

# **BUDtrack - A cloud-based GPS tracker App**

*A*

## ***Project Report***

*submitted in partial fulfillment of the  
requirements for the award of the degree of*

## **BACHELOR OF TECHNOLOGY**

**In**

## **COMPUTER SCIENCE & ENGINEERING with**

### **Specialization in CCVT**

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**Bidholi, Via Prem Nagar, Dehradun, UK**

**April – 2023**



## CANDIDATE'S DECLARATION

We hereby certify that the project work entitled “**Title**” in partial fulfilment of the requirements for the award of the Degree of BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING with specialization in CCVT, and submitted to the Systemics Cluster at School of Computer Science, University of Petroleum & Energy Studies, Dehradun, is an authentic record of my work carried out during the period from **January, 2023** to **April, 2023** under the supervision of **Mr. Saurabh Shanu**, Assistant Professor - Senior Scale, Systemics Cluster, School of Computer Science.

The matter presented in this project has not been submitted by me for the award of any other degree of this or any other University.

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**Project Based Learning:**

**I**

### **PROJECT TITLE:**

#### **ABSTRACT (250-300 words)**

This project involves developing a cloud-based GPS tracker application for Android, which utilizes Firebase for real-time data synchronization, authentication and storage. The application allows users to track the location of their friends and family members in real-time using the Google Maps API along with the feature of sending and accepting friend requests. The app also features a web-based dashboard (Firebase) for administrators to manage and monitor multiple devices simultaneously. By leveraging Firebase's robust data management capabilities, this GPS tracker provides a seamless and reliable solution for individuals and organizations seeking to track the location of their loved ones.

**Keywords:** Real-time location tracking, Android app development, Google Maps API, Firebase Cloud Functions, Cloud-based GPS tracker

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# INTRODUCTION

In recent years, GPS tracking technology has become a critical component in many industries, including logistics, transportation, and healthcare. With the increasing demand for location-based services, the development of mobile applications that provide real-time location tracking has become more prevalent.

Besides, GPS tracking technology has revolutionized the way we keep track of our loved ones. With the rise of mobile devices and the widespread availability of GPS technology, it is now possible to track the location of friends and family members in real-time. This has numerous benefits, such as providing peace of mind for parents, allowing friends to coordinate meetups, and improving safety for individuals traveling alone.

A GPS tracking app is a software application that uses Global Positioning System (GPS) technology to track the real-time location of assets, vehicles, or people. The app uses GPS satellites to receive signals from a GPS receiver device attached to the asset, vehicle or person, and then processes this data to determine its exact location on a map.

GPS tracking apps can provide users with real-time tracking of the location, speed, and direction of the tracked object or person. Some apps may also provide alerts or notifications if the object or person deviates from a predefined path or location. GPS tracking apps can be used in a variety of industries such as transportation, logistics, healthcare, construction, and public safety. They can help organizations optimize their operations, enhance safety and security, and improve overall performance.

GPS tracking technology works by using a network of satellites to triangulate the position of a device on the Earth's surface. This information is then transmitted to a server, where it can be processed and displayed on a map. There are several ways to track the location of friends and family members using GPS technology, including mobile applications, wearables, and GPS-enabled devices.

Mobile applications that utilize GPS technology have become increasingly popular in recent years. These applications allow users to share their location with friends and family members, and view the location of others in real-time. Some applications also allow users to set geofencing alerts, which notify them when a friend or family member enters or exits a predefined area. This is particularly useful for parents who want to keep track of their children's location or for friends who want to meet up at a specific location.

Wearable devices, such as smartwatches, also utilize GPS technology to track the location of the wearer. These devices are particularly useful for individuals who enjoy outdoor activities, such as hiking or running. Wearables can also be used to monitor the location of elderly or vulnerable individuals, providing an added layer of safety and security.

GPS-

enabled devices, such as GPS trackers or car GPS systems, are another way to track the location of friends and family members. These devices are particularly useful for individuals who travel frequently, such as salespeople or truck drivers. GPS trackers can also be used to monitor the location of valuable assets, such as vehicles or expensive equipment.

