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by SUJAN SHRESTHA .

ASSIGNMENT

TECHNOLOGY PARK MALAYSIA

CT097-3-3-CSVC

CLOUD INFRASTRUCTURE AND SERVICES

NP3F2304IT

HAND OUT DATE: AUGUST 2023

HAND IN DATE: OCTOBER 2023

WEIGHTAGE: 50%

INSTRUCTIONS TO CANDIDATES:

1   Submit your assignment at the administrative counter.

2   Students are advised to underpin their answers with the use of references (cited using the Harvard Name System of Referencing).

3   Late submission will be awarded zero (0) unless Extenuating Circumstances (EC) are upheld.

4   Cases of plagiarism will be penalized.

5   The assignment should be bound in an appropriate style (comb bound or stapled).

6   Where the assignment should be submitted in both hardcopy and softcopy, the softcopy of the written assignment and source code (where appropriate) should be on a CD in an envelope / CD cover and attached to the hardcopy.

7   You must obtain 50% overall to pass this module.

Acknowledgement

To complete this project, I needed the assistance and guidance of some well-known individuals, and I consider myself quite fortunate to have had such consistent for the completion of our work I would like to thank **Asia Pacific University (APU) and Lord Buddha Education Foundation (LBEF)** for giving me this wonderful opportunity to transform my knowledge and ideas into theoretical concepts and practical implications.

I also want to express my sincere gratitude to the course lecturer, Mr. **Manish Bhattarai** sir, for giving me all the instructions I needed to do my work. Without his entire support, active direction, and encouragement, this study effort would not have been possible.

Finally, I would want to thank my faculty members who have directly or indirectly assisted me in obtaining the ultimate consequence of assignment by transmitting critical information.

Yours Sincerely,

Sujan Shrestha (NP000611)

BSc.IT

Table of Contents

Table of Figures

1 Introduction

In this evolving landscape of IT enterprises and organizations, one of the emerging technologies has been cloud technology, which is a powerful force, offering on-demand self-service, expensive network access, rapid scalability, resource pooling and other measurable service outcomes. It's within these services that current IT organization's journey unfolds. Currently in this assignment our focus is on the Example Social Research Organization, a fictional non-profit which plays a pivotal role in the realm of social science research, offering valuable gateway to ensure a source of global development data, encompassing critical metrics like life expectancy trends over the past decade. This data is readily accessible to researchers through the organization's dedicated website.

At the helm of this initiative, there is Shirley Rodriguez who is a diligent researcher in this organization involved in development of the website as a conduit for dispersing invaluable data resource. To ensure seamless data access, Shirley has leveraged a MySQL database followed by a PHP-driven webpage. However, the website found its digital way with a commercial hosting service and as its popularity is rising, it has discovered numerous challenges and obstacles. End-users began registering various complaints regarding the sluggish and slow website responsiveness, there was even an attempt at a ransomware security breach, although it was ultimately fought.

Recognizing the pressing need for a more robust and secure hosting solution, Shirley ventured into Amazon Web Service (AWS). Her website has found a new way as Elastic Compute Cloud (EC2) instance, situated within a public subnet. And this is where our team comes into play with the task of completing the migration into more secure implementation to ensure the accuracy and security of data returned by the query page.

1.1 Aim

The project aims to enhance the Social Research Organization's website by migrating to Amazon Web Service (AWS), with a focus on improving security, performance, and scalability. The goal is to offer social science scholars with a dependable source of vital world-wide development information.

1.2 Objectives

Here are the major objectives to meet the aim by our team:

- Design a solution to securely store sensitive data and ensure security and accuracy of the data returned by query pages.
- Identify and recommend AWS services such as Amazon RDS and its associated backups for secure hosting of the MySQL database, mitigating potential data loss.
- Develop a strategy for secure administrative access implementation using AWS Identity and IAM to control and monitor administrative privileges.
- Propose data migration techniques utilizing AWS Database Migration Service for transferring data from existing environment to AWS securely.

