unnecessary consumption of cloud services.

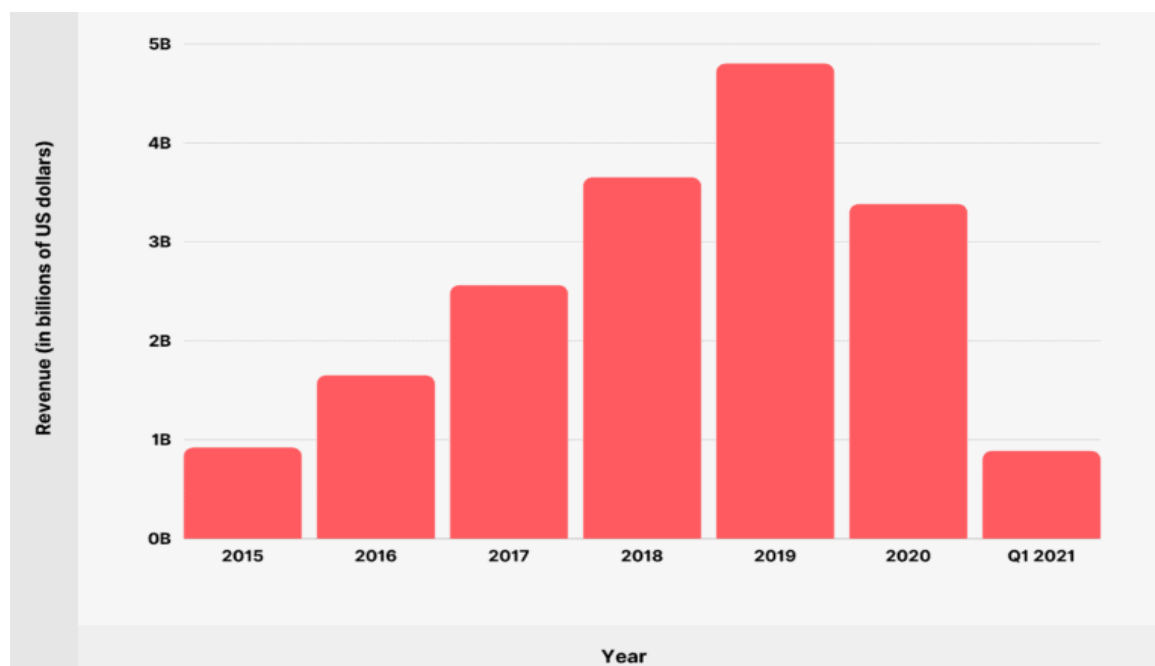


Figure 13. Airbnb revenue per year. (Dean b 2021)

Reliability and Availability

Since most cloud services are offered virtually, all services are operational and accessible any time without having serious malfunctions due to the increased number of AWS availability zones across the world. Netflix and Airbnb were able to allocate most of their resources to implement their strategies and focus on their growth without any interruption, as the cloud provider was responsible for ensuring that services perform consistently and meet the expectations of Netflix and Airbnb. As a result, with high reliability and availability, productivity increases and the smooth operation of the business is ensured, even if there is increased demand or potential hardware issues.

In conclusion, companies that migrate to the cloud have access to a wide range of services and tools that increase their scalability and offer other characteristics as we have seen. It depends on each company to determine how to utilize these resources properly in order to achieve their business goals and avoid unexpected cost issues that may arise from wasting resources. Moreover, one more benefit that cloud computing provides is that the company's IT staff is not responsible for the infrastructure management like before, when they used traditional IT infrastructure. Of course, the IT staff will monitor and use the cloud services, but their primary duties are no longer on maintaining the cloud infrastructure. As a result, more human resources are available for innovative tasks, which can lead to increased productivity.

5 Discussion

Sooner or later, all companies will recognize the advantages of cloud computing and prioritize their strategy with this technology, as their main focus is on the services and products they provide, rather than managing their own IT infrastructure. Nowadays, it is challenging for companies to stay competitive and scale their systems fast, transitioning to cloud is essential to scale quickly up or down. As we saw in the Netflix case study, Netflix realized that they are an entertainment company and not a data center operations company, and the demand for additional equipment and computing power to run their operations across the world would result in huge expenses. The solution to their problem was to move most of their resources to the cloud, which helped them focus more on their primary business, which is content creation and distribution.

My opinion about Netflix and Airbnb is that they wouldn't have had such great success if they didn't move to the cloud, as this contributed significantly to their growth and business operations. Both companies chose the hybrid deployment model which gave them greater control over their resources by transferring some of their less important business resources to the cloud and this solution is much more cost-effective than managing all the resources on premises.