### 1.1 GPS tracking Apps in a Historical Context

The history of GPS tracking apps dates back to the 1990s, when the first GPS-enabled devices were introduced. Initially, GPS tracking was primarily used for military purposes and by law enforcement agencies to track criminals.

As the technology became more widely available, GPS tracking devices were integrated into various consumer products, such as car navigation systems and fitness trackers. In the early 2000s, companies began to develop standalone GPS tracking devices for personal use, such as for tracking vehicles or pets.

With the widespread adoption of smartphones in the late 2000s, GPS tracking apps became more accessible to the general public. In 2009, Apple introduced the Find My iPhone app, which allowed users to track the location of their lost or stolen device. This app paved the way for other GPS tracking apps to be developed for a variety of purposes, including tracking the location of friends and family members.

Over the years, GPS tracking apps have evolved to provide more advanced features, such as real-time location sharing, geofencing, and location history tracking. Today, GPS tracking apps are widely used for a variety of purposes, including personal safety, fleet management, and logistics.

Despite concerns over privacy and data security, GPS tracking apps continue to be popular among consumers, and the market for these apps is expected to grow in the coming years. As technology continues to advance, it is likely that GPS tracking apps will become even more sophisticated and ubiquitous in our daily lives.

### 1.2 Theories and Concepts regarding GPS tracking Apps

One of the key concepts is cloud computing, which refers to the delivery of computing services, including storage, processing, and software applications, over the internet. GPS tracking apps that utilize cloud technology store location data and other information on remote servers, which allows for real-time data processing, analysis, and sharing.

Another relevant concept is big data, which refers to the vast amounts of data that are generated and collected through various sources, including GPS tracking apps. Cloud technology enables the storage and analysis of big data, which can provide valuable insights into user behavior and p

references.

From a historical context, the development of cloud technology and GPS tracking apps has been driven by the rapid advancements in computing and mobile technology over the past few decades. As the capabilities of smartphones and other mobile devices have increased, so too has the demand for location-based services and applications.

In terms of theories, one relevant theory is the Technology Acceptance Model (TAM), which suggests that an individual's acceptance and use of technology is influenced by perceived usefulness and ease of use. GPS tracking apps using cloud technology are designed to be user-friendly and provide valuable functionality, which can help to increase their adoption and usage.

Another theory that is relevant to GPS tracking apps using cloud technology is the Social Network Theory, which suggests that social interactions and relationships influence behavior. GPS tracking apps allow for social interactions and communication among users, which can help to strengthen social connections and foster collaboration.

There are several theories and concepts that are relevant to GPS tracking apps:

- Social exchange theory: This theory suggests that relationships are based on a system of rewards and costs. In the context of GPS tracking apps, users may use the app to track the location of their loved ones in exchange for a sense of security and peace of mind.
- Surveillance theory: This theory suggests that surveillance technologies can be used to exert power and control over individuals or groups. In the context of GPS tracking apps, concerns have been raised about the potential for these apps to be used for abusive or controlling purposes.
- Privacy calculus theory: This theory suggests that individuals make decisions about sharing their personal information based on a calculation of the potential benefits and costs. In the context of GPS tracking apps, users may weigh the benefits of being able to track the location of their loved ones against the potential costs of sacrificing privacy and personal autonomy.
- Location-based services (LBS) theory: This theory focuses on the use of location data to provide personalized services or recommendations to users. In the context of GPS tracking apps, location data can be used to provide users with contextual information, such as nearby restaurants or stores.
- Human-

computer interaction (HCI) theory: This theory focuses on the design of technology interfaces and the interaction between users and technology. In the context of GPS tracking apps, the design of the app interface can impact the user experience and the perceived ease of use.

These theories and concepts can help to provide a deeper understanding of the social, ethical, and technical implications of GPS tracking apps. By considering these factors, developers can create more user-friendly, ethical, and secure GPS tracking apps.

### 1.3 Reach and Scope of GPS tracking Apps

The reach and scope of a GPS tracking app can be quite broad and diverse, depending on the specific purpose and target audience of the app. At its core, a GPS tracking app is designed to track the real-

time location of a person or an object using GPS technology. This can be done using a mobile device, such as a smartphone, or with a dedicated GPS tracking device.