1.3 Scope

The project's scope is to enhance the security and scalability of Social Research's website infrastructure along with the availability using AWS resources, including AWS Elastic Compute Cloud (EC2), Amazon Relational Database Service (RDS), AWS System Manager, Auto Scaling and Virtual Private Cloud (VPC). Key aspects of the project include:

1.3.1 Design and Planning:

Conduct a assessment on security of the current website architecture in order to design and plan more secure and reliable architecture.

1.3.2 Infrastructure Migration to AWS:

Migrate the website and database from current plan to AWS.

1.3.3 Security Enhancement:

Implementation of security measure following best practices of AWS including different services such as AWS Identity and IAM for user access control, AWS Web Application Firewall for protection against web attacks, and regular security patching for EC2 instances and RDS.

1.3.4 Performance, Availability and Scalability Optimization:

Perform fine tuning of EC2 instance settings for optimization of website's performance, separate the database for MySQL using Amazon RDS for improved Scalability and performance, utilize AWS Elastic Load Balancing for traffic distribution and enhance other features.

1.3.5 Testing:

Test the architecture to ensure all the requirements are met and verify the aims and objectives.

1.3.6 Monitoring and Testing:

Continuously monitor the security, availability, and performance of the AWS-hosted infrastructure, to ensure ongoing processes behind the new architecture works properly.

2 Basic Terms of Cloud Service

2.1 Cloud Computing

Cloud Computing, a service that delivers different computing services such as servers, database, storage, networking, software, analytics, and intelligence, all these over the internet which we can refer to as cloud to make the resources flexible and enhance faster innovation and economics of scale. It is being vastly discovered by different organizations nowadays as it provides several alternatives now, starting with the fundamentals like storage, networking, and computing power to advance services such as natural language processing and AI integrations (Ranger, 2022).

Cloud Computing can further be classified using different service models as below:

Figure 1: Different Cloud Service Models (Elbe, 2021)

2.1.1 Software as a service (SaaS)

The SaaS vendors host the applications ensuring its availability to the users through the Internet.

2.1.1 Infrastructure as a Service (IaaS)

Ones who are not encouraged to operate data centers in their own area or premises use this service as IaaS gives them access to virtual computing resources through the medium of internet.

2.1.1 Platform as a Service (PaaS)

PaaS offers developers with an access to a platform to deploy their developed applications over the internet (Rosencrance, 2021).

2.2 Virtualization

Virtualization technology is the technology on which cloud computing is based on. Cloud allows users to build and run their own servers, and resources can be obtained by building multiple instances of the cloud. Virtualization allows cloud providers to create several virtual instances or computers capable of running on a single service and enables resource minimization. This simulated multiplication of resource utilization through multiple virtually simulated instances increases the efficacy and productivity if professional requirement (Menon, 2023).

Diving deep into the topic of virtualization, there are numerous types of virtualizations which are listed below:
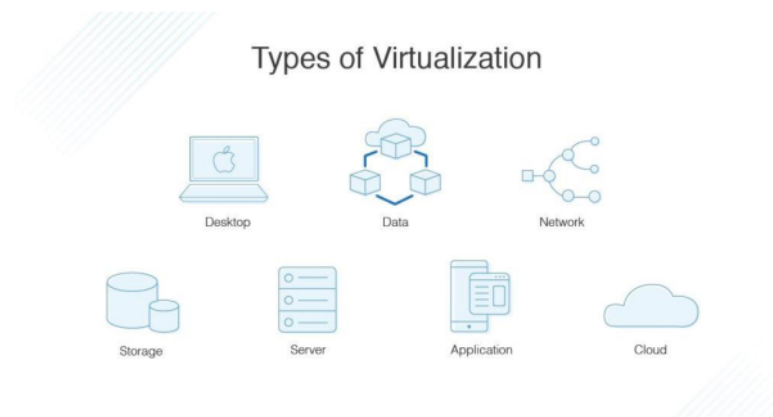
Figure 2: Types of Virtualizations (Kramer, 2019)

- Desktop virtualization
- Network Virtualization

- Storage Virtualization
- Application Virtualization
- GPU virtualization
- Cloud Virtualization

2.3 Amazon Web Service

AWS, short for Amazon Web Services, is a platform and storage service that provides organizations with a medium to securely store their important data and access different kinds of services through APIs. Amazon, the parent company of AWS, maintains a global chain network of data centers, making it a preferred choice for most organizations around the world. In fact, according to different reports, Amazon commands nearly 50% of the $32 billion public cloud infrastructure market. AWS extends its services to thousands of customers across more than 190 countries (Arora, 2023).

