Haaga-Helia
University of Applied Sciences Ltd.

Managing Digitalization Challenges with Amazon Web Services.

Ato Acquah

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Haaga-Helia
ammattikorkeakoulu Oy

Abstract

Author(s)
Ato Acquah

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Digitalization is a term that has been used for more over two decades. However, there are still numerous problems and challenges that plague the numerous institutions and organizations that seek to leverage technology on their journey in digitalization. The introduction of cloud computing has reduced and mitigated the problems embedded in digitalization. The thesis delves into the most common problems facing digitalization.

The purpose of this thesis is to elaborate on the various problems facing organizations and their digital products. The thesis provides an insight into how cloud computing services can mitigate the various challenges associated with digitalization.

The key focus of this thesis is how Amazon Web services one of the leading market leaders in cloud technology provides services that eliminates the various challenges associated with digitalization.

The research methodology applied is the case study method of research. The research utilizes document analysis together with literature review. The research answers questions on digitalization and its challenges, the cloud and its advantages and how the use of AWS services reduces the various challenges associated with digitalization.

This thesis is useful to organizations seeking to adopt the cloud and presents how challenges with digitalization can be mitigated with Amazon Web Services.

Haaga-Helia
ammattikorkeakoulu Oy

Abstract

Keywords

Digitalization, Amazon Web Services Cloud services, Cloud elasticity, Cloud Availability,

In the order of importance, 3–6 keywords that best describe the contents of the thesis.

Contents

Abbreviations

API	Application Programming Interface
AWS	Amazon Web Services
CAAS	Communication-as-a-Service (CaaS)
COVID19	Corona Virus Disease 2019
DOS	Denial of service
IaaS	Infrastructure-as-a-service
KPI	Key performance indicator
NAT	Network address translation
PaaS	Platform-as-a-service
SaaS	Software as a service
SQL	structured query language
SLA	Service level agreement
SSL	Secure socket layer
WAF	Well Architectured Framework
VOIP	Voice over Internet Protocol
VPC	Virtual Private Cloud

1 Introduction

Digitalization has been on the continuous rise for the last two decades. The importance of digitalization cannot be over emphasized as it has made traditional business gain more market share than before, and has eased the ways and means of doing traditional businesses. Digitalization has had a positive impact on various industries including logistics, health, property, transportation and education as well as governance. The case is that most industries in some way have benefited from digitalization. The ever fast changing pace of technology also compels companies and organizations to harness the latest technologies in order to sustain their existence and market share. It has been the case that companies who have not invested in taking advantage of the digital industry in this generation have also felt the negative impact of not doing so.

However, digitalization has also come with its challenges. The hurdles associated with digitalization are many. Challenges range from security issues, to overload of digital servers, database breaches and data theft. The end result associated with these challenges have been related to poor performance and unavailability of digital services. This in turn results loss of revenue and time to organizations. Cyber threat also continues to be a significant challenge facing digital platforms. As technology improves, threats likewise have become more sophisticated than before.

However, with the emergence of cloud computing, major challenges associated with digitalization have been mitigated and reduced. Legacy challenges such as server unavailability, overload of servers due to traffic spikes during peak seasons, cyber-attacks have been reduced. The mitigation measures include better security architectures in the cloud, better data protection measures and overall infrastructure have mitigated against the many challenges facing legacy digital platforms.

One major market leader in cloud services that has emerged in spear heading digitalization is AWS. AWS solutions and services have been providing secure and highly available digital solutions to organizations. Some of the measures deployed by AWS to reduce these challenges has been providing a robust network architecture, providing elastic cloud environments and provision of better storage and data recovery options.

The purpose of this thesis is to introduce the role AWS plays in ensuring highly available and highly secure digital environments to ensure enhanced performance of digital solutions to companies.

The results of this thesis are to guide management as to how their digital products can be deployed in AWS environment for better and secure performance. The thesis will also guide management as to the many advantages of the cloud and the AWS platform.

1.1 Thesis Objectives

Digitalization in this modern era is inevitable for organizations. As the world population continues to rise, organizations continue to find a way to serve their ever growing global local and global clients an easier and more easy and effective way of doing business. The onset of global pandemic COVID19, has further justified the need for organizations to perform their transactions by the use of the internet.

The objective of this thesis is to establish the importance and impact of digitalization in this current era. The thesis will further clarify the various threats and challenges that organizations phase in the digitalization project.
Another purpose of this thesis is to introduce the Cloud computing environment and its advantages and how introduction of the cloud is mitigating against the various challenges associated with digitalization.

Another objective of this thesis is to show how AWS, being one of the key market leaders in the cloud computing space mitigates against the various challenges associated with digitalization with its cloud computing services. By doing so the thesis will also show how AWS approach is beneficial to organizations.

1.2 Research Questions

The main objectives of this thesis are related to digitalization and its challenges, cloud computing and AWS platform. The thesis object related to digitalization is to introduce the digitalization and digital space and to elaborate on the challenges that digital products and services may face. The thesis objective related to the cloud is to introduce the various concepts related to the cloud. Another objective related to this thesis is to introduce one of the market leaders in the cloud AWS and to show how AWS is able to better provide a platform for digital products better security, better performance and better reliability.

The research questions that arise out of these objectives to be investigated are;

R1. What is digitalization and its challenges.

R2. What is the cloud and its advantages

R3.How does AWS solve problems associated with digitalization.

1.3 Thesis Scope

The scope of this thesis will cover computer server technology and the challenges they face during this era. The scope of this thesis will include literature on computer cloud and its advantages over traditional physical server environments.
The thesis will use AWS as a case for a cloud environment and how the environments eliminates and reduces the factors that affect the performance of web solutions on the internet and thus the scope will cover the necessary related AWS models in handling the objectives.
To summarize the scope will include

- Server technology
- Cloud technology
- AWS platform

The expected result will be will be useful to organizational IT departments, decision makers and IT architects.

1.4 Thesis structure

The thesis will be made up of 8 chapters. The first chapter introduces the thesis, its objective and the research problem to be investigated in this thesis. The thesis introduction will further include the research methods to be used in the thesis.

The second chapter of the thesis will introduce the subject of digitalization. The second chapter will further present the legacy infrastructure associated with digitalization. The second chapter will further elaborate on the various threats that digitalization faces with legacy infrastructure.

The third chapter of the thesis will introduce cloud computing and its various terminologies. The third chapter will further elaborate on the various advantages the cloud has over legacy digitalization platforms.

The fourth chapter of the thesis will present AWS platform and its operational paradigms. The fifth chapter of the thesis will be used to showcase and demonstrate how AWS platforms exactly eliminates the challenges facing legacy infrastructure in digitalization. The sixth chapter will conclude the thesis, and present the researchers thoughts on conclusion and further research ideas. IT will also inform on the researchers learning through the thesis process.

1.5 Research methods

The character of the thesis is mainly a qualitative research. This thesis research will mostly have features resembling the case study approach. The case study approach investigates a phenomenon within its real-life context (Yin R,2009). The approach was chosen for this research because the research will seek to describe, understand and by using the theory and best practices of AWS. The approach was also chosen because it focuses on contemporary events and the main research questions posed by this research are how and why (Yin R. 2009) This thesis will also make use of in-depth description of the entities, circumstances under which they are being used and it is for this reason that the case study research approach has been chosen.

Again, case study approach is linear but descriptive. It starts from the plan phase, followed by the design phase, and moves further on to the preparation phase collection analysis then sharing stage then follows.

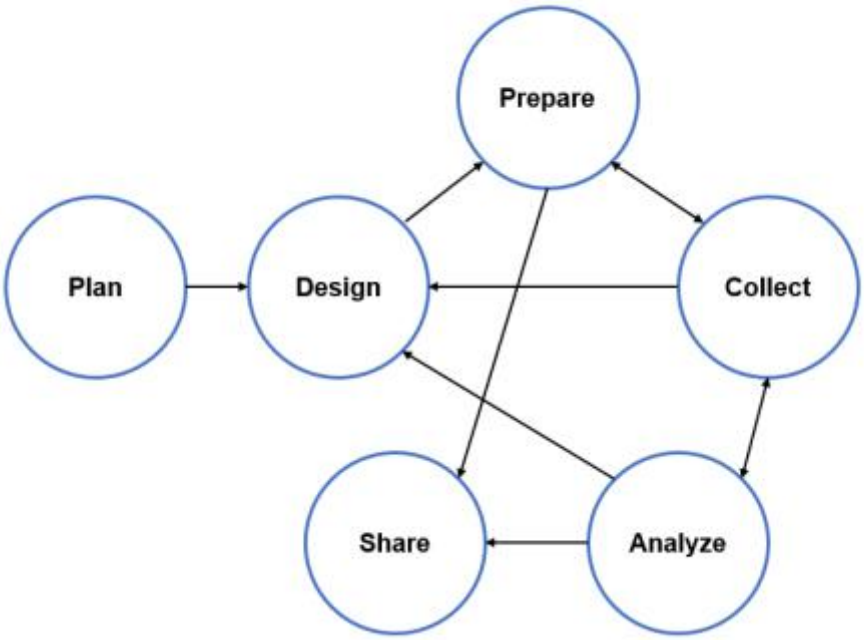

Figure 1. Linear iterative process (Adopted from Yin 20)

2 Digitalization

There have been many definitions in an attempt to define what is digitalization. The term digitalization is also used interchangeably with the term digital business as well as E-business. It is the provision of information, services and transactions through electronic media (Johnson 2018, 99). IBM, the first major electronic vendor also defines E-business as the transformation of key business processes through the use of internet technologies (Lindgren 2001,16). The term is a more inclusive and encompasses all sub definitions to the end that organizations main goal as of acquiring presence on the internet is to ultimately not just for selling or commerce, but on whole to make transactions and collaborations easier for all involved entities and stakeholders.

