INFT 3043 – Cloud and Concurrent Programming (SP5 2023)

Course	Cloud and Concurrent Programming (INFT 3043)
Name	Gitae Bae
Email	Baegy002@mymail.unisa.edu.au
Identifier	110310861
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Assignment 1: Cloud

Nüber

[Gitae Bae]

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Overview

This task involves creating Nüber (pronounced as "Noob-er"), a personal transportation service similar to Über. Nüber will operate as a crowd-sourced platform with three distinct user roles: system administrators, drivers, and customers who request rides and make payments. Your goal is to design a globally scalable and resource-efficient cloud-based application, and you'll need to provide explanations for the design decisions you make as part of this assignment. The Nüber project is intended to operate on Amazon Web Services as a cloud-based platform. This document outlines the system design of the application, encompassing factors such as privacy, data storage location, security, and storage solutions. Subsequently, it presents the comprehensive architecture of the project, detailing various services to be developed, along with concise descriptions and design rationales for each service. Finally, it offers suggestions for enhancing the application's quality through extensibility and concludes the document.

System Design

Cloud System

1. Global users - Initially, although Nüber is designed for global scalability, its initial release will be focused on serving users in nearby countries such as Australia and New Zealand and then, it will gradually expand into nearby countries such as Indonesia, Malaysia, Philippines, Vietnam, Thailand, China, Korea, Japan, etc., and even into Europe and America countries. The rationale for selecting is their shared AWS Cloud Front infrastructure, which allows for real-time, in-person testing upon the application's launch. Nüber Cloud will offer services wherever there is a demand and often, these services will cater to the specific needs of people residing in the countries where the demand exists. For example, Australia and New Zealand.

2. Changes across time of day - Typically, mornings to nights are considered peak hours, with afternoons being the peak period, while dawn hours are considered off-peak. This pattern also holds true for different days of the week. Notably, weekends witness significantly higher usage compared to weekdays. Drawing from this accumulated experience, statistical data, and analysis, the application can establish a scaling schedule. Since the Amazon Time Sync Service is available across the all-AWS regions, additional changes are not required. 'Amazon CloudWatch' serves the purpose of the 'crash report' functionality within this application. Its primary role is to gather data and analyze app usage trends over time. This analysis is instrumental in determining when to adjust the scaling schedule. AWS Auto Scaling can help your business to maintain foreseeable actions at the cheapest cost. Scheduled scaling is operating automatically only the date and time you specify when the scheduled scaling should occur. In the event that the capacity reaches its maximum threshold, it will automatically increase, albeit at a higher cost. To address this, the system will send notifications to the administrator user, prompting adjustments to the capacity settings.

3. Locality of users versus their data - Amazon Web Services (AWS) offers a swift Content Delivery Network (CDN) service that makes sure secure transportation of data, videos, applications, and APIs to customers worldwide. Additionally, this flexibility empowers organizations to deploy AWS services in alignment with specific regional regulations where they operate, and it gives them the discretion to determine the location for storing and managing their data. 'Amazon CloudFront,' is designed for minimal latency and high data transfer speeds. To ensure global access to applications, AWS Global Cloud Infrastructure is the most secure and reliable choice. AWS control planes and the AWS management console are distributed across various regions, guaranteeing secure operation for a minimum of 24 hours. AWS Support is a worldwide organization with multilingual customer service centers offering real-time assistance via phone or chat. Should customers encounter any issues, they can submit detailed problem descriptions along with screen captures or logs via a Support case. For more critical issues,

