Review

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Abstract: The reliance on cloud computing services and related technologies has increased due to their many benefits, including resource sharing and the need for organizations to maintain their competitive advantage in the digital market. Also, the pace of cloud growth has significantly increased because of COVID-19. Many companies and businesses have shifted their core processes to the cloud for seamless operations during the pandemic. This migration of legacy systems to the cloud creates many opportunities for businesses. However, on the other hand, it may also bring substantial challenges. Hence, a careful decision is needed to align with company goals. In this paper, we demonstrate the need and advantages of cloud computing, followed by highlighting AWS's characteristics as one of the leading cloud service providers. We also discuss the merger of AWS with SDN to improve cloud data security and performance. The outcomes of this study can provide a data migration strategy and guide decision-makers toward a secure and sustainable migration to a cloud computing environment.

Keywords: Cloud Computing; Amazon Web Services (AWS); Software Defined Networks (SDN)

1. Introduction

The Covid pandemic has greatly accelerated cloud adoption rates. Nearly all industries, including small and major businesses, healthcare, and education, have been driven to shift their important business processes online [1]. Based on a survey report conducted by Flexera in 2021, it is discovered that all seven cloud providers, including Amazon Web Service (AWS), Azure and Google Cloud, tracked in the State of the Cloud Report have experienced a rise in cloud usage [2] One of the main attractions of the cloud is its pay-as-you-go model, according to that businesses are only charged as per resource usage. Therefore, it is no longer a surprise to see many businesses starting to migrate into cloud service platforms. The big challenge with maintaining ICT infrastructure is the high costs in capital expenditure, accompanied by operational expenditure in maintenance, repairs, and upgrades. Figure 1 depicts the resource sharing in cloud computing environment.

Additionally, as more countries develop the infrastructure to support 5G, the network bandwidth speed available to the public increases, which then allows for applications such as cloud and streaming services to become much more usable [3]. The problem with these applications now is that the moment a user wishes to access them, they would need a fast and stable internet connection to use these services. This is because the content is generally not stored on an individual's local device but rather it is stored in the cloud. Hence, the user is required to download or stream from the cloud.

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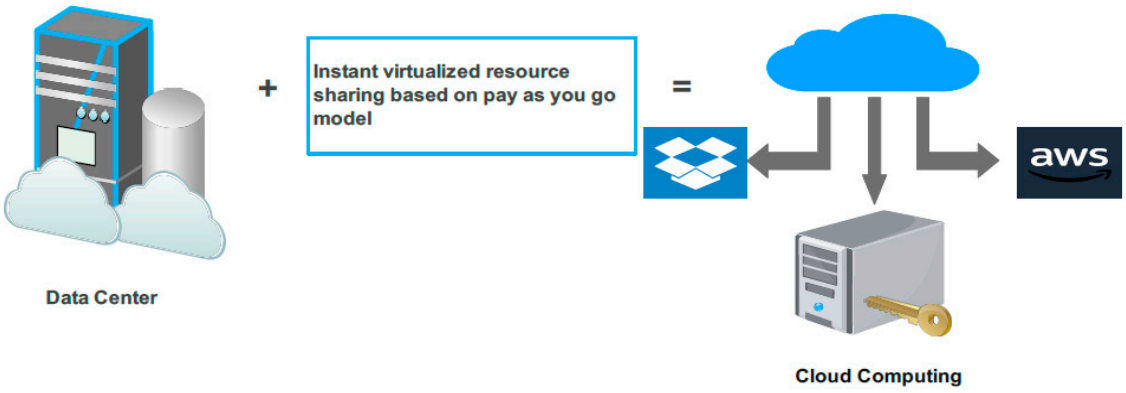

Figure 1. Resource sharing in cloud computing environment.

Some common cloud computing examples include streaming service Netflix, cloud file-sharing services like Google Drive and Dropbox, network-based communication tools like emails, calendars, Skype, and WhatsApp.

Cloud computing also enables big data analytics and on-demand resources. Some popular cloud computing business applications include Mailchimp, PayPal, Bitrix24, and Slack.

Cloud adoption is assisting businesses in achieving swift and result-oriented digital transformation because of that cloud usage is growing in popularity across a wide range of businesses such as cloud computing based healthcare increases the efficiency of the health care provider while decreasing costs and makes medical record-sharing easier, safer with automates backend operations and even facilitates the creation, and maintenance of, telehealth apps [4][5].The other cloud-based sectors include marketing and advertising firms, retail, finance, and education are just a few of the businesses that successfully migrate to the cloud. Even conventional businesses such as manufacturing, energy, and utilities are increasing their cloud utilization. Cloud based construction industry reduce the operational cost with increased collaboration and communication among the project teams [6]. However, despite the many benefits companies should take a thoughtful decision before migrating to cloud which helps them to achieve the competitive advantage.

