Cloud Computing

Mid-term Project Documentation

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1. **Executive Summary**

This project involved developing of cloud-based file sharing application using various services from Google Cloud Platform such as: Google Compute Engine (Virtual Machines), Google Cloud Storage, Google Cloud VPC (Virtual Private Cloud), Google Cloud Identity and Access Management (IAM). As a result, all the objectives was achieved and the project gave the opportunity to gain experience in working with cloud technology in practice.

2. Introduction

Clouds are natural evolution of traditional data centers with the main difference in utilizing resources as standards-based Web services and "utility" pricing model where customers are charged based on their utilization of computational resources, storage and transfer of data. They offer subscription-based access to infrastructure, platforms, and applications that are popularly referred to as IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and SaaS (Software as a Service).
Google Cloud Platform is one of the platforms that offer solutions in cloud computing with optimal prices and full documentation for its tools, that is convenient to use for beginners in cloud computing. Moreover, the user interface of the platform allows intuitively navigate within the tools and configure necessary objects without knowing specific language or principles, that makes deployment process more understandable.
In addition, GCP is well known for its global presence of data centers, networks and cloud services.

3. Project Objectives

- o Set up and configure virtual machines using Google Compute Engine.
- o Deploy the backend of the file sharing application on a VM, ensuring proper resource allocation and scaling options.
- o Implement file storage using Google Cloud Storage.
- o Design a system for uploading, downloading, and managing files, ensuring efficient storage use and access.
- o Create a Virtual Private Cloud (VPC) to manage networking for the application.
- o Configure firewall rules and load balancing as necessary to optimize performance and security.
- o Implement Identity and Access Management (IAM) to control user permissions and roles.
- o Ensure secure data transmission and storage using best practices for encryption and access controls.

4. Cloud Computing Overview

Vaquero et al. [2] have defined clouds as "clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized Service Level Agreements."

The principles of cloud computing are the foundational concepts that make it possible to deliver scalable, flexible, and on-demand services using models such as:
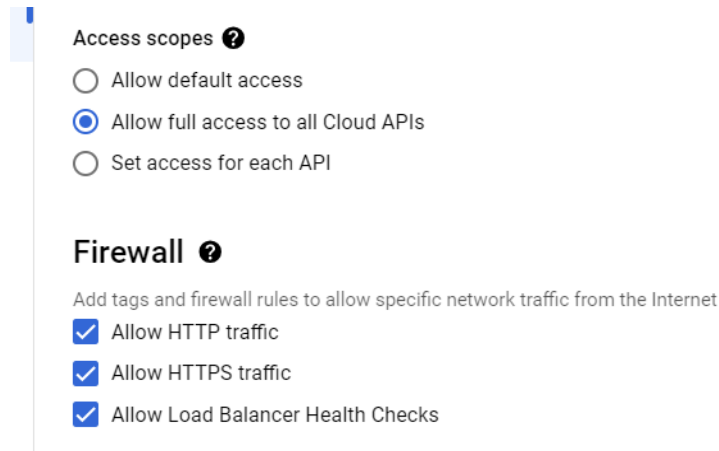
1. Infrastructure as a Service (IaaS) is the model of offering virtualized resources on demand. Resources such as computation, storage and communication.
2. Platform as a Service (PaaS) – Is the approach to offer higher level of abstraction to make a cloud easily programmable. Basically, platforms offer an environment on which users create and deploy applications and do not necessarily thinking about resources the application will use. Programming models and services offered as building blocks.
3. Software as a Service (SaaS) is a model when applications reside on the top of the cloud stack. Services provided by this layer can be accessed by end users through Web portals. Therefore, consumers are increasingly shifting from locally installed computer programs to on-line software services that offer the same functionality. Traditional desktop applications such as word processing and spreadsheet can now be accessed as a service in the Web.

5. Google Cloud Platform: Core Services

Google Compute Engine (Virtual Machines)
Google Cloud Storage
Google Cloud VPC (Virtual Private Cloud)
Google Cloud Identity and Access Management (IAM)
BigQuery
CloudSql
Cloud Run
Vertex AI platform