enterprise-level customers can engage with Support via chat or phone for immediate assistance. Additionally, the support team employs a screen-sharing tool to provide clearer solutions by remotely viewing customers' screens to identify and resolve problems.
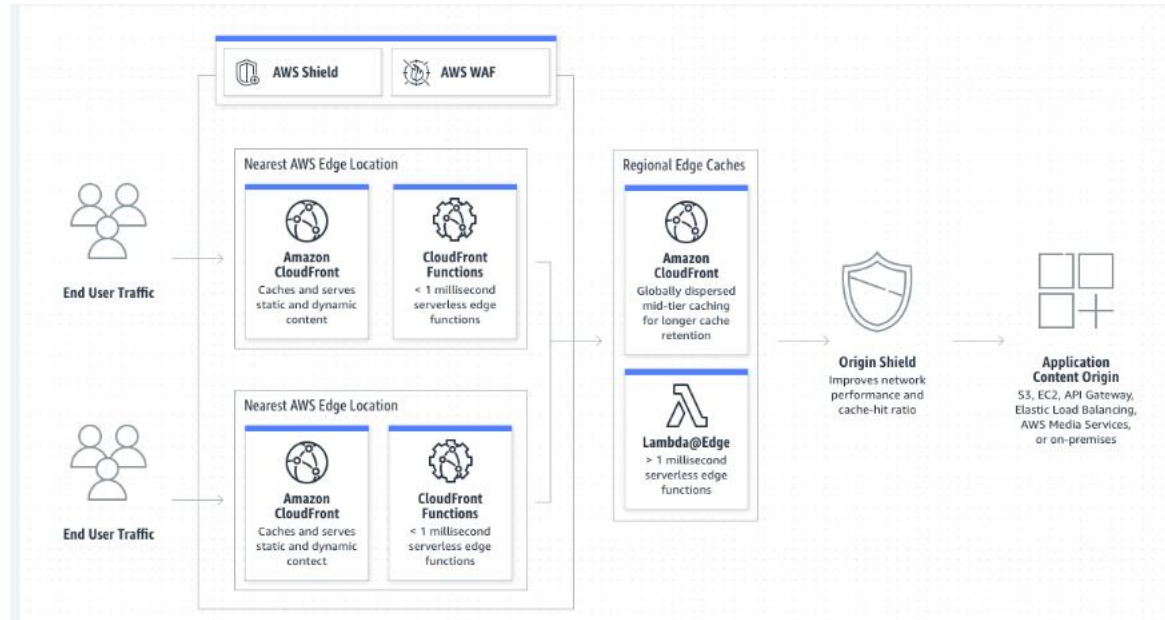

Figure 1: How CloudFront Works

Privacy

This Nüber application does not currently support any other national laws because it is only intended to support laws in Australia and New Zealand. The Australian Privacy Principles (APPs) place restrictions on how personal information is gathered, managed, used, disclosed, and in other way controlled. The Nüber application must clearly outline its data usage practices in its privacy policy and user agreement since it collects personal details during the application process. Additionally, the application requires driver users to upload their driver's licenses for qualification, necessitating a privacy policy and agreement' to be presented during the file upload process or included during the application's signup phase. Any future functionalities that require personal information for service must be communicated to users, who must provide consent. AWS respects user privacy and data security, and it only accesses customer data when legally compelled to do so. Furthermore, the Nüber application intends to utilize third-party APIs, and it will transmit requests and usernames as secure tokens. The project will be hosted on AWS, which prioritizes user privacy and data security. To mitigate risks like account breaches due to shared usernames and passwords, the application will enforce the use of complex and highly secure passwords during the signup process. The General Data Protection Regulation (GDPR) builds guidelines for the collection, processing, and deletion of personal data. In AWS, when dealing with data from Cognito and S3 storage, we must adhere to user requests while also complying with company policies and government regulations. If a user submits a request