The rest of the paper is organized as follows: Section 2 describes the need for cloud migration. Ssection 3 presents Amazon Web Services as an appropriate cloud computing solution and Section 4 concludes the paper.

2. Need for Cloud Migration

Cloud migration is the act of transferring the company's resources, including digital assets, services, databases, IT resources and applications, to a cloud computing environment [7]. Performing a cloud migration from an on-premises ICT infrastructure will significantly alter the company's structures and operations. The foremost biggest change is the server locations. The foundation and key component of cloud-based applications is virtualization. If the migration procedure and the allocation of resources through virtual machines are not efficient, it can have a big impact on the performance of the cloud service[8]. Hence, the effectiveness of cloud-opting decisions is dependent on several factors, including planning and impact analysis concerning current business applications [9]. The following are some key points that businesses need to consider before opting for cloud migration.

2.1. Cloud Migration Advantages

The growing demand of cloud services is gradually replacing the ICT infrastructures. According to a worldwide survey conducted by Statista, businesses expect the most declines in their 2020

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budget, for server infrastructures, datacenter facilities, storage infrastructure and networking infrastructure all ranked in the top five [10]. The decline in the need for these ICT infrastructures is not without reason, as there are certain flaws present in them. However, these flaws could be patched up through cloud migration. The following are the advantages that help businesses to carry their operations smoothly without any hurdles.

1. Pay-as-per usage Model.

ICT infrastructure causes rigidity through limited capacity growth, which makes it difficult for the company to adapt to these business spikes. Also, in some situations when business is not flourishing, the expensive ICT infrastructure becomes unused. Since cloud computing is based on pay-as-per usage model**, t**hrough cloud migration, the businesses will be provided with the scalability to adjust resources based on the business needs either by expanding or shrinking [11].

2. Cost Effective

Cloud adoption brings significant change in the cost structure. Once adoption of cloud platform is completed, the cost structure will alter from capital expenditure (CapEx) to operating expenditure (OpEx), where the company no longer has to purchase additional physical infrastructures and the need for necessary resources can be satisfied through a cloud service. These high costs can be avoided through cloud migration with the flexible pay-as-you-go model, whereby the costs are dependent on the business demand. Aspects like hardware, software and licensing then become the cloud service provider's responsibilities.

The cost to maintain and repair physical ICT infrastructures would instead be replaced by a variable cost of resources retrieval from a cloud service [12].

Adding to this point is being able to enjoy automatic technology upgrades that might not have been available previously due to the limited budget and resources. Businesses continue to remain updated with modern technology through cloud technology.

Moreover, a cloud environment typically has a minimal learning curve and can easily be adopted by the employees in the company, which is significantly better than having to go through a costly training process for adapting to the ICT infrastructure.

Furthermore, the company procedures would have to take a big shift, as employees with jobs revolving around the ICT infrastructure would no longer be needed. Instead, more people with the requisite cloud-native skill sets (e.g., cloud management) are needed [17].

3. Smooth Business Continuity (Data Backup & Recovery)

Another major flaw that is solved through cloud migration is the poor business continuity. Unexpected crises, like natural disasters or power failures, could occur at any given moment, which is why having the capability to keep data backed up and protected is so essential. A cloud platform could keep the organization's data constantly protected by keeping copies of the backed-up data in multiple geographical locations and redundant data centers, which would be difficult to achieve through a physical ICT infrastructure [13]. Hence, in case of any crisis business could be conducted as usual with the data retrieved from a temporary device.

4. Inter-Organization Data Sharing at Multiple Geographical Locations

Speaking of geographical locations, physical ICT infrastructure lacks the capabilities to allow inter-organization data sharing and collaboration opportunities. Cloud computing resolves this issue by facilitating an efficient data sharing process within the organization no matter the geographical location [14].

5. Mobility

The challenges regarding mobility restrictions no longer exist after cloud migration, as cloud possesses the location independent characteristic, which means the employees of the company can access applications and data from the cloud instantaneously with any device such as laptop, mobile

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phone or PDAs etc. as long as there is an internet connection. This is how adopting cloud would lead to gains in the workforce dynamicity and productivity [15].

