Research Paper on Cloud Computing Project for Distributed and Concurrent Programming Course

1. Understanding the Key Components of Cloud Computing

Cloud computing has emerged as a powerful technology that offers numerous benefits to organizations, including scalability, flexibility, cost-efficiency, and easy access to resources. Cloud computing has witnessed rapid development in recent years, offering IT infrastructure as a service through the network. This has provided users with an effective solution for building systems and applications according to their specific requirements. With the increasing demand for efficient data processing and storage, cloud computing has become a fundamental component of modern computing systems *(Luo et al., 2016)*. It enables businesses to handle large-scale data quickly and efficiently, making it suitable for processing immense datasets. Cloud computing provides a distributed computing paradigm that combines elements of distributed computing, parallel computing, and grid computing. The purpose of this research paper is to discuss the implementation of a cloud computing project for the "Distributed and Concurrent Programming" course at our faculty.

The project focuses on developing a small frontend application using Angular 15 and a Java Spring backend *(Lei & Shang, 2013)*. The frontend allows users to upload images, which are then stored in a Google Cloud bucket *(Lei & Shang, 2013)*. The backend of the project communicates with various Google Cloud services, such as Google Cloud Storage, Google Cloud Functions or Google Cloud Vision, in order to handle the uploading and processing of the images. The motivation behind this project is to explore the technologies used in cloud computing and understand their practical implementation. Moreover, the project aims to demonstrate how existing services can be reliably deployed and run on a cloud platform while meeting high scalability and availability demands. To achieve this, the project utilizes a Cloud Computing Service Platform based on OpenStack. This platform supports essential features such as service management, auto-scaling, security control, and high availability.

2. Infrastructure as a Service

IaaS forms the foundation of cloud computing, providing virtualized computing resources over the internet. This includes virtual machines, storage, and networking capabilities. By leveraging IaaS, organizations can offload the burden of managing physical infrastructure, resulting in cost savings and improved resource utilization.

3. Platform as a Service

PaaS offers a platform allowing developers to build, deploy, and manage applications without the complexity of infrastructure management. It provides a complete development and deployment environment in the cloud, enabling seamless collaboration and rapid application iteration.

4. Software as a Service

SaaS delivers software applications over the internet, eliminating the need for installation and maintenance. Users can access these applications from any device with an internet connection, streamlining software deployment and reducing operational overhead.

5. Exploring Practical Implementation in the Project

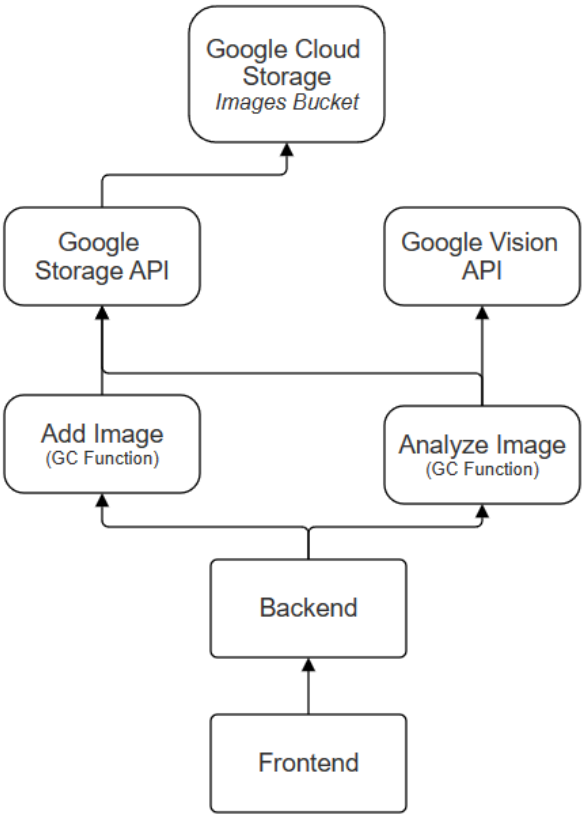
The project delves into the practical implementation of cloud technologies, specifically focusing on the utilization of Google Cloud services. By developing a

small frontend application using Angular 15 and a Java Spring backend, the project showcases the integration of cloud storage and cloud functions to facilitate image uploading and processing. The project aims to provide a web interface where users can upload images. The frontend sends the image to the backend, which then sends it to a service that uses *Google Cloud Vision* to annotate images within *Google Cloud Bucket* with a description based on image content. Additionally, the backend also sends the image to a Google Function, which stores the image in a bucket.

6. Leveraging Google Cloud Services

The integration with Google Cloud Services for storage and processing highlights the seamless interaction with cloud platforms, emphasizing the practical aspects of leveraging cloud resources for data management and computation. This approach not only aligns with the evolving landscape of cloud computing but also provides hands-on experience in harnessing the capabilities of a leading cloud service provider.

7. Diagram



8. References

- Lei & Shang (2013, October): "*The design and implementation of resource monitoring for cloud computing service platform";*
- Luo, Wu, Gopukumar & Zhao (2016, January): *"Big Data Application in Biomedical Research and Health Care: A Literature Review"*