for their data to be deleted, the system will automatically delete the user's information; however, in order to comply with legal requirements, certain information will be retained for a period of 90 days. Users have provided information such as phone numbers, email addresses, names, user IDs, user passwords, and photo IDs. This information has been shared for the purpose of accessing the login service, and specifically, the photo IDs have been stored.
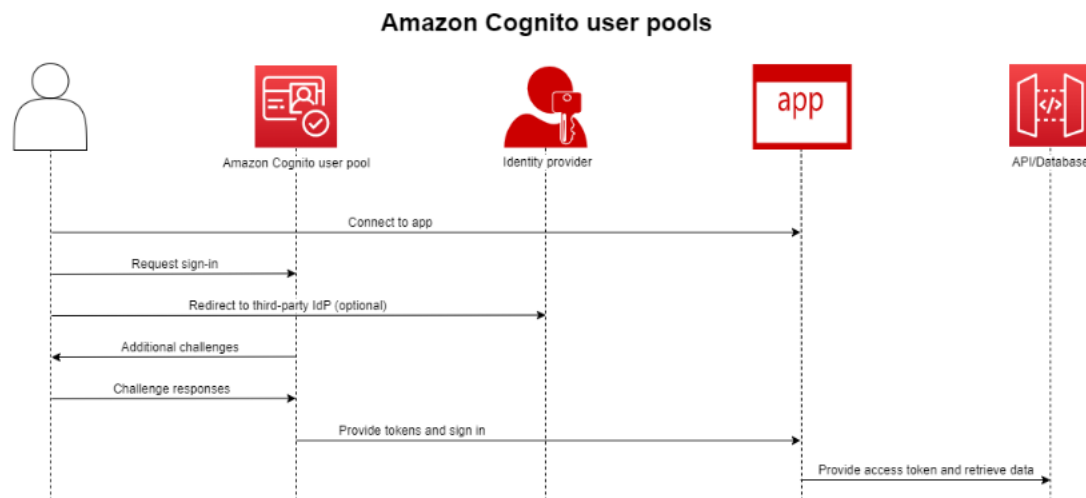

Figure 2: User Pools

Data Locality

Australians and New Zealanders are the application's primary target demographic. It must adhere to New Zealand and Australian (APPs) law for this Nüber application. If the application necessitates the collection of personal information from users for its services, it must provide a privacy policy and agreement during the sign-up process. The location we select plays a crucial role in data storage. If we opt for the USA Virginia region, our data will be stored on servers located in the USA Virginia data center. However, when it comes to meeting the requirements of specific countries, we are obligated to adhere to the data center standards established by the USA. This entails following comprehensive guidelines for implementing the standards governing the physical storage of data in the USA.

Data Security

AWS is obligated to implement reasonable measures to protect personal data. AWS gives a range of services designed to fortify data security against external threats, including:

AWS Identity and Access Management (IAM) is that developers is able to oversee approach to AWS services and resources, allowing them to make user pools and individually assign security credentials such as keys, passwords, and authentication devices. AWS Key Management Service

(KMS) is that developers have the capability to efficiently make and run encryption keys, exercising command over encryption across various AWS services and applications. AWS Secrets Manager: Developers can secure the necessary secrets required to access applications and services. Furthermore, even in the event of a hacker breaching your service, the presence of authentication on your online storage ensures that all personal information and user files remain inaccessible to the hacker, thus enhancing data security. The most effective approach is to proactively deter hackers from infiltrating our systems, but it's equally crucial to have measures in place to prevent data loss. To mitigate data loss, we can implement strategies such as creating backup folders, utilizing multiple S3 data storage instances, and employing EC2 backup instances. However, the paramount concern lies in ensuring the proper segregation of the internal network. It's imperative to establish trust and permission levels between different servers, limiting access rights to the minimum necessary for each entity.

Different external services

'Amazon API Gateway' is a comprehensive service for the effortless creation, publication, maintenance, monitoring, and securing of APIs on any scale. This service plays a crucial role in enabling the application to seamlessly integrate and utilize third-party APIs. We can utilize Cognito, S3 policy systems, and IAM user roles. The initial step involves configuring roles for all three components and establishing roles for both unauthorized and authorized users. This approach enhances data security and restricts access to authorized individuals only.

Breakdown

Figure 3: Cloud AWS Diagram
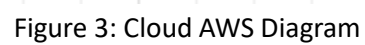
Authentication/user accounts