Gartner defines digitalization as the use of digital technologies to changes business models and provide new revenue and value producing opportunities (Gartner glossary). Digitalization in the public sector is usually termed an electronic service delivery (Johnson 2018, 99). Delivering services to the public by a digital process makes it easier for customers to interact with government at different levels.

Digitalization has enabled small and big organizations a platform where both types of organizations can compete. In the sense that traditionally the market reach of these companies was more or less localized. However, through the digitalization both company types can compete for a global market.

Well known examples of digital businesses include eBay, Meta or Facebook and Airbnb, Netflix.(Siebel T, 2019,66). Digitalization is both beneficial to the customer, as well as to the organization.

Digitalization offers customers smarter and faster services and actively shape organizations digital transformation models (Schalmo et al.2018,3). The idea of digital products services and mediums has been present for decades already with mass media campaigns being considered as digital channels for reaching customers in the 1990s and 2000s. It wasn't until from 2000- 2015 that companies realized purchases through these channels with the positive influx of digital payment options such as PayPal (Schalmo et al. 2018,5). The ultimate goal of digitalization is a digital transformation of organizations. Schalmo et al, defines digital transformation as a framework that includes networking of actors such as businesses and customers across all value chain segments and the application of new technologies (Schalmo et al.2018,5).

A road map proposed by Schalmo et al , proposes an approach to the digital transformation of business models.

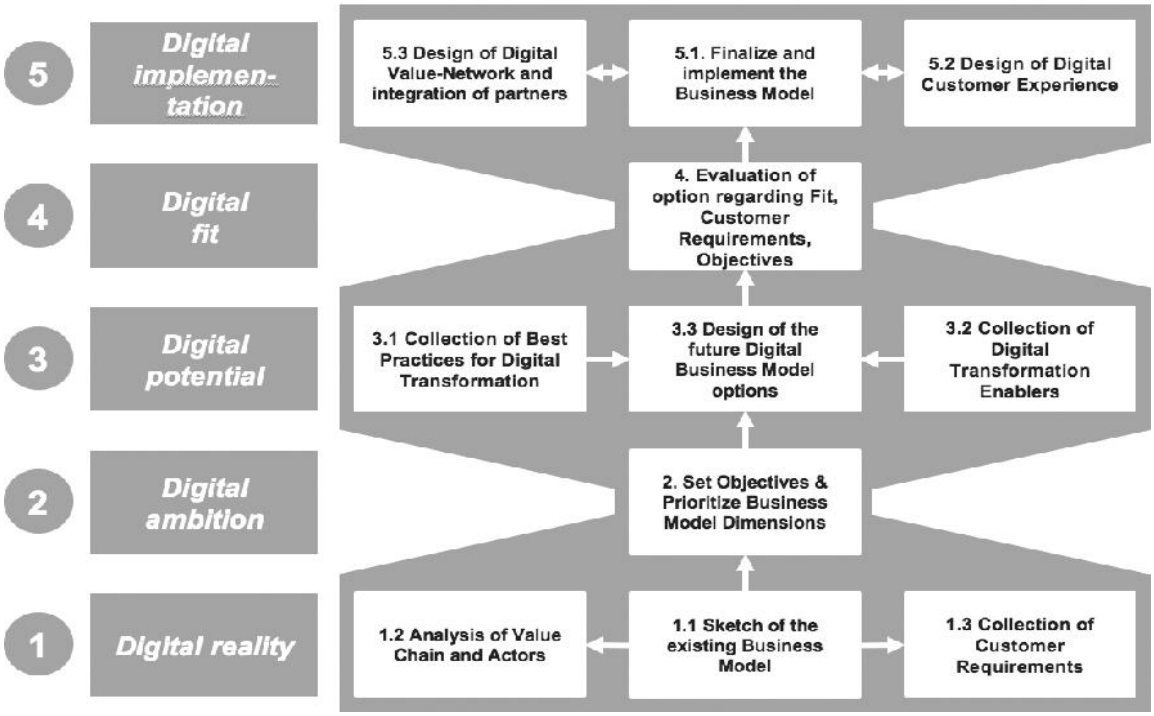

Figure 2. Digital transformation road-map (Schalmo et al. 2018)

In this road-map, the digital transformation is categorized into phases.

- **Digital Reality**: The digital reality phase sketches analyses existing business models of the organization. This is done with analysis of stake-holders and customer survey requirements to understand the digital reality of the organization in different areas.
- **Digital Ambition**: As a result of knowing the digital reality of the organization, the digital ambition phase determines which objectives should be considered for the business.
- **Digital potential**: The potential phase establishes the best practices and enabling conditions necessary to attain a digital transformation.
- **Digital Fi**t: This phase identifies various options available of the business model and these options are evaluated against the current business model.
- Digital Implementation: The implementation phase includes finalizing and implementing of the digital business model.

Schallmo et al, also present the digital radar which presents 4 enablers of the digital transformation process.

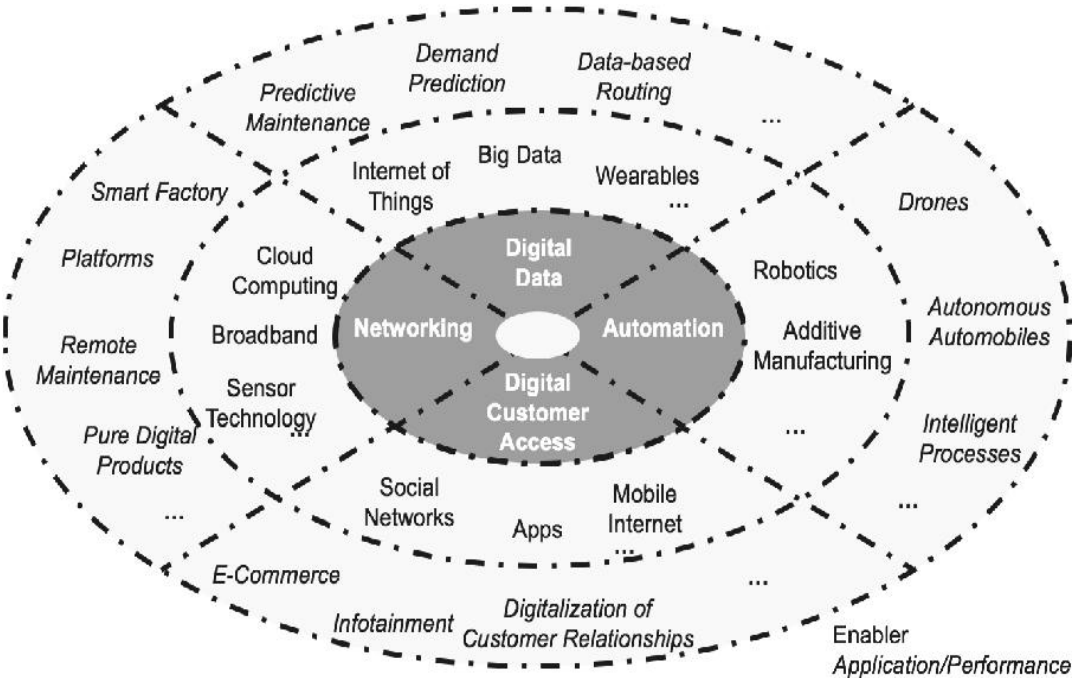

Figure 3. Digital Transformation radar (Schallmo et al.2018, 9).

These enablers are explained subsequently.