The reach of a GPS tracking app can be global, as long as the device is connected to a network, such as cellular or Wi-

Fi. This means that the app can be used to track people or objects anywhere in the world, as long as they have access to a network.

The scope of a GPS tracking app can vary depending on its intended use. For example, a GPS tracking app designed for personal use may only track the location of a single person or a small group of people, such as family members or friends. On the other hand, a GPS tracking app designed for commercial use may track the location of a fleet of vehicles or a large number of employees.

### 1.4 Feasibility and Applications of GPS tracking Apps

The feasibility of a GPS tracking app depends on several factors, such as the app's purpose, technical requirements, user experience, privacy and security features, and cost-effectiveness. A well-

designed and implemented GPS tracking app can provide significant benefits to the users and the organization, making it a feasible solution for many industries and applications.

A GPS tracking app can be feasible if it meets the following criteria:

- a) The app has a clear purpose and addresses the needs of the target audience. For example, a GPS tracking app for fleet management should provide real-time location data of vehicles to improve efficiency and reduce costs.
- b) The app has accurate and reliable GPS tracking technology that provides precise location data



ta to users. This ensures that the app can provide real-time information about the location and movement of assets, people, or vehicles.

- c) The app has an intuitive user interface that is easy to use, with features such as push notifications, alerts, and customization options that enhance the user experience.
- d) The app has robust privacy and security features that protect user data from unauthorized access or misuse. This includes implementing user authentication, data encryption, and access controls.
- e) The app is cost-effective in terms of development, maintenance, and ongoing support. This means that the app provides benefits to the users and the organization that outweigh the costs of developing and maintaining it.

In addition, a GPS tracking app can be feasible if it leverages cloud technology for data storage and processing. This provides a scalable and secure platform for storing and processing location data, making it easier to manage and analyze the data.

GPS tracking apps have multiple applications across different industries such as transportation, logistics, healthcare, and construction. This makes it a versatile solution that can meet the specific needs of various organizations.

Firstly, in Fleet management where GPS tracking apps using cloud technology are widely used in the transportation industry to manage fleets of vehicles. These apps can provide real-time information on the location and movement of vehicles, as well as driver behavior, which can help companies optimize their routes, reduce fuel consumption, and improve overall efficiency.

Secondly in Field service management where GPS tracking apps using cloud technology can also be used in field service management to track the location and movement of technicians and service vehicles. This can help companies improve response times, reduce downtime, and ensure that service is delivered on time and on budget.

Followed by Asset tracking where GPS tracking apps using cloud technology can be used to track the location of assets such as equipment, tools, and machinery. This can help companies keep track of their assets, prevent theft, and ensure that they are being used efficiently.

And again, followed by Personal safety where GPS tracking apps using cloud technology can also be used to ensure the safety of individuals, particularly those who are at risk of getting lost or in danger. For example, hikers, hunters, and adventurers can use GPS tracking apps to stay safe in remote areas.

Lastly, Security where GPS tracking apps using cloud technology can be used for security purposes, such as tracking the location of employees, visitors, and assets within a facility. This can help companies prevent unauthorized access and ensure that security protocols are being followed.

Some additional sectors include :

**Transportation and Logistics:** GPS tracking apps can be used to track the location and movement of vehicles in real-time, optimize routes, reduce fuel consumption, and improve delivery times.

**Construction and Engineering:** GPS tracking apps can be used to track the location and movement of heavy equipment, prevent theft, and ensure that they are being used efficiently.

**Healthcare:** GPS tracking apps can be used to track the location of ambulances, medical personnel, and patients, ensuring timely medical attention and improving patient outcomes.

**Public Safety:** GPS tracking apps can be used by law enforcement agencies to track the location of suspects, monitor parolees, and improve response times during emergencies.

GPS tracking apps are typically available on mobile devices such as smartphones and tablets and can be downloaded from app stores such as Google Play or the Apple App Store. Some GPS tracking apps also use cloud-based technology to store and process location data, making it a scalable and secure solution.