To support authentication, authorization, and user management in this project, we have selected 'Amazon Cognito.' 'Amazon Cognito' serves as a user management tool that facilitates various features during sign-up and sign-in processes. AWS Cognito enables seamless integration of multiple AWS services with mobile and web apps. It simplifies the management of permissions and access by offering robust authentication and security management, in addition to providing distinct user account services.
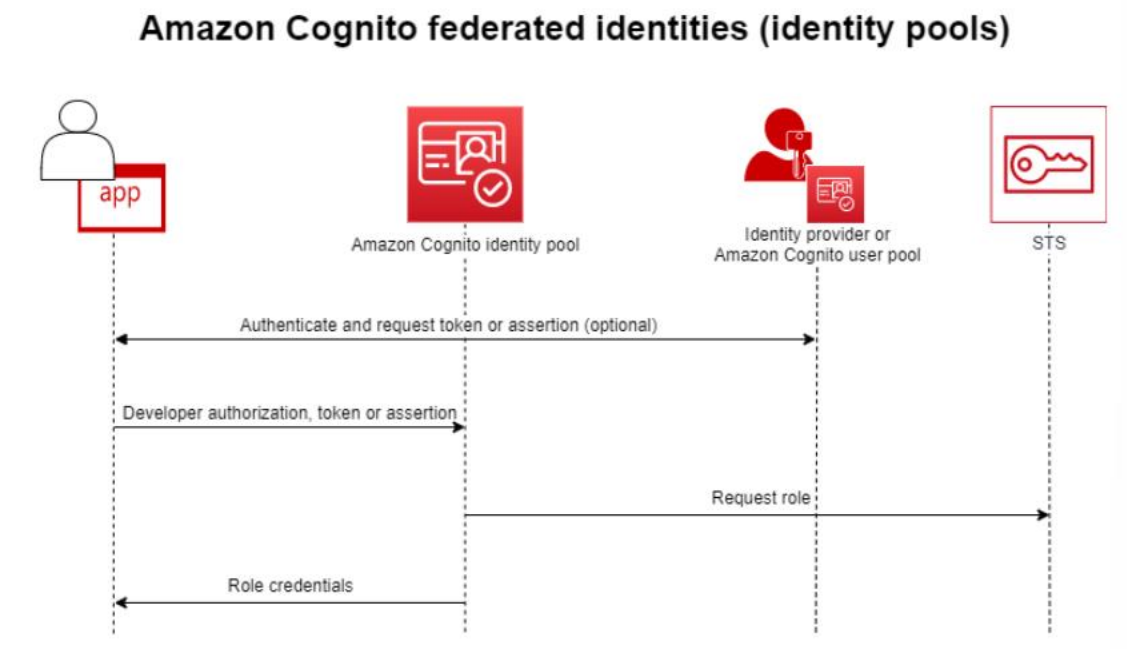

Figure 4: Identity Pools

File upload

To facilitate the file upload functionality in this project, 'Amazon S3' has been selected. We can utilize S3 storage and Cognito for this purpose. These two components are interconnected through the login process and data storage. Cognito facilitates secure driver logins, while S3 storage enables the secure upload and storage of image files. 'Amazon S3,' is a service designed for storing objects offered by AWS 'Amazon S3' delivers scalability, data reliability, top-notch security, and excellent performance. It includes strong permission management features to protect against unauthorized and public access. This is that administrator users with the requisite permissions can regulate the storage location of each file, ensuring secure storage. AWS places the utmost priority on cloud security, taking full responsibility for secure file storage. Regular testing and verification are conducted to ensure the highest standards of security.

Crash reporting

'Amazon CloudWatch' serves as the central repository for consolidating service logs, error codes, and bug codes. 'Amazon CloudWatch Logs' actively monitors applications and systems by collecting log data. It's capable of triggering alerts in cases where a specific bug or error repeatedly occurs beyond a defined threshold. 'Amazon CloudWatch' provides the functionality to create alarms for receiving notifications related to API activity.
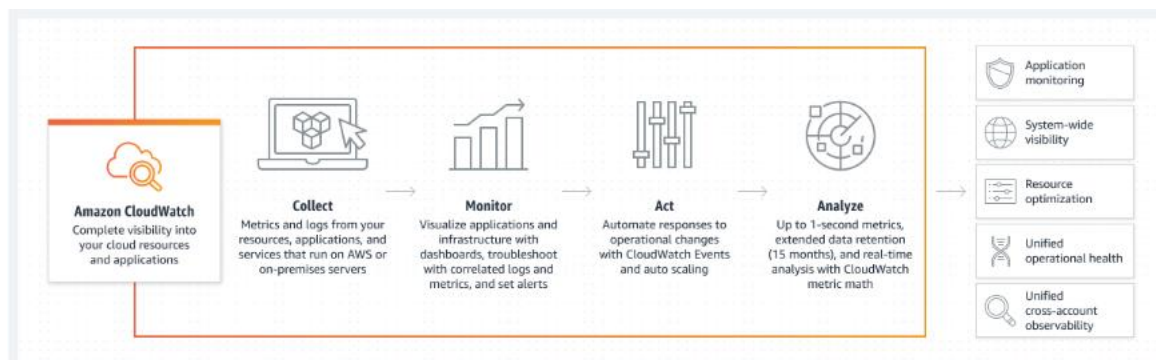