- Digital data: This is the collection and analysis of digitized data to facilitate and improve predictions and decisions.
- Automation: Combining AI technologies that enable autonomous work thereby reducing error, increasing speed and reducing co
- Digital Customer Access: The internet enables direct access to customers thereby offering them new services as well as transparency.
- Network: Networking of the entire chain allows for the synchronization of supply chains reducing production times.

2.1 Digital business infrastructure

To run a digital business entails the use of some infrastructure and supporting technologies that are necessary and current. Because of the fast-changing pace of IT technology, there is the need to ensure that solutions adopted for digital business are of a modern and current nature. Most digital business deployment follow best practice models and standards. The infrastructure and setup of a digital business directly affects the quality of service offered to users in terms of security, reliability and reliability. The internet has become the main enabler of digital business (shaw M.J,2002,3).

The main basic infrastructure that enables digital platform usage via the client/ server model.

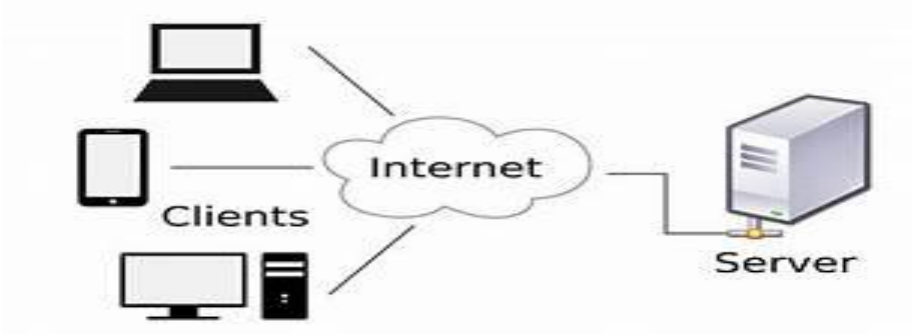

Figure 4. Client server model

The client is any process that request specific services from the server. The client and server process may as well reside in the same computer or different computers. The Server is a process that provides requested serves to the client (Yadav,C,2009,1). Typical examples of a client can be a laptop, mobile for or any other smart device. The server provides the service for more than one client. There are different type of servers popular among which are application server ,web server , database server and file servers.

The interaction between the client and the server is enable by the internet. Some of the standard protocols that clients and servers use to communicate with themselves are;

- File Transfer Protocols(FTP)
- Hypertext Transfer Protocol(HTTP)
- Simple Mail Transfer Protocol(SMTP)

2.2 Digital Business Challenges

Many organizations using the digital products have suffered in various forms of challenges which affect the reliability of their products. Challenges maybe arise from software failures, hardware failure, operator errors , environmental failures and security violations. Cyber security to data losses and also overload of servers during unplanned and peak seasons.

2.2.1 Security Violations

Cyber threat has been defined in many terms. The threat occurs as a result of the combination of humans, the internet and computers (Ulsch. M et al, 2014,19). Cyber-crime is a global phenomenon and cyber-attacks could come from any part of the world or from anyone. Cyber-attacks could emanate from disgruntled employees, industrial espionage and even terrorist (Vacca John R, 2013). It could also be as a result of compromise on information infrastructure as result of equipment failures, user errors, and natural disasters ((Vacca John R, 2013). Cyber threats are usually in two forms.

The first is cyber exploitation specifically aims at accessing data that should be kept away from unauthorized parties. The results of cyber exploitation usually leads to access of critical and sensitive data such as Social security number, medical records, classified information and user data(National Research Council, et al. 2014, 31) There are various ways which cyber exploiters get access to sensitive data. This could be achieved by various cyber techniques such as phishing, spy-ware and even hacking. Cyber-attacks are constantly improving and getting more sophisticated by the day. Cyber exploitation results in exploitation of data.

The second form which cyber threats usually occur is through cyber-attacks. A cyber-attack is defined as an intended action to cause destruction of data, or to cause a denial of needed service over an information network. Common types of cyber-attacks include DOS attacks, virus, SOL-injection, man in the middle attacks. Cyber-attacks usually result in the destruction of data and services.

A cyber threat could be composed of both forms of exploitation and attack. They both target the security and network infrastructure of their victim organizations or individuals.

Other security violations that become a challenge to digitalization are password exposure to the wrong personnel.

2.2.2 Software Challenges

The internet is the biggest network that connects various small other networks. Every day, more and more people globally gain access to the internet and internet related services. Server overloads are caused when there is increase in the number of users to a server or a network. This increase maybe a natural occurrence as happens in certain spike periods for example Black Fridays. Some cyber-attacks may also be designed to put stress on some networks and applications to resemble user activities. Servers may also be unavailable during routine maintenance for some period of time. Every unavailable server time causes organizations and stake holders some revenue and reputation.

During server overloads pressure is put on infrastructure and this may cause the infrastructure or services to malfunction. Some of the characteristics of server overloads may include error codes display, delayed request, denial of service and web servers returning partial content.

Errors in computational logic can also cause digital solutions or web applications to fail. Examples of such computational errors maybe a wrong reference to a non-existent table in the database synchronization errors, among others.

2.2.3 Hardware and Environmental Challenges

Data losses to organizations occurs in various forms. Data loss could occur from natural disasters in such case where physical infrastructure of housing digital products and services are affected. Data losses could also occur from application failure and system failure that may also arise from various other reasons. Simple network failure and network intrusion could further result in data loss. Cyber threats may also result ultimately in the loss of critical data. All these reasons can cause data losses which in the long run will result in accumulated cost to organizations. Traditional data recovery methods tends to be complex, requires high budgets and resources to organizations. Recovery time for traditional recovery methods may be lengthy, sometimes taking even weeks.

Challenges to digital solutions could also occur as a result of various hardware failures. For instance, network hardware failures could occur and result in a loss of connection to the server.

2.2.4 High cost

Setting up a digital platform can be costly. The infrastructure needed from computers to networks devices and other devices can be high. The cost of training and maintaining

administrative and network professional will also add to the buildup of overall cost. This is also further additional cost in maintaining and updating software, protection against cyber threats, the list goes on and on. It is very expensive for organizations to run wholly digital servers to run their digital products.

2.2.5 Operator Challenges and errors

This challenge usually occurs when operators of the digital product enter incorrect parameters for instance during maintenance checks. Procedural errors may also occur for instance when the database is not backed up , restoring wrong backups during maintenance, accidental deletion of file. Other accidents that may also occur maybe for instance accidental disconnection of power supply.

3 Computer Cloud Computing Services

The cloud has been described as an essential foundation and driving force of digital transformation and it is currently entering its second decade. This chapter will introduce the various concepts associated with the cloud and enumerate its advantages.

3.1 Cloud computing deployment Models

The cloud can be deployed in various ways depending on who owns the cloud and what type of services are offered. The various cloud deployment models are explained below.

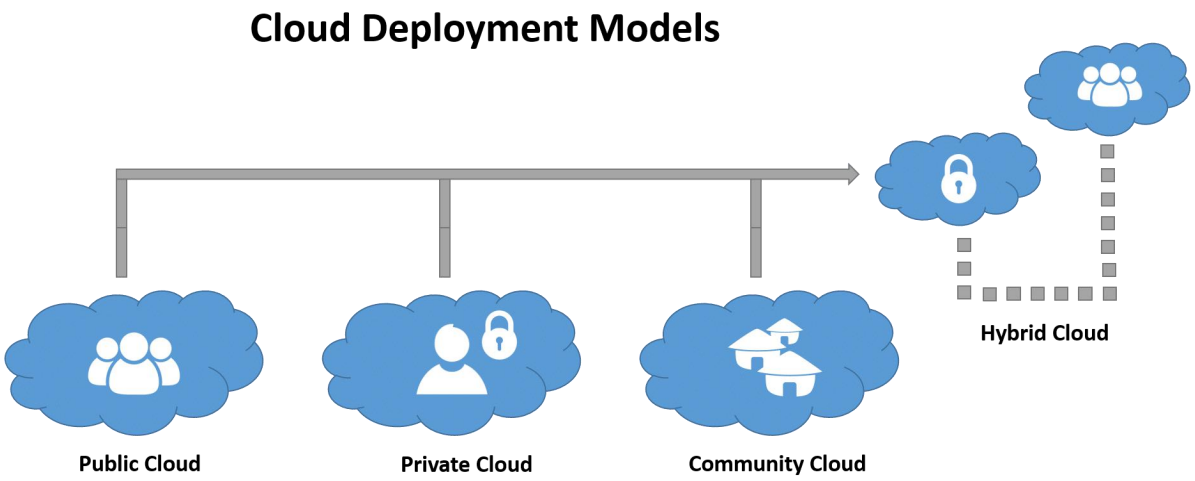

Figure 5. Cloud Deployment models

- Public cloud is cloud infrastructure that can be used and is available to the public as the name suggest. The public cloud is owned and managed by specialized cloud-based companies such as Amazon, Azure, IBM and Google.
- Private cloud deployment infrastructure is owned by an organization and it is operated for the benefit of a single organization. As the name suggest the resources in this cloud are solely belonging to a single organization.
- Hybrid cloud combines the use of private and public cloud resources. This mix of private and public cloud environments enables organizations to store more sensitive information on private cloud as to public cloud.
- Community cloud is the fourth deployment model of the cloud where