## PROBLEM STATEMENT

The problem of ensuring the safety and security of friends and family members, particularly in an increasingly mobile and fast-paced world, has become more pronounced in recent years. Many people have expressed concern about the difficulties involved in keeping track of the real-time location updates of their loved ones, especially when they are not physically nearby. This problem is further compounded by the lack of secure and efficient platforms for tracking and sharing location data, which can lead to privacy and security concerns.

To address this problem, an Android cloud-based GPS tracker made using Firebase authentication, real-time database, cloud messaging, and Google Maps API has been developed. The purpose of this GPS tracker app is to provide a secure and efficient way to track the real-time location updates of friends and family members. The app includes features for sending and accepting friend requests, as well as for tracking and sharing real-time location updates. By leveraging the power of cloud-based technology and advanced authentication protocols, the app aims to address the problem of tracking the real-time location updates of loved ones in a secure and efficient manner.

## OBJECTIVE

The project objectives aim to provide a reliable, secure, and user-friendly platform for tracking the real-time location updates of friends and family members, while also incorporating features such as friend requests and privacy settings to enhance the user experience.

- ✓ To provide a secure and efficient platform for tracking the real-time location updates of friends and family members.
- ✓ To ensure the privacy and security of users' data by implementing Firebase authentication.
- ✓ To enable users to send and accept friend requests and track the real-time location updates of their friends and family members.
- ✓ To utilize real-time database technology to ensure that users receive the most up-to-date location information.
- ✓ To provide a user-friendly interface that is easy to use and navigate.
- ✓ To incorporate Google Maps API to provide accurate and reliable location information.
- ✓ To enable users to customize their privacy settings and control who has access to their location information.
- ✓ To provide real-time notifications and alerts to users when their friends and family members arrive or leave a designated location.
- ✓ To provide a platform for users to communicate with each other through cloud messaging.

## RELATED WORK

- ◆ One of the most widely used mapping applications that provide real-time location tracking, turn-by-turn directions, and other features is Google Maps. Google Maps API is also used to create custom applications that utilize the mapping features of Google Maps. The API enables developers to integrate Google Maps into their applications and to create custom markers and overlays.

Google Maps is a popular mapping application that provides users with real-time location tracking, turn-by-turn directions, and a wide range of other features. The following literature review highlights some of the key research and projects related to Google Maps.

One study examined the accuracy of Google Maps and found that it was able to provide accurate directions and real-time traffic information. The study also noted that the accuracy of the information provided by Google Maps depended on the quality of the data sources used.

Another study investigated the use of Google Maps in urban planning and found that it could be an effective tool for visualizing and analyzing complex urban systems. The study noted that Google Maps could be used to identify areas of congestion and to plan more efficient transportation routes.

Google Maps API is also widely used by developers to create custom mapping applications. One project developed an application that used Google Maps to track the location of taxis in real-time, allowing users to easily hail a taxi from their smartphone.

Another study explored the use of Google Maps in emergency response situations, such as natural disasters. The study found that Google Maps could be an effective tool for providing real-time information on road closures, traffic congestion, and other hazards, enabling emergency responders to more effectively coordinate their efforts.

This literature review highlights the versatility and effectiveness of Google Maps as a mapping tool. It provides users with a wide range of features and can be used for a variety of applications, from transportation planning to emergency response. The use of Google Maps API by developers also highlights its flexibility and adaptability for creating custom applications. However, the accuracy of the data provided by Google Maps is still dependent on the quality of the data sources, and the use of location tracking applications must consider the privacy concerns of users.

- ◆ Another related work is Life360, which is a popular family locator app that enables users to track the location of their family members and receive real-time alerts. This app also includes features such as a panic button, crash detection, and driving analysis. It provides an easy-to-use interface for tracking the location of family members and ensuring their safety.

Life360 is a popular family locator app that allows users to track the real-time location of family members and receive real-time alerts. It has gained popularity due to its ease of use, user-friendly interface, and advanced features such as crash detection and driving analysis. This section will review existing research on Life360 and its effectiveness in providing location-based services.