2.3.1 Global Infrastructures

At the core of AWS's infrastructure lies the AWS Region and Availability Zones. An AWS Region represents a distinct geographic area where multiple Availability zones are situated. Each zone comprises separate and differential data centers. These Availability Zones offer a unique advantage by allowing different organizations to run their critical databases and applications with enhanced fault tolerance, availability, scalability, and security (Bandaru, 2020).

2.3.2 AWS's Overview

2.3.2.1 Storage Service:

AWS provides an indigenous way with rich array of storage solutions for data storage, encompassing Amazon S3 (Simple Storage Service), Amazon EBS (Elastic Block Store), and Amazon Glacier for long term data archiving, among others.

2.3.2.2 Compute Services:

AWS also offers a comprehensive suite of computing resources, including Amazon EC2 (elastic Compute Cloud) for flexible server provisioning. AWS Lambda for serverless computing and so on.

2.3.2.3   Networking Services:

Aws expands networking capabilities with services like Amazon VPC (Virtual Private Cloud), which creates isolated network environments, and Amazon Route 53, which manages DNS (Domain Name System)

2.3.2.4   Identity and Security

Identity management, encryption, and security monitoring are all important parts of security and identity management. Aws provides solutions for these issues through services like Aws identity and Access Management (IAM) and AWS Security Hub.

2.3.2.5   Serverless computing:

AWS Lambda gives programmers the ability to run code without worrying about server administration, making it the ideal solution for scalable, event-drier applications.

2.3.2.6   Edge Computing:

AWS offers services like AWS Outposts and AWS Wavelength to bring cloud services loser to the network's edge decreasing latency for crucial applications.

3 Proposed Solution Architecture

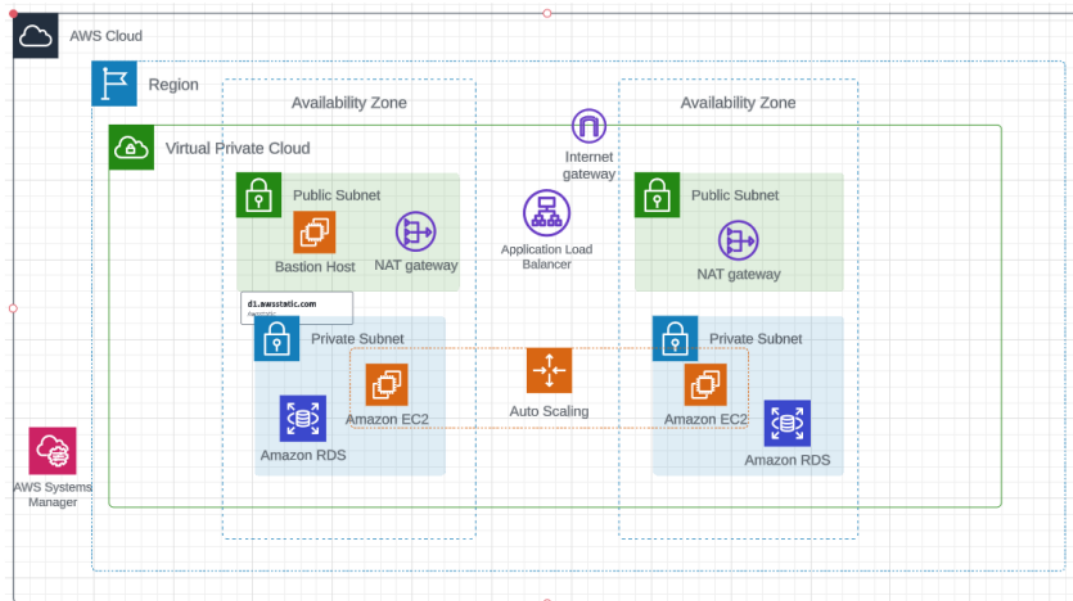## 3.1 Sample Architecture Diagram for AWS