3.2 Cloud service models

The cloud makes available, various service models which organizations can capitalize on. These service models predominantly the work load which organizations will have to have performed with legacy systems on premise of organizations. The most common service offered by cloud companies are;

- **Infrastructure-as-a-service (IaaS)**

This service offers various IT infrastructure readily available on demand to customers. Such infrastructure can include computing power, data storage, and networking resources readily available as a service and on demand. Infrastructure is typically delivered on a virtual platform as a service. This service enables organizations to quickly get access to IT infrastructure that will otherwise will have needed traditional outsourcing procedures such as due diligence, negotiations and lengthy contract procedures shipping and installation. With this type of system , customers can tailor their infrastructural requirement to the purpose for what they are needed and when they are needed. This service offers various advantages to organizations and to customers. The service offers the use of latest technology, secured environment, and practically low cost of investments. The service also offers readily configured ITIL based framework, a customized framework of best practices in the IT sector(Rittinghouse J.W,74,2009).

- **Platform-as a-a Service (PaaS)**

The PaaS is a model that practically caters for the building and delivering of web-based applications. This service makes available the necessary tools needed by developers, IT managers or end users to support the implementation and delivery of web-based services and applications. This service enables organizations to reduce their budget by directly opting for tools and platforms that can deploy and implement real time applications there by creating instant value. With this model organizations have no need to worry about what infrastructuree their products are running on but can then focus on innovation rather than infrastructure. Again, PaaS tends to be cost effective as customers of PaaS only pay for the time and period used for development, delivery and maintenance of applications. PaaS specifically offers tools and applications needed for organizations to implement their digital solutions over the use of the internetv(Rittinghouse J.W,88,2009). Typical PaaS offerings may include work-flow application development and design, testing, deployment, hosting, virtual offices among others (Rittinghouse J.W,88,2009).

- **Software -as-a-Service (SaaS)**

SaaS is a service model that allows for the distribution of software through a vendor who offers this software to customers and clients. The model is again economical as clients and patronizes only pay for what software and applications they use during a specified period of time. One good benefit of SaaS is that it all branches of the organization are have a streamline administration of the applications in use. This ensures data compatibility across multiple branched organizations.

- **Commmunication-as--a-Service (CaaS)**

This type of cloud service offers organizations the an opportunity of outsourcing enterprise communication to specialized communication cloud vendors (Rittinghouse J.W,2009,69). The vendors are responsible for providing communication infrastructure and software such as VOIP services, Instant messaging and video conferencing capabilities to the clients. A good advantage of this service is that the cost of maintaining and managing a carrier-grade data center makes it economical for organizations patronizing this solution as the cost is spread among the customer base of the vendor company.

Figure 6. Common cloud compute service models.

3.3 Advantages of the cloud

The advantages of cloud services and its affiliated services are numerous. The advantages include technical advantages to financial advantages and then to more security related advantages.

3.3.1 Scalability and Elasticity of the cloud.

Scalability and elasticity of the cloud are sometimes used interchangeably. Elasticity of the cloud is defined ability of cloud resources to increase or reduce when needed. Scalability is the capability of enterprise applications and its ecosystem components to handle workloads with respect to its demand without compromising on its overall efficiency (Kumar, S.S. 2014,1). Scalability of the cloud refers to the long term ability to increase computing resources such as computing power and servers and databases resources and to decrease these resources when not needed. According to Kumar, scalability has 4 dimensions. These are Load scalability, functional scalability, Integration scalability and geographic scalability (Kumar, S. S.2014,6)

Many enterprises have a growth pattern. However there are various instances where enterprises have experienced not so unpredictable patterns in the use of their enterprise software due to increased workload traffic and even cyber-attacks that mimic load traffic. The cloud enables for and handles such fluctuations through its elastic nature.

Functional scalability is the ability of web application to accommodate additional functions without a reduction significantly in their performance. This means enterprises can add new services, business functions and utilities to their web applications without a significant reduction in performance of the application.

The other dimension of scalability is the integration scalability. As new functionalities are added to web applications there is the need to integrate these new functionalities into existing web applications This dimension of scalability ensures easy integration of new functions without a significant reduction in performance of the existing application.

The last dimension of scalability, geographic scalability ensures that the performance of a web application is acceptable irrespective of geographic location. All other things being equal, data retrieval has lower latency in with respect to geographic location. Latency is defined as the amount of time it takes for a data packet to travel from one designated time to another.

3.3.2 Capital expenses to operational expenses

Before the cloud, enterprises had to put up with the capital cost of deploying on site IT infrastructure in putting up their web applications. The infrastructure included up to date network systems sourced and purchased from leading infrastructure manufacturers like IBM and Cisco Systems among others. Thee sourcing of these systems took a considerably long time and the setup by IT professionals also took some time. There was also the need to see to the maintenance of these purchased systems, equipping them with latest technology and tools also took considerable chunk of organizational resources.

Today with various cloud models offering pay-as -you -go services, organizations can readily and speedily setup infrastructure for new projects in minutes with just a matter of clicks of the mouse button. Various sourcing processes which considerably increased the time as a resource, have been eliminated. Cost of setup and hiring of network professionals to maintain and configure production systems has also been reduced significantly.

Emergence of the cloud has also reduced cost in the sense that, organizations sometimes budgeted for infrastructure which was not needed and ended up being an extra capital expense when it could have been channeled into other areas of production. Today with such characteristics of the cloud such as its scalable nature, organizations can make allocation for the adequate infrastructure needed. When these adequate infrastructures become inadequate due to growth or unforeseen circumstances, the cloud dynamically can provide for the shortage for instance in the case of customer traffic. Most cloud services offer the model where companies only pay for as much resources as needed. In this model there is very little wastage of resources as companies only pay for what they use.

Considering these factors, the return on investment for companies adopting to the cloud is is usually significant. Various unnecessary traditional cost is eliminated and channeled to other areas of production. Further still, companies do not need to maintain a huge human resource team to maintain and setup resources. This helps the focus of companies to be fixed on their main competitive advantage being offered.

3.3.3 Security

The cloud offers a higher level of security compared legacy solutions. Although there is a mirage of considerations that go into the total security of the cloud. Some of these considerations may include such as regulatory requirements, standards, information classification and security awareness.

Security in the cloud is based on several considerations such as regulation requirements, adherence to standards, security management and awareness and information classification. Other considerations related to the architecture of security in the cloud hardware, software secure execution and production environment (Krutz R.L et al,2010,182). Most enterprises also have a well-designed security strategy. However, most cloud service providers have their own of security management. It is therefore essentials for companies to line up their own security strategy to line up with that of the service providers security strategy.

The cloud offers advanced security features to guarantee that data of customers as securely stored and managed in accordance with their security strategies. Advanced features such as access management helps secure data from unauthorized access.

3.3.4 Reliable disaster recovery

Another important advantage of the cloud is its ability to backup and restore data when needed. Cloud based services provide enhanced data storage and recovery options. More often than not , natural disaster may occur at different time and uniformed times. The cloud however has effective backup services that enable organizations to secure their work from various schedule points. Some cloud service companies like AWS have different servers located in different regions. The probability of a natural disaster occurring at different regions at the same time is very low. This ensures that organizations at all times organizational data is kept safe.

Recovery of lost organizational resources due to occurring natural disaster can be than in a relatively short time in the cloud.

4 Case Amazon Web Services

4.1 History

Amazon Web Services is a leading cloud service provider. It started its operations in 2006 by offering its first service to the public which was the simple query service. AWS is a subsidiary company of Amazon.com Inc which stated its operations in 1994. Currently AWS can boast of more than 200 fully featured services, millions of customer including the fastest growing start-ups, largest enterprises and leading government agencies (AWS). Appendix 1, shows some of AWS most popular services. AWS serves over a million active customers in more than 245 countries and territories. AWS is currently the world market leader in cloud computing. Appendix 2 gives data on AWS snapshot and score in the cloud computing space against other vendors.