6. Virtual Machines in Google Cloud

1. Navigate to Compute Engine component in Google Cloud Console and create instance.
2. Configure with the parameters required for the project.
   I have chosen default configurations to keep low cost but allowing full access (figure 1.)
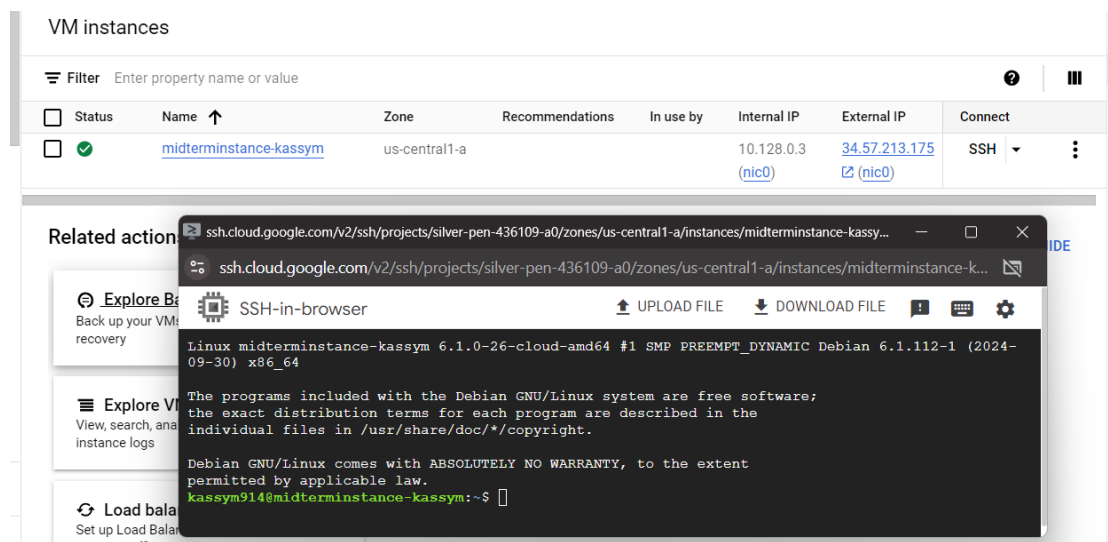
Figure 1.

3. Connected to the VM via ssh (figure 2.)

Figure 2.

4. Built basic Node.Js app in cloud shell (figure 3., figure 4)

```
kassym914@cloudshell:~ (silver-pen-436109-a0)$ npx express-generator --view=ejs midtermapp

   create : midtermapp/
   create : midtermapp/public/
   create : midtermapp/public/javascripts/
   create : midtermapp/public/images/
```

Figure 3

```
kassym914@cloudshell:~/midtermapp (silver-pen-436109-a0)$ PORT=8080 DEBUG=midtermapp:* npm start

> midtermapp@0.0.0 start
> node ./bin/www

  midtermapp:server Listening on port 8080 +0ms
```

Figure 4.

5. Created firewall rule to allow traffic to go through port 8080 (figure 5)

← Create a firewall rule

0.0.0.0/0 ✕

Second source filter
None

Destination filter
None

Protocols and ports ❓
◯ Allow all
◉ Specified protocols and ports

☑ TCP
Ports
8080

E.g. 20, 50-60

36109-a0) ✕   + ▾

6. app (silver-pen-436109-a0)$ PORT=8080 DEBUG=midtermapp:* npm start

Figure 5.

7. Connected to the vm through shell (Figure 6.)

Figure 6

8. Installed nodejs figure 7

Fugure 7.

9. Copied app from shell to instance (figure 8.) and started the app (figure 9.)

Figure 8.

Figure 9

7. Storage Solutions in Google Cloud

Cloud Storage allows users to access files from different networks and devices, it's convenient in building of web applications. Moreover, Google cloud storage is very flexible and easy to create and configurate. In the case of applications, it can perform as a file system and it is applicable for backups. Lifecycle management allows to set rules that can minimize memory usage. (Configurations list shown on figure 10.)

Figure 10.

Cloud storage allows you to set up a lifecycle rule that automatically delete objects after certain period of time and also you can configure access controls

8. Networking in Google Cloud

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To create VPC network I chose default configurations and set ipv4 range for subnet
123.123.123.0/25 as shown on figure 11.

subnets. Learn more ⧉

Figure 11.