Figure 3: Architecture Structure Diagram for AWS

Link to the above architecture diagram: https://lucid.app/lucidchart/0399a5c7-f66d-411b-b028-d446ea1baf09/edit?viewport_loc=8%2C-164%2C1984%2C974%2C0_0&invitationId=inv_3d04cd99-8cdb-41fd-98ce-3cffcd5b61cc

In the above architecture, it is basically divided into two Availability Zones (AZs), isolated from each other to improve toleration of faults and errors. In each Availability Zone, there are different public and private subnets. In the public subnet, the Application Load Balancer (ALB) and other resources that requires access via the internet are housed and resources like Amazon EC2 instances and Amazon RDS instances that needs to be reachable from within the VPC but not internet are included in private subnets. The Bastion Host, a dedicated EC2 install is utilized in order to safely access the private subnet from the internet. The private subnet's EC2 instances can access the internet thanks to the NAT Gateway without needing directly exposed to the public internet. By automatically starting and stopping EC2 instances according to the demand, the application's availability is made sure by Auto scaling group.

4 Services Used

4.1 Amazon EC2

Amazon EC2 generally referred to as Amazon's Elastic Compute Cloud is a cloud computing solution that gives you secure, scalable computing power. It is meant to simplify web-scale virtualization for developers. This is an easy-to-use interface that makes it possible for enterprises to acquire and set up capacity where they will have control over their computer resources and are able to test computing environments quickly and easily. Organizations can quickly ramp up capability when computing calls for change by reducing the amount of time required to acquire and boot more instances of servers from hours to minutes with the support of Amazon Web Services (AWS) EC2. Amazon EC2 transforms this computing economics as it allows organization to only pay for the capacity that is really required by them (Misk, 2013).

4.2 Amazon RDS

Amazon RDS, or Amazon Relational Database Service, is a cloud-based service that makes it possible for simpler setup as well as faster running and scalability of relational databases on the internet. As a cloud-based database service, Amazon RDS is a service that performs conventional database-related tasks and provides affordable, expandable capacity for an industry-standard relational database that's easy to manage. This streamlines the setup and process through the elimination of time-consuming manual labor, enabling the team to focus more on the application (G., 2018).

4.3   Amazon Elastic Load Balancer

Elastic Load Balancer (ELB) is a cloud-based AWS service that intelligently allocates incoming traffic from an application to a variety of targets and virtual devices across a variety of availability zones (AZs). Incoming loads will be split among a large number of targets, including EC2 instances, containers, and IP addresses across a number of Availability Zones. Elastic Load Balancer further maintains track of the health of registered targets by analyzing and redirecting traffic to the ones that are in a good state of health. Elastic Load Balancing is able to modify load balancer capacity as a result of incoming traffic. (Mangayarkarasi).

4.4   AWS System Manager

A service that offers a browser-based interactive shell, CLI and browser-based remote desktop access for management of instances in cloud, premises, and edge devices without the need to open inbound ports, manage Secure Shell (SSH) keys, or employ bastion hosts. AWS System Manager is also known as SSM where users can execute remote commands without managing SSH and automate operations across the AWS resources. AWS System Manager aids in maintain the security and compliance by scanning the managed nodes (Gaur, 2023).

4.5   Auto Scaling

Auto Scaling is an Amazon service that helps organizations to maximize their utilization and cost efficiency to manage payment as per organization's utilization of resources that they actually need. AWS Auto Scaling will automatically eradicate any extra resource capacity when demand declines which saves a certain amount for organization. It is a cost-free service that enables organization to reduce their expense associated with their AWS setup (SentinelOne, 2021).