Figure 7. Cloud Vendor market share (Gartner 2021)

The figure above is the Magic quadrant for cloud infrastructure and platform services. It shows cloud computing market share competitors depicting them in 4 quadrants. Competitors are placed in the quadrant taking into consideration their ability to execute and the completeness of their vision. The four quadrants are labeled in terms of niche

players in the industry, Challengers in the industry Visionaries and the market leaders. The position of AWS in the top section of the leaders quadrant indicates its control and position in the cloud computing industry. Their main competitors are Microsoft and then Google.

4.2 AWS Global Infrastructure

The AWS global infrastructure is structured around AWS regions and Availability Zones. An AWS region is a physical geographical location. In AWS a region may have several availability zones. AWS has several discrete data centers in each availability zone. Having several availability zones allows supports and enables solutions that are made highly available, because when one zone is offline during unforeseen events the other zones take up load in real-time. Currently AWS is present in 26 geographical regions and has a total of 84 availability zones (AWS White papers.) .

Each AWS region has been designed to be isolated from other regions. The reasoning behind this logic is that, in the unfortunate incident of disaster and cyber-attacks there is the greatest level of tolerance. Similarly, each availability zone is isolated but these availability zones in similarly region are connected through low-latency links. Again each availability zone as an independent failure zone. Security is the of priority in AWS.

Figure 8. AWS Infrastructure locations(AWS white paper)

4.3 AWS Philosophy

AWS operates under a set of rules and principles called the Well-Architectured Framework (WAF) which helps customers understand the advantages and disadvantages while operating under AWS. The Well-Architectured Framework serves as a guide to organizations architectures in AWS are aligned with best practices. It helps organization technology officers, architects, developers and teams review their architectures in conformance to best practices in operations in the cloud.

The Well-Architectured Framework is based on five main principles or pillars. These pillars are;

- Operation Excellence
- Security
- Reliability
- Performance Efficiency

- cost optimization.
- Sustainability

Before applying the well WAF AWS identifies a set of general principles that facilitate good design and architecture in the cloud .

4.3.1 Operation Excellence

The operation excellence pillar ensures that organizations have the ability to run and monitor their systems to deliver their business value whilst contiguously improving and supporting processes and procedures (AWS white papers, Operational excellence,6,2020). In observing this principle companies must understand their organizational priorities, organizational structure and operating model. According to AWS there are five design principles companies must follow to achieve realization of operational excellence pillar. These are:

- Perform operation as a code: In this design principle, the main aim is to eliminate human error by defining entire workload as code and updating with code. Scripts are used for operation procedures and their execution is automated and are main triggered as response to events. This minimizes and limits human error.
- Make frequent reversible Changes: This design principle is to encourages small incremental changes that can easily be reversed when there is a failure.
- Refine Operations procedure frequently: This design principle encourages refinement of operations procedures. This principle encourages the use of reviews on procedures to ensure that operations procedures used are effective and known by operational teams.
- Anticipate failure: This design principle encourages a review of potential areas and sources of failures in order to mitigate against failure. Failure scenarios and their impact must be understood. Another aspect of this design principle is to test response procedures for anticipated failure scenarios and to ensure that operating teams are familiar with response scenarios.
- Learn from all operational failures: This design principle ensures that there are lessons learned by operational teams and through the entire organization from all operational events and failures.

In conclusion organizational excellence is an ongoing and continuous process. Focus in operational excellence is incremental improvement based on existing priorities. The best practices discussed in this section helps customers in achieving highly responsive and adaptive deployments. Some key cloud services that support this continuous iteration process include AWS Config, Amazon cloud watch and Amazon elastic search service.

4.3.2 Security

This pillar is introduces best practices in design and delivery and ensures maintenance of secure AWS workloads. The security pillar documents current recommendation and strategies applied in designing secure cloud architectures. The security pillar conforms to various design principles which are:

- Implementing strong identity foundation: This design principles conforms to the best practice of least principle and enforces separation of duties with authorization for each AWS resource interaction. One key AWS service associated with this feature is the AWS IAM service which enables users to securely access AWS resources.

- Enabling traceability: This best practice monitors, alerts and audit actions to AWS environment in real time. It uses the integration of logs and metrics to automatically respond and take actions. One key service is the AWS cloud trail service which records API calls .

- Apply security at all layers: Security measures are applied to all layers of architecture such virtual private networks, operating systems, load balancers among others. Some examples of AWS service layer protection include AWS VPCs which protects the network resources in a network.

- Automatic security best practices: Implementing software-based security mechanisms and measures enables services like scaling more rapidly and cost effectively.

- Protect data in transit and rest: This practice encourages classification of of data into sensitive classification and mechanisms such as encryption. This reduces direct human access reducing the risk of data loss or modification. A good example of data protection service in Amazon is Elastic block storage which protects data enabling with encryption technology.

- Prepare for security events: This practice encourages for security incident preparation by establishing an incident management process that aligns to organizational

requirements. A good example of incidence response usage is authorizing IAM to grant the necessary authorization to incidence response teams.

4.3.3 Reliability

The fourth pillar in AWS is the reliability pillar. This document a set of best practices and principles to enable recovery of system and infrastructure from service failures and disruptions. The main design principles to be adhered to are;

- Test recovery procedures: This principle and best practice allows customers of AWS test system failures and validation of system recoveries. This principle helps to bring to light failure pathways that can be rectified before the occurrence of real-time failure scenarios.

- Automatically recover from failure; These principles introduce monitoring system resources and setting automated threshold triggers that automated recovery when needed.

- Scaling horizontally to increase aggregate system availability: This principle introduces the best practice of replacing large resources with small resources thereby reducing the impact of a single point of failure.

- Stop guessing capacity: Again, AWS introduces the best practice of not dynamically adding or removing resources when needed. When resources are too much saturated it results in under performance. One common approach of cyber-attacks is to saturate needed resources on organizational platforms.

- Manage change in Automation: AWS advocates as a good principle using automation in handling infrastructural changes.

4.3.4 Performance Efficiency

This pillar of AWS encompasses the ability of using computing resources efficiently and adapting to changes but sustaining efficiency of the platform. The design principles advocated for this pillar are;

- Democratizing advance Technologies: This principle advocates for difficult and to implement technologies to be pushing that into the cloud vendors domain thereby rendering it more consumable to the organizational teams. For example , technology such as machine learning requires expertise that may not be available to the organizational team.

- Going global in minutes: Easy deployment of solutions into multiple geographical regions results in lower latency and better experience for customers.

- Using serverless architectures: AWS advocates for more serverless architectures to be used in the cloud to eliminate the need for maintaining servers. A typical example of this is using AWS storage services like S3 which have the ability to run as static websites. This optional can also reduce transaction cost eliminating the need for server management.

- Experimenting more often: AWS also advocates more experimenting through testing taking advantage of available virtualized platforms.

- Mechanical sympathy: This best practice by AWS simply advocates for the usage of technological approach that best achieves the desired goals.

4.3.5 Cost Optimization

This pillar simply advocates for the elimination of unneeded cost or sub-optimal resources. The main principles of design in germinating cost are :

- Adopting a consumption model: This principle advocates for implementing resources as much as organization can consume or are consuming. For instance some services can be stopped for instance during the weekends when they are not in use. This is a good way to reduce cost.

- Measuring overall efficiency: The total output of systems can be measured against its associated cost to effectively control and understand the gains in increasing output and reducing cost in future.

- Not spending money on data center operations: This principle simply implies that the workload of mainlining a data center is born by AWS to enable organizations focus on their core businesses.

- Analyzing and attributing expenditure: In AWS it is easy to identify the usage of resources and its allocated cost thereby further rendering easier for organizations to measure their return on investments.

- Using managed services to reduce the cost of ownership: The many services of AWS enables customers to remove operational burden on maintaining servers for tasks such as emailing or managing databases.

5 AWS in Action

Majority of the challenges facing digital products are software based even when they have not been explicitly stated. The AWS platform seeks to mitigate against these challenges through various means addressed in the reliability pillar of the AWS WAF. Reliability pillar focuses on making digital solutions continuously available. This chapter will focus on how AWS makes digital solutions continuously available with well-designed AWS services for customers. This chapter will also present and analyze a digital solution architecture that is based on the reliability pillar in AWS.
As stated earlier Amazon has numerous customer services that go a long way to fulfill the principles and best practices elaborated in the AWS WAF. However different services may be at the core of achieving highly available and highly scalable solutions mainly based on the scenario. Highly available solutions imply that the solutions points of failures do not interrupt the normal functionalities of the solution. This implies being able to handle network spikes, server overloads resulting in denial of service.