Cloud computing, apart from being more economical than traditional IT infrastructure, enables companies with cloud-based solutions to implement their plans more quickly. The offered scalability of cloud computing gives companies greater flexibility, agility and faster deployment of resources.

5.1 How businesses used to operate before cloud computing

As we saw in the previous chapters, cloud computing is the best solution for companies that want to scale to the next level and meet their goals. Especially for smaller businesses that are not yet well-known in the market and need to take advantage of all available solutions and resources to be competitive. To understand the real advantages of cloud computing and the changes it has brought, it's important to examine not only the work processes after cloud transition but also how business operations used to be done before cloud. So, let's examine how businesses typically operate using traditional IT infrastructure.

In the past, companies used to run their operations on premises by having to manage and maintain significant resources. Business growth and expansion relied solely on the company's resources, which meant additional costs for purchasing hardware and software equipment. For instance, they had their applications and data stored in data centers, which consisted of multiple servers, data

storage systems, networking equipment and security protocols. So, in addition to hiring staff to implement their business plans, companies also had to hire IT professionals to ensure that everything ran smoothly in their IT infrastructure.

Also, with traditional IT infrastructure, companies are responsible for upgrading their equipment (hardware, software) a process that is time-consuming and costly. This means that every company must ensure that their infrastructure is secure and has alternative solutions in case of issues such as security breaches, database malfunctions, or power outages.

Furthermore, the traditional IT infrastructure lacks mobility, meaning that employees can't access the necessary resources remotely and they must physically go to the office. This made it challenging for companies to adapt to changing business needs and workstyles. Considering the current situation after the pandemic, the necessity of remote work during that period was crucial for many companies and if cloud computing wasn't available, I can't imagine how companies would have continued their daily operations.

Considering the above, we can see that companies with traditional IT infrastructure are not only responsible for their business plan and goals, but also for managing their own IT infrastructure. This means that companies must invest more time, effort and money to ensure that business operations run smoothly.

5.2 Costs before and after cloud migration

With traditional IT infrastructure companies must pay a variety of costs that are generally divided into two categories: capital expenses (CapEx) and operating expenses (OpEx). CapEx are related to long term assets that will provide ongoing value to the company. These kinds of costs include the purchasing and maintaining hardware, software, and other IT equipment, as well as building and setting up data centers. On the other hand, OpEx are related to daily operations costs like consumables, electricity power and salaries. The biggest problem of companies is that traditional IT infrastructure approach requires a significant upfront capital investment (CapEx) to build and manage data centers.

I couldn't find an example of an exact number of costs before cloud migration but, according to a study they found that organizations can save up to 50% on IT costs by moving to the cloud. (Shende 2023) CapEx in cloud is significantly reduced because the cloud provider is responsible for purchasing and maintaining physical hardware. Companies still have OpEx that are related to their daily operations, but they pay their cloud provider only for the specific cloud services they use, such as computing power, storage and other resources.

Let's now look at Netflix's costs after migrating to the cloud. Netflix's cloud provider is AWS which charges them \$0.021 per GB of transferred data per month. Since Netflix transfers four billion GB of data every month, this translates in a monthly cost of \$84 million or an annual cost of \$1 billion. If we consider that Netflix's revenue is approximately \$25 billion, the actual streaming costs including resources such as servers and other infrastructure, are about 4% of their total revenue. (Tyagi 2021) So, we can see that the difference is quite big and the choice of transitioning to the cloud can impact the future of every company.

5.3 Security in cloud

At the beginning, cloud computing, like everything new in the market, was treated with suspicion due to lack of expertise and security concerns regarding the storage of sensitive data on cloud servers. But over the years, security in the cloud has been enhanced by cloud providers with modern technologies to ensure the safety of data and systems.

Cloud providers have adopted various security measures that are implemented at different levels of cloud infrastructure and utilize monitoring tools to track cloud activity. The resources operate inside a VPC which already has firewall, but it allows additional actions to enhance security. In cloud computing, data encryption is an important tool to prevent unauthorized access to data, while adding another layer of protection inside the instances can be achieved by using third party firewalls.