Figure 5: How CloudClock Works

Analytics

To utilize 'Amazon Pinpoint' for the objective of facilitating application analytics and monitoring is a key aspect. Although 'Amazon Pinpoint' is typically known as a marketing communication service, its role in this project entails gathering data from both applications and users. Additionally, communication services will serve to offer events to users. The first involves following application usage. 'Amazon Pinpoint' is able to provide insights into the frequency of overall app usage and individual user engagement statistics. The second focuses on recording departure and destination locations, along with routes. Utilizing data collected from user experiences, this information will contribute to the creation of more efficient maps. If shared with driver users, it can enhance the quality of service. The third task centers around registering and tracking authentication status. 'Amazon Pinpoint' is able to monitor all instances of registration and authentication failures during user interactions, alerting developers to any issues that may be hindering the registration and authentication processes.
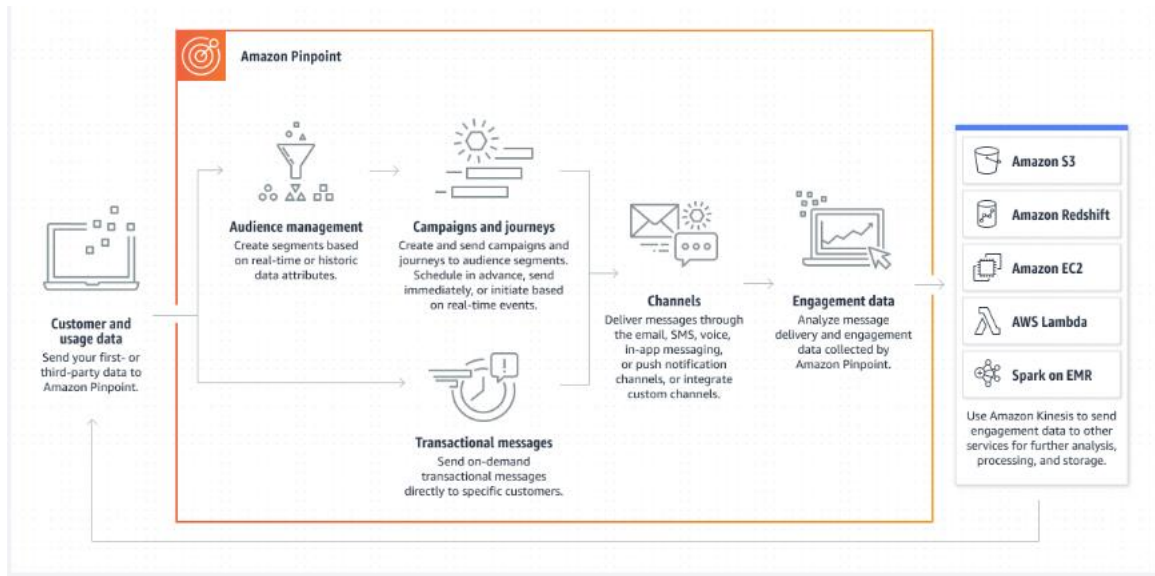
Figure 6: How Pinpoint Works