5.1 Architecture of Highly Available Solutions

High availability is critical for enterprise business and for generating substantial customer satisfaction, customer loyalty and enhances improves competitive edge (Kumar S,S 2014,59). Customers begin to question solutions that have relatively availability periods and failures during the time of their usage. All other things being equal, undecided customers may look toward competitors who provide the same service. If the platform is also a revenue generating platform, every second of downtime results in loss of revenue. In the same s sense, some companies may gain a competitive advantage through this means of providing highly available solutions when compared to their competitors, they are unable to attain same level of availability. This also enhances the brand of the competitor who is able to attain high availability.

Attaining high availability is also essential to certain industry such as the health industry, for instance in retrieving patience records. It is essential that such industries have the necessary availability because of the critical nature of the industry in saving lives.

Some key characteristics of a highly available architecture may include;

- Highly available architecture should plan strategies to handle all possible point of failure.
- It should support fail-over and fallback scenarios
- It should include proactive monitoring and automate self-detection and self-correction

- It should provide a strategy for planned and unplanned downtime

5.2 High Availability Planning

The first step in attaining high availability solutions is to perform a high availability planning which results in identification or availability Key Performance Indicators (KPIs) (Kumar S,S,2014,60). Among the KPIs may include

- Availability Service Level Agreement (SLA)
- Business functions and transactions and processes
- Data backup
- Tolerable downtime limits.

There are various entities to consider during high availability planning stage. Figure 9 below gives a snapshot of the entities involved in planning for availability.

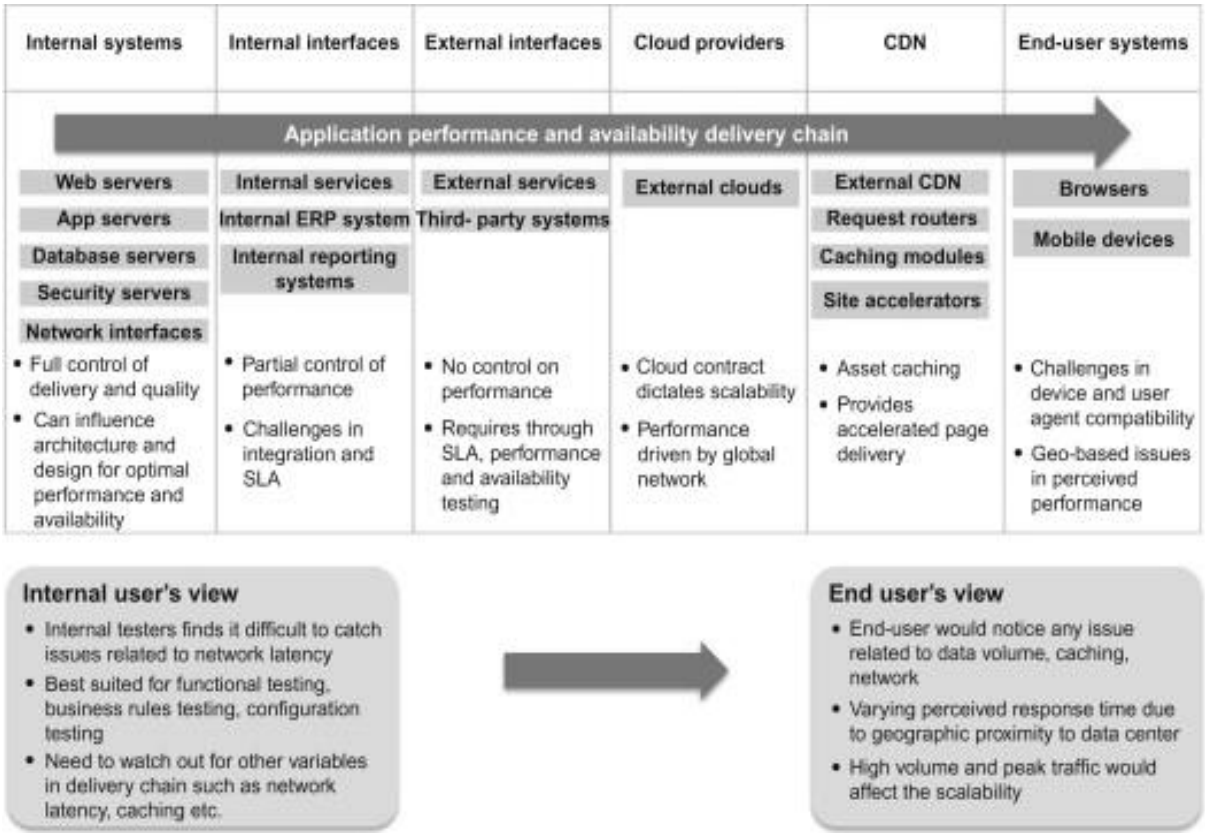

Figure 9. Availability delivery chain.

- **Internal Systems**

As shown in Fig above the first layer to consider is the internal systems layer which is made up of web servers, application servers Database servers and network servers and legacy systems. The internal systems are maintained by the organization. They are considered to be the primary systems responsible for availability and performance. These systems are setup and maintained by organizational teams and systems administrators. The internal systems unit are also regularly monitored in terms of performance and reliability. Enterprise architects and application maintenance teams have the most control of all the layers in the delivery chain where they can exert influence performance and reliability.

- **Internal Interfaces**

As shown in the figure above, this layer in the delivery chain is made up of ERP systems, reporting systems and internal services. This layer is typically controlled by subject-matter experts, interface architects.

- **External Interfaces**

External interfaces usually is made up o third party interfaces, external feeds and web services. They are often integrated through plugins services, APIs and other client application components. They are usually controlled by third-party vendors. They can pose a challenge in application availability when data inputs and user-generated components in not in conformance to third party requirements thereby compromising the availability of the organizational product.

- **External cloud**

Availability may be pegged on the cloud infrastructure and the service level agreement between the cloud provider and the organization pertaining to availability. In this layer of delivery chain, the cloud provider is the main player and maintains and enforces the service level agreement. Some concerns of availability from this layer may arise from local regulations, security and privacy.

- **Content delivery network(CDN)**

Content delivery layer is responsible for caching asses such as videos and images on network servers. Most cloud providers provide network servers for this purpose. CDN is usually controlled by the CDN vendor with the infrastructure team specifying requirements. CDN is configured with the optimal algorithm to ensure optimal performance.

- **End User Systems**

The end-user is the final layer of the product delivery phase but not the least. The performance experience perceived by the end-user greatly influences the perception of the enterprise product.

5.3 Architecture of highly scalable solutions

Scalability is the ability of enterprise application and its ecosystem to handle workload increases and demand and still maintaining its overall efficiency (Kumar S,S 60,2014). Th enterprise application ecosystem is made up of infrastructure such as network infrastructure, web servers, database servers and all other systems involved in delivering the enterprise application.

5.3.1 Dimensions of Scalability

As shown, Scalability can be applied to various layers of the enterprise application ecosystem. These layers can be categorized into the different dimensions of scalability application. Some different dimensions of scalability are Load scalability, functional scalability, Integration scalability and geographic scalability.

Load scalability simply refers to the ability of the enterprise application to tolerate increase in workload without affecting its performance. Increase in workload could be an increase in service requests, users, input data among others. As stated earlier one of the methods of cyber-attacks is to significantly increase service request and users one enterprise applications. This may result in unresponsive service request and thereby decreasing the overall image of the organization.

Functional scalability also refers to the ability of an enterprise applications to easily accommodate additional functionalities. Typically, during maintenance stages, new enhancements and updates maybe added to the application, including business functions, utilities and different interfaces.

Integration Scalability is defined as the capability of applications to connect easily with new interfaces and service upgrades.

Geographic scalability refers to the ability of web applications to perform optimally irrespective of the geographical request, and performing with acceptable range of

performance. Latency times may increase depending on how far request to applications are placed geographically.

5.3.2 Scalability Challenges

Various scalability challenges arise at different levels of the enterprise application ecosystem. Some of the challenges may arise at the software level or software base challenges whereas others maybe based on the hardware level and process levels.

At the software level, improper design patterns in applications in applications may have an effect on the performance and availability of enterprise applications. Scalability challengers may arise out of the various levels of the ecosystem such as database and web-server layers. Caching may also affect the scalability of the application. Caching is defined as a temporary storage of data, usually in proximity of the users location to readily make available frequently used data. Since caching also reduces the direct load and request on applications, a poor caching system results in service request directly loading a server, which may affect the overall performance and efficiency of the server. Scalability may also be affected by the inability of key application components to scale. For instance, when authenticating components are not able to handle a particular number of logins at a time at results it results in a queuing load during peak times. Scalability challenges may also arise when scalability scenarios are not pretested to simulate real-time work load and traffic.

At the hardware level improper infrastructure planning as results in Scalability challenges. Designing optimal infrastructure elements such as servers, network capacity and data storage to meet estimated requirements may result in scalability issues.