4.6   Virtual Private Cloud (VPC)

Amazon Web Service provides a great service with the use of which organizations are allowed to start up AWS resources in a private predefined virtual network logically separated with Amazon Virtual Private Cloud (Amazon VPC). There is a significant advantage of using Amazon VPC as it allows use of the scalable infrastructure of AWS while closely resembling a network that is conventional where organization can operate their own data center. The utilization of Amazon VPC means logically isolating from other networks where subnets, gateways and security groups can be configured as well as selecting an IP address range for the VPC (Vacca, 2017).

5 Possible Solutions

5.1 Availability

Several solutions have been explored and developed to address the issues that were previously stated by Shirley of her website to ensure the dependability, responsiveness, and resilience of the website while utilizing AWS service.

5.1.1 Amazon ELB (Elastic Load Balancer)

Distributing traffic among numerous EC2 instances in various Availability Zones adds a layer of availability and fault tolerance. The website is still available to browse even if there exist problems in particular Availability Zones.

5.1.2 Disaster Recovery Plans:

To build reliable disaster recovery plans, AWS Backup and AWS VPN are combined. Even in the face of foreseen circumstances, this tactical combination makes sure that data recovery and availability are given priority.

5.1.3 Amazon EC2 Scalability

By using automatic resource scaling and various Availability Zone deployments, EC2 instances can withstand traffic spiked without going offline, providing customers with high availability.

Multi-Availability Zone Replication:

The database is replicated across various Availability Zones when Amazon RDS Multi AZ is used. This redundancy ensures that even if one Availability goes down, the database will still be accessible.

5.1.4 Virtual Private Cloud (VPC)

Resources can be launched through virtual networks from a logically isolated area of the AWS cloud called a VPC. By enabling organizations to create their own network topology, set up routing, and manage traffic flow. It offers network level security to make the resource secure as organizations will be able to configure VPC subnets, security groups, and Network Access Control Lists (NACLs).

5.2 Scalability

5.2.1 Amazon EC2 Auto Scaling:

Utilizing Amazon EC2 Auto Scaling enables instances to be automatically adjusted based on changes in traffic, improving both performance and cost-effectiveness in accordance with AWS-recommended standards.

5.2.2 Amazon RDS Database Replicas:

It is advised to use Amazon RDS to create database replicas to accommodate increased read loads to improve scalability while maintaining effective database operations. This replica of database will help in smooth scalability of database operations with certain improvisations.

5.2.3 Auto Scaling:

Using Auto Scaling to flexibly change the number of EC2 instances in response to traffic demands is in line with AWS best practices for scaling.

5.2.4 Serverless Option:

AWS Lambda: When employing serverless computing. Considering the use of AWS Lambda will automatically scale the handling process of the workload, to offloading of specific tasks or operations from organization's PHP application. This lessens the requirement for traditional servers to be managed.

5.3 Security

5.3.1 Secure Configuration of Amazon EC2 instances

A core AWS best practice for preventing security threats and data breachers is to guarantee the secure configurations and ongoing administration of Amazon EC2 instances.

5.3.2 Amazon RDS Security Features:

Utilizing the security features of Amazon RDS, such as encryption, database authentication and access controls, strengthens the security of database and its contents while adhering to the security procedures advised by AWS.

5.3.3 Security Management and Automation (AWS System Manager)

AWS System's Manager's role in automating and managing security tasks efficiently aligns with AWS. practices for enhancing overall security. Automation of security operations including patch

management, compliance monitoring, and system setup is possible with AWS system manager. Utilizing these automation technologies can improve overall security posture and expedite security management.

5.3.4   Encryption

For data encryption in Shirley's database, utilization of the AWS Key Management Service (KMS) would be perfect. Additionally, enforcement of SSK/TLS encryption for information travelling between the database and query page or PHP application can be implemented.

5.3.5   Access Control (AWS IAM)

IAM Roles: Utilization of the least privileged concept to define IAM roles. For instance, only grant EC2 instances the access rights necessary to the AWS Systems Manager Parameter Store.

5.3.6   Amazon Web Application Firewall (WAF)

WAF Rules: To filter and block harmful traffic, set up AWS Web Application Firewall (WAF) rules. Design the WAF rules in such a way to stop cross site scripting (XSS) attacks or SQL injection and other harmful attacks.