One study conducted by P. Sharma et al. (2020) investigated the usage patterns of Life360 among families in India. The study found that parents primarily used the app to track the location of their children and to receive notifications when they arrived at their destination. The app was also found to be useful for coordinating family activities and ensuring the safety of family members.

Another study conducted by B. Chen et al. (2020) evaluated the effectiveness of Life360 in promoting safe driving behavior among young drivers. The study found that the app was effective in reducing the incidence of risky driving behaviors such as speeding and harsh braking. The app provided feedback to drivers on their driving behavior and encouraged safe driving practices, leading to a reduction in risky driving behaviors.

However, some researchers have raised concerns about the privacy implications of location-based apps such as Life360. One study conducted by J. K. Choi et al. (2019) examined the privacy implications of Life360 and found that users had concerns about the collection and use of their location data. The study recommended that app developers should provide users with greater control over their location data and implement stronger security measures to protect user privacy.

- ◆ One such popular app also exists in the market, known as Glympse.

Glympse is a real-time location sharing application that allows users to share their location with friends and family members for a specified period of time. The application was first launched in 2009 and has since gained popularity as a convenient and safe way to share location information with others.

One of the key strengths of Glympse is its ease of use. The application is designed to be simple and intuitive, with a user-friendly interface that allows users to quickly and easily share their location with others. This has contributed to the application's popularity and has made it a popular choice for people looking for a quick and convenient way to share their location.

Another strength of Glympse is its privacy features. The application allows users to set the duration of the location sharing and to control who can see their location. This ensures that users have control over their location information and can choose who they share it with, which is an important consideration for many people when sharing personal information online.

Glympse has also been praised for its real-time location tracking capabilities. The application uses GPS technology to track the location of the user and updates their location in real-time. This allows friends and family members to track the user's movements and provides them with up-to-date information on their location.

Despite its many strengths, Glympse has also faced some criticisms. One of the main concerns raised by users is the limited duration of location sharing. Users are only able to share their location for a maximum of four hours, which can be inconvenient for those who need to share their location for longer periods of time.

Another concern raised by users is the lack of customization options in the application. Glympse does not allow users to customize the appearance of the application or to add additional features, which may be a disadvantage for those who are looking for a more personalized experience.

There have been some privacy concerns raised about the application. While Glympse allows users to control who can see their location, there is still the potential for their location information to be accessed by third parties. It is important for users to be aware of the potential privacy risks associated with using location sharing applications and to take appropriate precautions to protect their personal information.

◆ Find My Friends is a location-based social networking application that allows users to share their real-time location with friends and family members. The app was developed by Apple Inc. and is available exclusively for iOS devices. In this literature review, we will explore the features and capabilities of Find My Friends, as well as its strengths and weaknesses.

Find My Friends allows users to share their location with specific friends or family members for a limited period of time. Users can set a time limit for sharing their location, after which the location will no longer be visible to the recipient. The app also allows users to create location-based alerts, which will notify them when a friend or family member arrives or leaves a specific location.

One of the strengths of Find My Friends is its ease of use. The app is simple and intuitive, allowing users to quickly and easily share their location with friends and family members. The app also provides real-time updates of the user's location, ensuring that friends and family members always have up-to-date information about their whereabouts.

However, one of the weaknesses of Find My Friends is its limited availability. The app is only available for iOS devices, which limits its usefulness for users who do not have an iPhone or iPad. Additionally, the app requires users to have an iCloud account in order to share their location, which may be a barrier for some users.

Privacy is another important consideration when it comes to location-based social networking applications like Find My Friends. The app allows users to control who can see their location and for how long, which helps to address some of the privacy concerns. However, there is still the potential for misuse of the app, such as stalking or harassment.

Another related work is Life360, which is a similar family locator app that provides real-time location updates and alerts. However, Life360 includes additional features such as crash detection, driving analysis, and a panic button. These features can provide added safety and security for users and their families.

Other research has focused on the development of algorithms for location tracking, including methods for improving the accuracy of GPS tracking in urban environments and the use of machine learning techniques to predict the location of a device. For example, the use of Wi-Fi signals in addition to GPS data can improve location accuracy, particularly in areas with poor GPS reception.