5.4 AWS Highly available an d Highly scalable infrastructure

As explained earlier AWS bases its main principle of architecture on the five pillars of the WAF. These are Operational Excellence, Reliability, Cost optimization, Security, Performance. Thus, every architecture in AWS seeks to follow and adhere to best practices of the WAF.

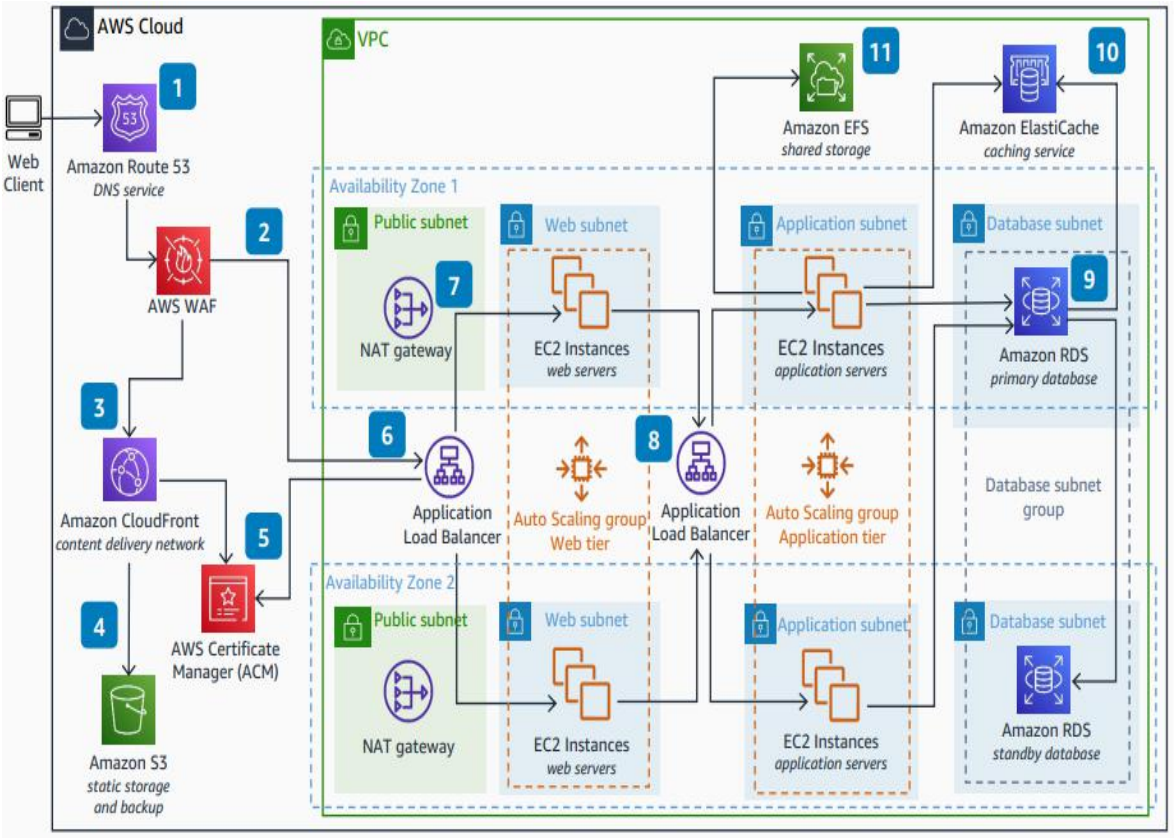

Figure 10. Web application Architecture (AWS White-papers)

The figure 10 above, shows a typical web Application architecture in AWS. This architecture will be highly available and highly scalable to clients and users of the service. The diagram will be explained subsequently to detail how the architecture above is resilient.

- **VPC** - A VPC in AWS stands for virtual private cloud. It closely resembles a traditional network and allows resources to be launched into the VPC.

- **Subnets** - Subnet is a range of IP-addresses that are available in the VPC. Subnets can be public or private. Public subnets are routed through an internet gateway and therefore can be accessible to the public. Private subnets on the on the hand are not routed through the internet. VPCs ensure the security of AWS applications with very rigid security settings further making it hard for attackers to get hold of resources.

- **Availability Zones** - As explained earlier, AWS places in servers in the different availability zones located around the world. Availability zones is one of the key components in archiving highly scalable and highly available architecture.

- **EC2 instances** - Elastic compute cloud instances are computing infrastructure that contain the main web application resources.

- **Amazon RDS** - Amazon relational databases contain and house the data of the application.
- **Amazon Elastic cache**- Is a Cache service provided by amazon to ease the pressure or direct usage of other services like the RDS.
- **NAT gateways**- Is the network address translation service and is use for accessing instances in private subnets.
- **Load balancers** are a key component in AWS for providing highly scalable infrastructure in AWS. There are different types of load balancers. The gateway load balancer, network load balancers, application load balancers and classic load balancers.
- **AWS WAF** - This is a firewall service provided by AWS
- **Amazon cloud front**- Is a content delivery network for reducing latency for static data in AWS
- **Amazon S3**- Amazon simple storage service is a service for storing static data.
- **AWS certificate manager** - Simplifies ssl certificates certificates management.

Attaining highly available solutions in AWS is can made possible by deploying solutions in multiple availability zones. In this case an application can keep operating even though there may be an interruption of a component. AWS as stated focuses on automation and decoupled services and best practices such as monitoring and health checks can detect deficiency in performance of various components and services. The services and components in one availability are totally replicated and synchronized in the new availability zone. Therefore, when unhealthy component or service is detected in one availability zone the other components in the other availability zone is made as the main destination point, while the unhealthy component is flagged for fixing. One of such AWS services is for monitoring is Amazon cloud Watch. Monitoring helps to detect failures in individual subsystems and the system as a whole.

Deploying in multiple availability zones also reduce the latency for customers. For example customers traffic will be directed to the availability zone which is closest to them and that will reduce the connection times to the web application. The application load

balancer service can be used in AWS to route this kind of request to the application. In this way performance of the application is maintained as well as its efficiency.

The auto scaling group also handles scaling of resources in AWS automatically. During peak times AWS auto scaling group adds the necessary compute power and instances for your application. Similarly, it also reduces the and removes excess compute power and other resources when not needed. This can be achieved in collaboration with other services like AWS cloud watch where metrics and other key performance indicators may be defined. Scaling can also be defined in the schedule where resources may be defined to increase or decrease during particular dates and time.

5.5 Mitigating the challenges of digitalization

AS shown with this previous architecture diagram, combing the various components of AWS can go a long way in addressing the various challenges facing digitalization.

5.5.1 Enhanced security .

The **security pillar** in the AWS well architectured highlights the best practices to be used to improve overall security of organizational products. Security in AWS is enhanced on various levels. AWS provides services and components to strengthen the security of the digital space. As stated in chapter 4, an identity and access management service allow sonly authorized personnel access to resources. On the infrastructure level, AWS VPC protects organizational digital resources with a combination of complex security architecture that makes it hard for cyber threats and attacks to gain control. The combination of these various levels of security provision makes it hard for third parties and unauthorized access into organization resources.

Having webs servers deployed only in private subnets make it more secure. Access to the web servers are only gained through the deployment of a NAT gateway.

5.5.2 Software Challenges

One of the main challenges facing digitalization was challenges with software challenges. Naturally with the global population increase, organizational organic growth and unforeseen or peak period usage of digital solutions, the workload on digital infrastructure can increase substantially. The AWS philosophy pillar of **reliability** ensures the usage of best practices in mitigating against such scenarios. The provision of various services such

as application load balancers, multiple availability zone deployment and being managing change with automation can mitigate against the digital problem.

5.5.3 Hardware and environmental challenges

Hardware and environmental challenges also as established is one of the areas facing digitalization. As AWS cloud provides various services in availability zones, with discrete physical locations, the problem is partially solved. AWS further has services that backup organizational data, in the wake of **natural disasters**, organizations can restore their data from restore points. This challenge in AWS is strongly mitigated by the **reliability** philosophy as stated in the preceding chapters. Best practices such as automatic recovery as well using the multiple availability deployment model ensures that, in the instance of a natural disaster at one availability zone, your organizational resources will still be available at the other availability zone.

5.5.4 Cost optimization

The cost of technology has always been high. However, AWS provides a significant return on investment. The initial cost of adopting to the cloud may seem high, but in the long run that cost has a significant return on investments, saves time and resources used in establishing organizational own servers. The AWS cost **optimization pilla**r as elaborated in chapter four, provides the best practices to be practiced to enable organizations save cost in the cloud. Among the best practices are adopting a consumption module in the cloud which means organizations only pay for only the resources they require and these resources can be increased or reduced when needed. Another best practice to mitigate against the challenge of cost of technology is the heavy provision of technology infrastructure provided by AWS, thereby allowing organizations to focus on the their key value propositions and customers rather than on IT infrastructure.