6 Data Migration

6.1 AWS Database Migration Service

When it comes to Data Migration, one of the services provided by AWS, that is AWS Database Migration Service can be implemented. AWS Database Migration Service is an Amazon Web Services (AWS) service enabling transitioning between data from relational databases to data warehouses, NoSQL databases, and a variety of other kinds of data storage. AWS DMS allows data to be moved into the Amazon Web Services (AWS) cloud from both cloud-based and on-premises setups. Using AWS Database Migration Service can be very beneficial as it is a robust and reliable tool capable of streamlining the process of database migration to AWS Cloud smoothly (AWS, 2021).

In the context of Example Social Research Organization, transition of their MySQL database to Amazon RDS can be made smooth with AWS DMS. With the help of AWS Database Migration Service, the source MySQL database can be connected to Amazon RDS instance. This will allow our team to configure the replication endpoints, where the target Amazon RDS instance and the information regarding the source MySQL database are both provided. Processes like data extraction, transformation, and loading (ETL) from the source to the target will be performed by DMS after it is configured. AWS Database Migration Service can carry both full load and ongoing replication in order to make sure that the data is constantly synchronized between the source and Amazon RDS.

6.2 Amazon RDS (Relational Database Service)

As previously stated, Amazon RDS is a web service that simplifies the setup, operation, and scaling of relational databases. Because Amazon RDS is a type of database managed service, it is capable of handling the common database management process and services affordable and scalable capacity for a relational database that is of industrial standard. This is beneficial to organizations as it eradicates tiresome manual processes and allows organizations to concentrate more on the application.

In the context of Example Social Research Organization, the Amazon RDS compliments the migration process of MySQL database of organization as it offers a fully managed environment that is dependable, scalable, and high performance for database operations. For Example, Social

Research Organization, RDS will provide a MySQL database engine that has been tuned for hosting research statics data. After the creation of RDS instance, the company can customize it by configuring and changing the instance type, storage options and security settings that suit the unique requirements of the Example Social Research Organization's website. Utilization of Amazon RDS will relieve the organization of the operational strain by handling the database administration duties which contains backups, patching and maintenance. To control the flow of website's traffic, it can simply be scaled up and down in order to interface other AWS services easily. Amazon RDS ensures data integrity and availability as it provides encryption options and strong security controls in order to protect the sensitive research data, Switching to Amazon RDS will allow firm to gain more responsive and secure database which eventually improves the functionality of their websites and offers an effective platform for retrieving statistical data.

6.1.1 Migration of MySQL database to Amazon RDS steps

- SQL Dumping process often starts with SQL Dump file which often contains .sql file extension which contains database structure and data. Typically, this file is created through MySQL utilities.
- Export a SQL dump of the existing database from your current hosting environment.
- Create an IAM role with permissions to access the Simple Storage Service (S3) bucket where you will store the SQL dump.
- Upload the SQL dump to an S3 bucket.
- Use the AWS Database Migration Service (DMS) or a custom script to import the SQL dump into the AWS RDS database.
- Ensure the necessary database configurations (e.g., schema, tables, indexes) are set up correctly.
- Update the PHP website's database connection settings to point to the new AWS RDS database.

7 Conclusion

Our team has successfully created and transferred the Example Social Research Organization's website to AWS cloud with a more detailed plan and architecture. The plan and architecture were created by keeping our aim and objectives in mind to meet all requirements of the project which was to ensure the availability, security and scalability of the organization's website and data. In this architecture, various Amazon Web Services have been utilized such as Amazon RDS, Amazon DMS, VPC, Amazon WAF, Amazon EC2, Amazon ELB and many others. These various services were planned and designed to ensure the migration of the PHP based website and MySQL database to Amazon cloud was smooth. These services will ensure the security and scalability of the website as they enforce more robust, reliable and a secure platform for the organization's website to operate.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

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Article Error You may need to use an article before this word. Consider using the article **a**.

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Possessive

Article Error You may need to use an article before this word.

Possessive

P/V You have used the passive voice in this sentence. You may want to revise it using the active voice.

Article Error You may need to remove this article.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.