Some other important measures that are providing additional layers of protection around the instances are IAM, ACLs and security groups. With Identity and Access Management (IAM) service, the administrator authorizes who can manage and control the resources within the cloud infrastructure by giving specific permissions policies to users or groups about the actions that are authorized to do. Access Control Lists (ACLs) provide an extra level of security to the cloud environment at the subnet level by filtering inbound and outbound traffic. With ACLs we can create a set of rules to organize network access inside the VPC. Security groups are another security measure that works at the instance level and are used to control inbound and outbound traffic. Security groups are created by default when a VPC is created and it can further be modified by adding more rules about the traffic.

Cloud providers are constantly seeking to improve security measures and that's why they have teams of experts equipped with advanced security tools to analyze and perform penetration tests to find potential security gaps and protect their infrastructure. Everyone knows that security is the top priority and cloud providers over the years have invested time and effort to prove that cloud security is solid and sometimes can be more effective than on premises security.

5.4 Steps before and after transitioning to the cloud

The process of migrating from traditional IT infrastructure to the cloud is not simple. It requires careful planning and coordination between the company and the chosen cloud provider to ensure a successful transition.

As we saw in Netflix's example, the entire process of Netflix migration took eight years, as it required slow and steady approach to avoid any problems such as database malfunctions or streaming service issues. To ensure the migration process, companies need to prepare in advance by taking actions such as identifying what they want to achieve by changing their old infrastructure and check which resources and applications from the current IT infrastructure will be transferred to the cloud. Also, companies must think about which cloud provider is most suitable for them as well as which cloud deployment model suits better for the company and meets their business needs. Finally, the migration strategy should be carefully planned with the guidance and expertise of the chosen cloud provider and agree about the expected duration of the migration process and discuss further about any potential risks that may arise during the process.

When the migration process is completed, the company must train their IT professionals to work in the new cloud environment and get familiar with the new services. Cloud experts must check the security measures for ensuring company's sensitive data and continuously evaluating the performance of the cloud services. As we saw in the Airbnb case study, a lack of expertise led the company to a period where the costs were the same as the revenue and that's why is important to take advantage of the wide range of cloud services and use the most cost-effective cloud solutions. Also, it's important to continuously stay up to date and collaborate with the cloud provider to take advantage of the new market trends. All the above are the key for a company to get the full potential of cloud computing, without wasting unnecessary cloud resources.

Sources

Ajeenkya, S. 22 September 2020. Netflix Case Study: Analysis. LinkedIn. URL:

<https://www.linkedin.com/pulse/netflix-case-study-analysis-ajeenkya-suryawanshi/> . Accessed: 9 March 2023.

Algosec. Cloud Compliance. URL: <https://www.algosec.com/resources/cloud-compliance/>. Accessed: 3 March 2023.

Amazon Web Services. 09 January 2014. Airbnb Scales Infrastructure Automatically Using AWS. Online video. URL: https://www.youtube.com/watch?v=xQBNn67rL_o&t=128s&ab_channel=AmazonWebServices . Accessed: 18 March 2023.

AWS a. What is cloud computing. URL: <https://aws.amazon.com/what-is-cloud-computing/>. Accessed: 23 February 2023.

AWS b. Shared Responsibility Model. URL: <https://aws.amazon.com/compliance/shared-responsibility-model/> . Accessed: 3 March 2023.

AWS c. Airbnb Case Study. URL: <https://aws.amazon.com/solutions/case-studies/airbnb-case-study/> . Accessed: 19 March 2023.

Bhardwaj, R s.a. SaaS vs PaaS vs IaaS: Understand the difference. Ipwithease. URL: <https://ipwithease.com/saas-vs-paas-vs-iaas/> . Accessed: 24 February 2023.

Biswas, S. A history of cloud computing. Cloudtweaks. URL: <https://cloudtweaks.com/2011/02/a-history-of-cloud-computing/> . Accessed: 20 February 2023.

Clouve. 26 November 2020. Comparing the top 3: Google Cloud, AWS & Microsoft Azure. Clouve blog. URL: <https://www.clouve.com/blog/comparing-the-top-3-google-cloud-aws-microsoft-azure/> . Accessed: 26 February 2023.

Dean, B. a. 07 October 2021. Netflix Subscriber and Growth Statistics: How Many People Watch Netflix in 2022?. Backlinko . URL: <https://backlinko.com/netflix-users> . Accessed: 25 March 2023.

Dean, B. b. 02 June 2021. Airbnb Revenue and Booking Statistics (2022). Backlinko. URL: <https://backlinko.com/airbnb-stats>. Accessed: 25 March 2023.

Flynn, J. 19 December 2022. 25 AMAZING CLOUD ADOPTION STATISTICS [2023]: CLOUD MIGRATION, COMPUTING, AND MORE. Zippia. URL: <https://www.zippia.com/advice/cloud-adoption-statistics/> . Accessed: 3 March 2023.