6. Focused Business Processes

One of the more persistent problems with ICT infrastructure is the deployment process, which requires a prolonged duration of infrastructure setup, as well as constant hardware testing and configuration. Efficiency in the manufacturing industry is important, especially during moments when market opportunities are up for grasp. With a cloud platform, the company can achieve this efficiency with not only faster deployments, but also without disturbing the company's core business processes. Thus, allowing the company to gain a competitive advantage, as well as shifting the focus from deploying ICT infrastructure to other processes like manufacturing and innovating the services/products[16]. As stated previously, the infrastructure deployment process is a hassle, with their own infrastructure, the company is likely to expend more resources towards developing its own applications for the company operations. Despite the personalization, it is best for the company to discard these inefficient processes and start utilizing cloud applications. For example, customer management processes could be dealt with customer relationship management (CRM) cloud applications, like Salesforce and Agile CRM. Following up with the difficult infrastructure deployment process is the complex challenge that comes with it.

Thus far, cloud migration has proven to be a process worth following through, as it could solve the many problems identified in ICT infrastructure.

7. More Physical Space

With access to a cloud platform, on-premises infrastructures are made redundant, as resources are hosted offsite in that cloud platform. Hence, the current onsite infrastructure can either be freed up for more physical spacing or can be used for other assignments of more importance.

2.2. Cloud Migration: A thoughtful Decision

As observed, the organizations would have to go through several major changes because of cloud migration. Hence, it is important there should be more careful thoughts given to justifying the purpose of cloud migration. Whether the purpose is for gaining better IT performance or saving costs, the purpose must be clearly defined for the company to fully utilize the advantages, so that the cloud can bring to its maximum potential [17].

Moreover, the company must employ a well-defined cloud migration strategy. Selecting the appropriate cloud deployment and service models that align with the company's cloud goals, as well as the cloud service provider that can meet the company's cloud needs, is equally significant to identifying the purpose of adopting cloud. Following are the main reasons businesses should take care before moving to cloud infrastructure.

a) Cloud Migration Strategies

Organizations can select from a variety of cloud migration options based on their requirements and competencies. A migration technique that the company can implement is rehosting, which is the simplest, most cost effective and time-efficient of all migration techniques. It involves the transferring of on-premises data and applications to a cloud environment without the need to change much of the underlying code [18]. Other techniques that the company can utilize are re-platforming and refactoring, repurchasing, re-architecting, and retiring are some of the typical strategies.

Other cloud migration tactics are extended to lift and shift, such as the shift to SaaS migration, move and improve, rip and replace etc. Each of these techniques has its own pros and cons, and organizations should select the one that most effectively meets their goals.

b) Cloud Migration Timeline & Cost

Aside from the listed factors to consider, the company must also consider the migration timeline and costs. The company might suffer unwanted losses in productivity and financial loss without a

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clearly defined migration strategy. Adding onto this is the potential vendor lock-in issue once cloud migration is completed, especially if cloud migration is towards a heterogeneous environment.

c) Use of Existing ICT Infrastructure

Additionally, the company has to consider the use of existing ICT infrastructure. Aligning the cloud migration process with the hardware life cycle would optimize the use of them. Even then, the complexity of certain infrastructures would make the cloud migration process difficult without the necessary talent and expertise.

d) Decreased Level of Control

The final major change involves the decreased levels of control. With cloud migration, the company will no longer have full control over its resources, services and data in aspects like access restricting and maintenance executing. In the case of an unexpected error, the company can only wait patiently for the cloud service provider to deal with it. Further, businesses are vulnerable in context of security, because the resources of a company are resided offsite, rather than being able to protect them with self-implemented on-premises security measures.

In conclusion, the company must realize the multiple alterations brought along with cloud migration, as well as the several factors to consider before executing this critical decision.

3. Amazon Web Services: An Appropriate Cloud Computing Solution

The demand for cloud-based services continuously increases as time goes on due to smooth and cost-effective conduct of business operations and fact the many applications built on top of it. With the understanding of demand growth out of the way, it is advantageous for the company to choose a cloud service provider that can offer them a wide variety of services and at the same time have assurance that they are the best enterprise-based solution in the market. Amazon Web Services (AWS), Microsoft Azure, and Google Cloud are among the leading cloud service providers. The other significant cloud service companies are Alibaba, IBM, and Oracle. Among all AWS is the most prominent cloud service provider. It is the world's most extensive and widely used cloud platform, providing over 165 fully featured services from data centers across the world. According to an analysis report by Gartner, a research and consultant-based organization, they have concluded that when comparing multiple cloud service providers, AWS is the most enterprise ready in comparison to its competitors [19]. Some of the notable organizations using AWS are Adobe , BMW, Canon, and Autodesk[20].