5.5.5 Operational challenges and errors.

One of the established challenges facing digitalization was operational errors digital platforms. Again, the AWS philosophy of operational excellence, mitigates and reduces this challenge. AWS uses design principle such as performing operations as a code. Human factor is reduced and eliminated as much as possible. Again, workloads can be designed to make small frequent changes and these changes can be reversed in AWS without affecting the customers and users of the product.

6 Conclusion

The purpose of this thesis was to establish the importance of digitalization and present the various challenges organizations face in digitalization and digital products. The thesis further was to introduce computer cloud and its advantages. The final goal of this thesis was to show how AWS as a platform could mitigate against the various challenges associated with digitalization and the digital environment.

This chapter will review the research questions and show how the objectives of the thesis have been met. This chapter will also further review my thoughts for further development and present a reflection on my learning's during the thesis project.

The research questions identified for this thesis were;

1. Find out what digitalization was and to investigate the various challenges associated with.
2. To find out what was the cloud and its advantages.
3. To find out how AWS solved the various problems associated with digitalization.

The first research question of what was digitalization was clarified in the second chapter. It was established that the concept of digitalization is not a new term and has been around for several decades. However, the definition of the term varies from various sources and the broad nature of the term digitalization is used interchangeably with various others terms such as e-business or digital business. That notwithstanding the common denominators of the definition of digitalization was leveraging technology and enabling organizations reach out to a wider market.
The chapter further presented a road map for digital transformation and presented some enabling factors that help organizations during digital transformation.
The chapter further presented the basic infrastructure needed for digitalization. The chapter further outline the main challenges facing digitalization forming the critical research question for the thesis. Establishing the challenges facing digitalization forms an integral part of this thesis report.

The second research question, what is the cloud and its advantages, was answered in the third chapter (cloud computing services). The introduction of the various cloud models and services was presented as part of the literature review for the stated research question. The chapter went on to present the various advantages the cloud had over traditional pre-cloud era.

The third research question, what is AWS and how does it solve the various challenges associated with digitalization was answered in the fourth and fifth chapters. The fourth chapter sought to introduce AWS and its working philosophy along with its best practices. To recap the main philosophy of AWS is based on 5 principles or pillars. These principles;

- Operational Excellence
- Security
- Reliability
- Performance Efficiency
- cost optimization.

The fifth chapter also sought to present digital solution architecture in AWS that solved the challenging problems embedded in digitalization. Among the various challenges facing digitalization, the core problem was ensuring reliability of the product at all times. The problem of reliability of the digital product was most common through the various stated challenges in the second chapter (Digitalization) as the thesis sought to establish the various challenges of digitalization. To reiterate various challenges facing digitalization in organization were;

- Security violations
- Software challenges
- Hardware challenges
- Human /Operational Errors
- High cost.

Again, the working philosophy of AWS seeks to mitigate against the various challenges facing digitalization and digital space as shown through the various chapters.

Technology continuous to evolve and thus organizations must similarly provide the necessary management for evolving. The organizational philosophy of AWS addresses changing technology and are committed to providing solutions and services that meet current evolving situations and challenges.

6.1 Further development

It has been a rewarding journey to deepen my understanding of digitalization and the cloud and the rewards and benefits of the cloud. The concept of digitalization although being present for many decades still is in a very young age and not all the rewards and challenges are fully appreciated.

A further development in the line of this thesis will be to see how other cloud vendors solve the similar problem facing digitalization and the digital cloud. Example the other market leaders in the cloud space Azure and Google.

6.2 Reflecting on my learnings.

I am currently preparing for a career in the cloud space. Although my work experience is in IT, cloud adaptation is now seeming to be the new path for many companies. This thesis, has thrown light and introduced me to AWS and its cloud services.

It has been a challenging but rewarding task exploring different resources and deepening my knowledge on digitalization and the cloud.

6.3 Validity and Reliability

The thesis has been done following a method most suitably close to the case study approach. In qualitative research , validity can be informed by evaluating the results of the thesis as against the research questions. The outcome of the thesis answers the various research questions presented in the thesis.

Reliability can also be informed by questioning if the derived outcome would be same should the thesis should have been conducted by another candidate. The literature reviewed and models analyzed in this thesis will most probably lead to the same outcome.

To increase the reliability and validity of this thesis more literature and diverse sources should have been reviewed.

At the end of this thesis, it is to be noted that many companies are seeking a presence on the cloud to resolve the various understated challenges facing the digital environment. This study can give a direction to such companies by giving an introduction in context to the current market leader in the cloud space.

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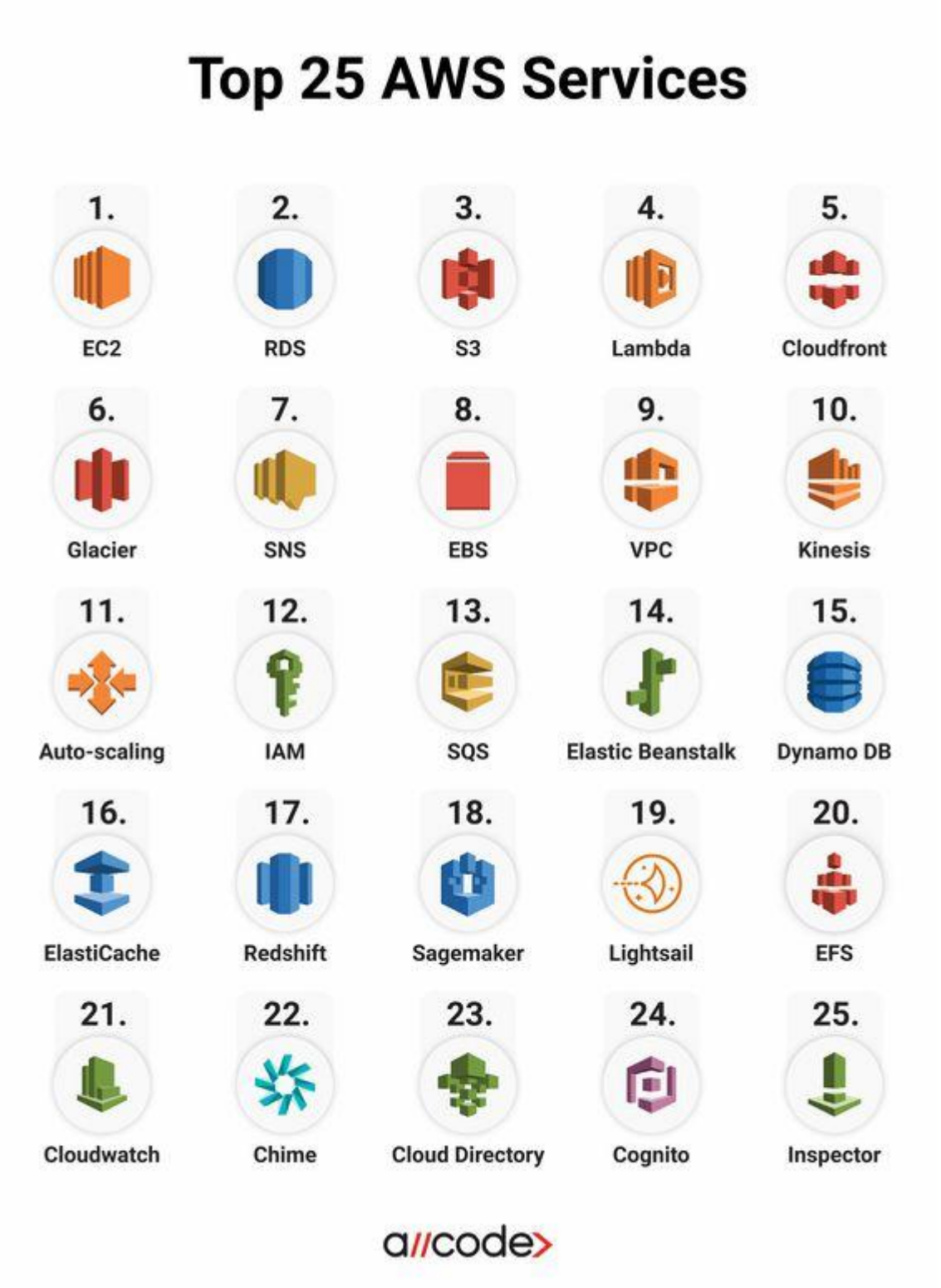
Appendix 1. Top 25 AWS Services



Appendix 2. Gartner Scorecard for AWS Services Iaas and Paas