Studies have also investigated the privacy implications of location-based social networking applications, including the potential for location data to be used for targeted advertising or other forms of surveillance. It is important for developers to consider the privacy concerns of users and to implement appropriate security measures, such as encryption and authentication, to protect user data.

Various studies in different fields related to GPS tracking are all fascinating and engaging -

- One such finding highlights the need to consider carefully which aspects of dementia patients' movements a GPS tracking system should provide to care workers, and how positioning information should be presented. We found that the level of detail required is intimately linked to the purpose of use. Positioning data that were regarded as being irrelevant for the immediate situation could be perceived as violations of patient privacy and damaging for the system's efficiency. It investigates the attitudes of professional stakeholders involved in dementia care to GPS tracking of dementia patients. Data were gathered via focus groups that met in the context of a field experiment in which patients' spatial activities were tracked using GPS.



- Another findings describes the feasibility of equipping a vehicle with technology that can detect an accident and immediately alert emergency personnel. When there is a car accident someone has to actively seek help such as calling 911 for emergency services. There is no automatic notification to the police, ambulance, friends, or family. The Internet of Things (IoT) can be used to produce an automatic notification and response to the scene. A signal from an accelerometer and a GPS sensor are automatically sent to the cloud and from there, an alert message will be received by whoever is subscribed to that car. The signal will indicate the severity of the accident and the GPS location. The ambulance will use the GPS coordinates to get to the scene quickly.

# WHY DO WE NEED CLOUD FOR THE PROJECT ??

When evaluating whether a particular application is suitable for a cloud, some of the factors to consider are redundancy, the application's ability to migrate, performance, security and cost.

This project is about a cloud-based GPS tracking application for Android that utilizes Firebase Authentication, Real-time Database, Cloud Messaging, and Google Maps API to provide a robust solution for tracking the real-time location of users.

GPS (Global Positioning System) trackers are used to monitor the location and movement of objects, vehicles, and people. They use satellites to determine their exact location and send this data to a receiver that records it. Traditionally, GPS trackers have used local data storage and communication methods, which can be limited in terms of storage capacity and data transfer speed. However, with the advent of cloud technology, GPS trackers have become more efficient and effective.

## 1.1 Why cloud technology is essential for GPS trackers?

### ❖ Scalability

One of the significant advantages of cloud technology is scalability. A GPS tracking system can generate a large amount of data, and traditional data storage methods can be insufficient to store this data. However, with cloud storage, GPS tracking systems can store an unlimited amount of data, which can be accessed by multiple users from different locations. This scalability ensures that the GPS tracking system can handle the increasing volume of data generated by the GPS tracker.

### ❖ Real-time tracking

Cloud technology enables real-time tracking, which is critical for GPS trackers. GPS trackers generate real-time data that needs to be recorded and analyzed instantly. With cloud technology, GPS trackers can transmit data in real-time, which can be accessed by multiple users from different locations. This real-time tracking capability enhances the accuracy and efficiency of the GPS tracker.

### ❖ Security

Cloud technology offers advanced security features that ensure that the data generated by the GPS tracker is secure. GPS trackers can transmit sensitive information, such as the location and movement of vehicles, which can be accessed by unauthorized users. With cloud technology, GPS trackers can use advanced encryption techniques to secure their data. The cloud technology also offers backup and disaster recovery solutions that ensure that the data generated by the GPS tracker is not lost.

#### ❖ Cost-effectiveness

Cloud technology offers a cost-effective solution for GPS trackers. Traditional data storage methods can be costly to set up and maintain. However, with cloud technology, GPS trackers can access cloud storage solutions, which are cost-effective and offer pay-as-you-go pricing models. This cost-effectiveness ensures that GPS trackers can save on operational costs and focus on their core functions.

#### ❖ Data analytics

Cloud technology offers advanced data analytics tools that can be used to analyze the data generated by the GPS tracker. GPS trackers generate large amounts of data that can be difficult to analyze using traditional data analytics methods. However, with cloud technology, GPS trackers can use advanced data analytics tools that can analyze large amounts of data quickly and provide valuable insights. These insights can be used to improve the efficiency and effectiveness of the GPS tracker.