AWS has been operating since 2006 [21], which means that new customers can be assured that the company has a long enough period to mature their product fully. As the cloud service provider is much more mature, there will be more variety of products and services offered as well. This implemented in the cloud infrastructure, it is likely that AWS has a solution for it. With that being said, the report will now be going over some of the points that make AWS the better choice. Figure 2 shows the main advantages of the AWS.

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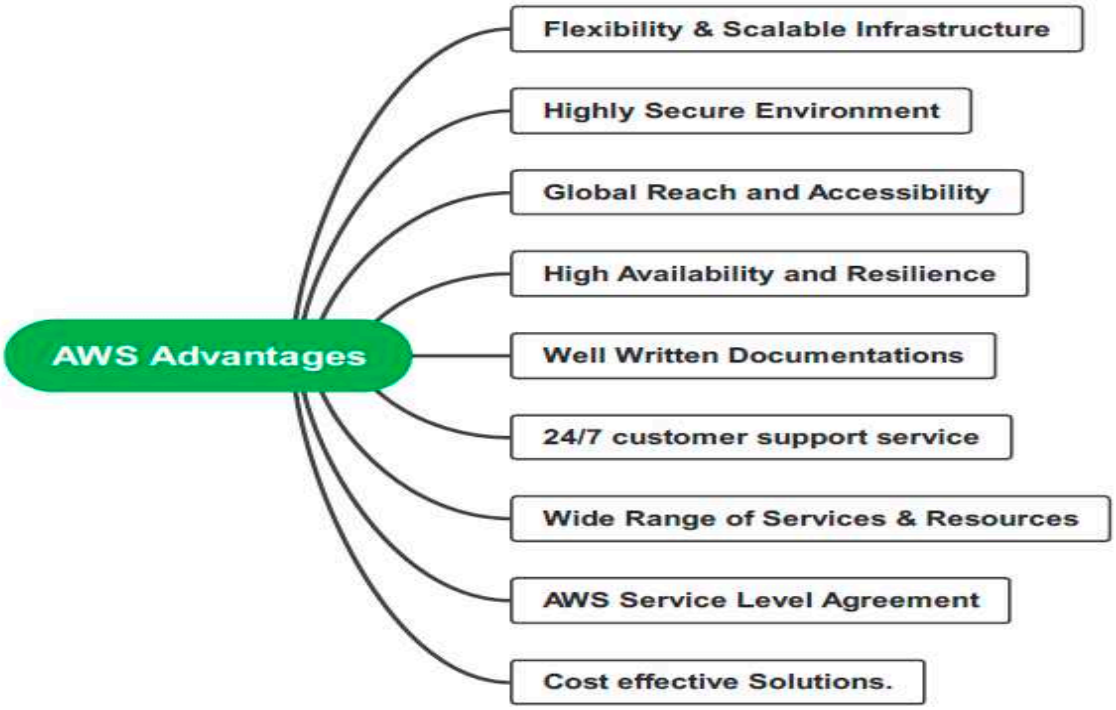

Figure 2. AWS main advantages.

a) Flexible and Scalable Infrastructure

AWS offers its clients flexible infrastructure to choose the required resources from a wide range of services and allow businesses to add or remove resources as per business need. Further, the infrastructure can easily be scalable both horizontally and vertically.

b) Highly Secure Environment

AWS encrypts the data in transition and at rest with compliance of various industry standards. Also provides identity and access management controls.

c) Global Reach and Accessibility

AWS services are available in multiple geographical regions around the world with ease of deployment and to manage services globally. AWS has an extensive worldwide network of data centers and service locations. Along with compliance of local regulations and data privacy laws.

d) High Availability and Resilience

Resilience and High Availability (HA) are key terms in AWS. High availability describes a system's capacity to continue operating even if several of its parts malfunction. Resilience is the capacity of a system to bounce back from errors and keep the normal function on. Numerous services offered by AWS might assist businesses in creating extremely reliable and robust systems. Included in them are AWS Regions and Availability Zones, which offer numerous physically distinct and segregated Availability Zones interconnected via low-latency, high-throughput, and highly redundant networking. AWS has resilient infrastructure with built in redundancy in multiple availability zones to ensure continuity of service with automated failover and disaster recovery capabilities[22].