Mapping

To leverage 'Amazon Location Service' to incorporate location and mapping-related features. We selected Amazon Location Service to provide the capability to establish and customize path calculator resources, enabling the selection of data providers for path calculation. Firstly, this project is designed to be a cloud-based service hosted on AWS. Therefore, 'Amazon Location Service' offers superior accessibility compared to Google API. It can be seamlessly integrated directly into the application without the need to traverse through an API Gateway, resulting in reduced processing time. Secondly, given that this project operates on AWS, opting for an Amazon service eliminates the need to transmit data to a third party, enhancing security measures.
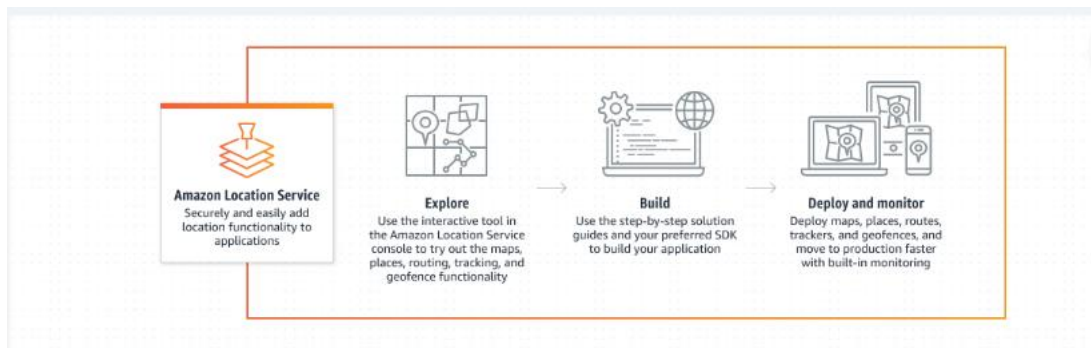

Figure 7: How Amazon location service Works

Payments

To employ Amazon DevPay as the payment system for this project.Amazon DevPay facilitates charges for services provided by AWS.It operates as a supported billing system, requiring both sellers and buyers to possess an account on amazon.com. In this scenario, the customer must be an AWS user. The term "DevPay" encompasses both the seller's and buyer's perspectives, functioning as a payment system known as "Amazon Payment."

Music integration

To integration in this project to choose Wowza for music. Wowza is a streaming music engine software that allows for customized playback of music or videos within the AWS cloud system. I prefer using software for several reasons:

Universal Accessibility: Software like Wowza enables music or video playback from anywhere and at any time.

Multi-Level Content Security: It offers robust security measures for protecting various levels of content.

Scalable Modular Architecture: Wowza provides a scalable and modular architecture, making it adaptable to changing needs and growth.

Flexible Deployment Options: It offers flexible deployment options, ensuring compatibility with various project requirements.

Extensibility

Passengers can choose car type or size and price of each car style and Passenger users can provide feedback with comment and rate on their driver's service, which is visible to other passengers and driver users. This system promotes service improvement and transparency. Also, Passengers can create bookings with specific details such as time, departure, and destination. These bookings are stored online, and the system automatically assigns a suitable driver user to fulfill the request.

Justification

As a cloud-based web application, and as a result, the majority of tasks will be facilitated by AWS systems. This project is focused on the development of the frontend web component, and API will be utilized to create a scalable full-stack application, leveraging the capabilities of AWS. The design's primary objectives include functionality, effective communication, and user-friendliness. Access to AWS's application hosting platform is available through well-documented web service API.

Conclusion

The Nüber application's primary goal is to create a cloud-based solution on AWS, necessitating the utilization of multiple AWS systems and third-party APIs. When utilizing AWS, we have the flexibility to choose the operating system, web application, programming language, database, and other required services. AWS employs a comprehensive approach to website security, encompassing operational, physical, and software-based measures, ensuring end-to-end protection. With AWS, we gain the advantage of accessing computing resources and storage from anywhere, providing exceptional portability. Cloud computing brings cost-efficiency, rapid implementation, location independence, network accessibility, resource pooling, reliability, scalability, and simplified maintenance. While it generally enhances security through managed services, it's important to note that a lack of expertise in the cloud provider can pose threats to user environments.

Gitae Bae baegy002(110310861)

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