Gupta, H. 22 September 2020. The success story of a small company that grew as a service hub because of AWS- Airbnb. LinkedIn. URL <https://www.linkedin.com/pulse/success-story-small-company-grew-service-hub-because-aws-gupta/> . Accessed: 14 March 2023.

hAhA Innovations 01 February 2021. Evolution Of Netflix 2002-2021. Online video. URL https://www.youtube.com/watch?v=WEKpucf5QJU&ab_channel=hAhAInnovation . Accessed: 7 March 2023.

Izrailevsky, Y., Vlaovic, S., Meshenberg, R. 2016. Completing the Netflix Cloud Migration. AboutNetflix. URL <https://about.netflix.com/en/news/completing-the-netflix-cloud-migration> . Accessed: 7 March 2023.

Knight, M. 08 July 2021. What is Cloud Computing. Dataversity. URL: <https://www.dataversity.net/what-is-cloud-computing/> . Accessed: 24 February 2023.

Mercier, J. 14 July 2021. What is a hypervisor's role in computing and virtualization. Wwt. URL: <https://www.wwt.com/article/what-is-a-hypervisors-role-in-computing-and-virtualization> . Accessed: 24 February 2023.

Optisolbusiness. 14 August 2020. Top 10 AWS Services for digital transformation. optisolbusiness. URL <https://www.optisolbusiness.com/insight/top-10-aws-services-for-digital-transformation> . Accessed: 10 March 2023.

Pareek, A. 2022. What Are The 6 Most Common Cloud Services in 2022?. Customerthink. URL: <https://customerthink.com/what-are-the-6-most-common-cloud-services-in-2022/> . Accessed: 28 February 2023.

Patra, C. 15 September 2022. Amazon DynamoDB: What It Is and 10 Things You Should Know. Cloudacademy blog. URL <https://cloudacademy.com/blog/amazon-dynamodb-ten-things/> . Accessed: 10 March 2023.

Prickett Morgan, T. 15 September 2015. AIRBNB SHARES THE KEYS TO ITS INFRASTRUCTURE. Nextplatform. URL: <https://www.nextplatform.com/2015/09/10/airbnb-shares-the-keys-to-its-infrastructure/> . Accessed: 16 March 2023.

Reciprocity. 2 December 2021. NIST'S Definition of Cloud Computing. Reciprocity blog. URL: <https://reciprocity.com/blog/nists-definition-of-cloud-computing/> . Accessed: 24 February 2023.

Shende, J. 14 March 2023. Top Risks and Rewards of Moving to the Cloud. Isaca. URL: <https://www.isaca.org/resources/news-and-trends/isaca-now-blog/2023/top-risks-and-rewards-of-moving-to-the-cloud> . Accessed: 2 May 2023.

Susic, P. 2023. 64+ Cloud Computing Statistics, Market Share, Industry & Growth (2023). Headphonesaddict. URL <https://headphonesaddict.com/cloud-computing-statistics/> . Accessed: 28 February 2023.

The Stack. 30 May 2022 Airbnb's AWS costs were getting out of hand. Here's how it tackled them. thestack. URL: <https://thetack.technology/lessons-from-how-airbnb-scales-flexes-and-owns-its-huge-cloud-workloads-to-control-aws-and-other-costs> . Accessed: 19 March 2023.

Turningcloud. 21 January 2021. 4 Cloud Deployment Models: Their advantages and disadvantages. Turningcloud blog. URL: <https://www.turningcloud.com/blog/cloud-deployment-models/> . Accessed: 25 February 2023.

Tyagi, K. 21 September 2021. NETFLIX pays over \$1 Billion/year to Amazon. kartikeytyagi. URL: <https://kartikeytyagi.medium.com/netflix-pays-over-1-billion-year-to-amazon-1c4f4a69be63> . Accessed: 3 May 2023.

Watts, S., Raza, M. 15 June 2019. SaaS vs PaaS vs IaaS: What's The Difference & How To Choose. BMC blog. URL: <https://www.bmc.com/blogs/saas-vs-paas-vs-iaas-whats-the-difference-and-how-to-choose/> . Accessed: 2 March 2023.

Yachin, D. 01 July 2021. State of Cloud Security 2021: More Aware Yet Very Exposed. Ermetic blog. URL: <https://ermetic.com/blog/cloud/state-of-cloud-security-2021-more-aware-yet-very-exposed/> . Accessed: 1 March 2023.