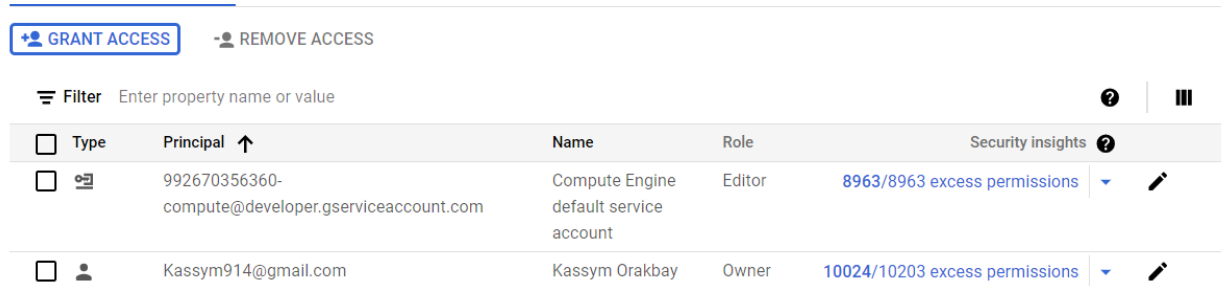VPC provides networking functionality to VM instances, k8s clusters and serverless workloads and makes globally accessible and firewall rules guarantees the security. Example of creation of firewall rule shown on figure 5, it allows traffic on port 8080.

9. Identity and Security Management

Security Measures: Describe the measures taken to ensure data security, such as encryption and access controls.
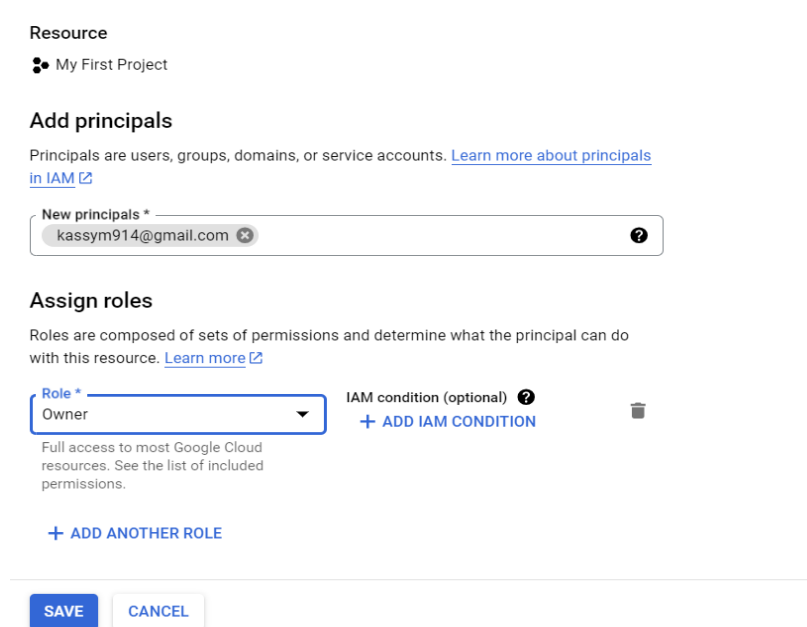
In IAM you can see the users who have access to the project and their roles. Role means the number of actions that user can do within the project (Figure 12.) This allows to configure and control permissions.

Figure 12.

Based on that, you can add or remove access of specific participant (figure 13.) This access controls guaranties data security and prevents unwanted data modifications.

Figure 14.

All the data that is stored in Google is encrypted at the storage layer using advanced Encryption Standard (AES) algorithm, AES-256.

10. Testing and Quality Assurance

To evaluate the correctness of the project on the basic level is better to choose manual testing, where you can go through project and see the every aspect working correctly. However, To test the every piece separately, it's better to use unit test, because, usually cloud projects built on several different tools, that is better test separately. All depends on what type of testing you want to provide (load testing, performance testing and etc.)

11. Monitoring and Maintenance

For the monitoring of the application and state of the whole processes GCP offers Cloud Monitoring tool. Google Cloud Observability provides out-of-the-box dashboards for a wide range of service types, including Google Cloud products like Compute Engine, Kubernetes Engine, Cloud Run, Cloud SQL, BigQuery, and Anthos along with third party integrations like PostgreSQL and ElasticSearch.

12. Challenges and Solutions

During the project I faced different challenges such as week network connectivity, time consuming processes in cloud console and the aspects of usage of different tools in GCP. Experience of the previous assignments helped to handle it and documentation of the tools in Google cloud platform.

13. Conclusion

Project gives the opportunity to fully experience resources given by Google Cloud Platform and helps in understanding principles of working in cloud platform and its difference from traditional approach. Through this project, we've gained practical insights into deploying and managing resources effectively in a cloud environment, equipping us with skills and knowledge that are essential in today's digital landscape.

14. References

1. Cloud Computing principles and paradigms

2. L. M. Vaquero, L. Rodero-Merino, J. Caceres, and M. Lindner, A break in the clouds: Towards a cloud definition, SIGCOMM Computer Communications Review, 39:5055, 2009.
3. Default encryption at rest | Documentation