e) Well Written Documentations

In the given scenario, the organization is in the phase of migrating their IT infrastructure to the cloud. For the migration process to be successful, it is necessary to understand the functionality hence AWS assures the provision of the well written documentations on the products offered by the cloud

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service. To add on, AWS also provides many video tutorials on top of their documentation to perform specific tasks. Educational content in the form of videos is preferred by some, as they may find it easier to consume and follow along instead of reading from a written documentation.

f) 24/7 customer support service

Further, a dedicated section in the AWS website [23] covers information related to integration in the areas of API Management, Event Bus, Messaging, No-code API Integration and lastly, Workflows. In addition to that, in case of facing any difficulties by the cloud engineers involved in the migration process, the organization can acquire 24/7 customer support service directly from AWS [24]. Further, interested organizations can pay for a customer support tier that is higher than the basic tier. With the higher support tier, AWS would provide much more dedicated personnel to assist organizations with any cloud-based issues they are facing.

g) Wide Range of Services & Resources

There are plenty of AWS resources and services available to assist business needs in the migration process with continuous development and introduction of new services. Moreover, AWS offers easy integration with third party services. For starters, the company can take up the AWS Migration Acceleration Program (MAP), which is a well-proven program built upon the vast AWS cloud migration experiences of more than a thousand enterprise customers. MAP can accelerate the migration process of the company with just three phases in Assess, Mobilize, and Migrate and Modernize [25]. Other than this, there are a variety of tools at the company's service, which provides their own specialized purpose. The AWS Migration Hub is an online service that would help the company to assess, plan and execute migration projects. Services like the AWS Server Migration Service (AWS SMS) and the AWS Database Migration Service (AWS DMS) help to migrate the company resources, particularly workload running on physical machines and large amounts of data respectively [26].

h) AWS Service Level Agreement

Lastly, the Service Level Agreements (SLA) offered by AWS is very attractive for its customers. Using the Amazon EC2 which is an Infrastructure as a Service (IaaS) [14] product as an example, they guarantee at least 99.99% availability in each region the product is offered. If AWS has failed to uphold the SLA's specified by them, they would then be required to compensate their customers. In the context of failing to maintain an uptime 99.0% or more, they are required to provide customers service credits worth up to 10% of the customer's cost [27–35].

i) Cost effective Solutions.

Like all cloud service providers AWS is also based on Pay-as-you-go pricing model. This helps businesses to optimize resources as per need and reduce costs using cost management tools.

Therefore, with the number of benefits mentioned above, the decided recommendation regarding the cloud computing solution for migration is AWS.

3.1. AWS merger with SDN - Data Security with Improved Performance

As we discussed earlier AWS is a cloud computing platform offered by Amazon that provides a range of services such as computing power, storage, and databases, while SDN or software defined networking is a network architecture that separates the network control plane from the data plane which offers better and flexible network management [28] [36–43]. Hence, the top cloud service providers such as AWS and Microsoft Azzure deploy the SDN based infrastructures [29] [44–52].

AWS with the combination of SDN is used to optimize network operations, improve security, and enhance performance. For example, AWS offers services such as Amazon VPC, which allows users to create a virtual network with complete control over IP addresses, subnets, and routing tables, while SDN offers the ability to dynamically control network traffic flows. Additionally, AWS also offers services like Elastic Load Balancing and Auto Scaling that can be integrated with SDN to automate the scaling and management of network resources.

Another use case for AWS and SDN is in improving network security. SDN allows for fine grained control over network traffic, enabling security policies to be implemented more efficiently [30] [53–60], while AWS provides a range of security services such as AWS Shield, which protects against DDoS attacks, and AWS WAF, which filters out malicious traffic. Further, AWS and SDN can also be used to improve performance by providing more efficient routing and traffic management [61–66]. AWS offers services such as Amazon Route 53 for DNS management and Amazon CloudFront for content delivery, which can be integrated with SDN to optimize traffic routing and content delivery.

4. Conclusion

Because of its obvious simplicity, and versatility, cloud computing is a revolutionary innovation that is set to transform how IT infrastructure is made available for businesses with an upgraded and improved version at a lower cost. Today, an increasing number of enterprises are shifting their business operations to the cloud for competitive advantage and to maintain their presence in digital world. In this paper we highlight the need and advantages of cloud computing for enterprises and discuss the importance of aligning cloud migration process with business goals. We also present Amazon Web Services (AWS) as an appropriate cloud computing solution. Further, the combination of two state of the art technologies i.e., AWS and SDN improves performance and data security in cloud.

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