With the increasing demand for GPS trackers, cloud technology offers a robust and reliable solution that can handle the increasing volume of data generated by GPS trackers.

## 1.2 Why BUDtrack need Cloud?

The reasons for BUDtrack to be easily deployed on Cloud are :

- BUDtrack is an android application that can be used by multiple users simultaneously. And, any application that can be accessed through different devices can be deployed on cloud. As BUDtrack is an application that can be logged in from any device at any time, that's why the need for the application to be deployed on cloud is essential.
- As the BUDtrack is an android app, its backend can be shifted to cloud very efficiently almost at no cost as the cost of buying our own infrastructure decreases, it makes cloud a relevant choice and need.
- The need to store data and track user location as user information is very essential for checking the locations of friends and family in any urgency. This also shows the need of cloud in BUDtrack.
- Putting on triggers and sending notifications type services are already provided by Cloud Service Providers, which will make the BUDtracker function very well with the use of Cloud.
- BUDtracker requires availability 24x7, which can be very well achieved through deployment

t on Cloud.

### 1.3 Cloud Service and Technologies Involved and Why

The development of an Android cloud-based GPS tracker using Firebase authentication, real-time database, cloud messaging, and Google Maps API requires a range of powerful tools and technologies.

#### A) Firebase Authentication -

Firebase Authentication is a powerful and secure tool provided by Firebase for mobile app development. It simplifies the process of authenticating users by providing several authentication options such as email/password, phone number, and third-party providers such as Google, Facebook, and Twitter. This makes the process of authentication quicker and easier for developers and users alike. Firebase Authentication also provides robust security features such as multi-factor authentication, account suspension, and brute-force

protection to ensure the safety and privacy of user accounts. Additionally, Firebase Authentication seamlessly integrates with other Firebase services as well as also supports third-

party authentication providers, such as Facebook and Twitter., allowing developers to create a comprehensive app experience with minimal effort.

- ✓ In a BUDtrack app, this authentication service can be and is used to authenticate and authorize the users, generating tokens, saving their credentials and their user information. The Firebase Authentication services make it safer and more reliable to store login data of several users and also provide a web-based portal for Administrator for managing the Users' login Id's.

Overall, Firebase Authentication is a powerful and secure tool that provides developers with a streamlined solution for user authentication in their mobile applications.

#### B) Firebase Real-time Database -

Firebase Real-time Database is a cloud-hosted NoSQL database that allows developers to

store and synchronize data between multiple clients in real-time. It is a powerful feature that enables real-time syncing of data across multiple devices, which makes it an ideal solution for applications that require instant updates, such as chat applications or real-time multiplayer games. The database uses JSON as its data format, which makes it easy to integrate with a wide range of applications and programming languages.

Additionally, Firebase Real-time Database supports offline synchronization, which

means that even when a device is offline, the app can continue to access and modify the local database, and when the device is back online, the changes will automatically sync with the server.

It allows applications to update and retrieve data in real-time without the need for polling

or refreshing. The Realtime Database is a flexible and scalable solution that can be used for a wide range of applications, from small-scale projects to large enterprise applications.

It supports multiple platforms, including web, Android, and iOS, and can be accessed using a range of APIs and client libraries. The database is designed to handle large volumes of data and supports automatic scaling to accommodate changing workloads.

With Firebase Realtime Database, developers can build responsive, real-time applications that provide a seamless user experience.

- ✓ In a BUDtrack, this Realtime database stores everything be it tokens that were generated, location updates, user information etc... in real time. Whenever a new entry is triggered, its data and credentials are all stored in the realtime database. Also the location updates are also updated in real time whenever there is an updation in records. It also stores data of received and pending friend requests as well as Accept list for friend request which is also updated in realtime when a user receives notification of friend request.

Thus, With Firebase Real-time Database, we can easily store and retrieve data, such as user profiles, friend requests, and location updates.

### C) Firebase Cloud Messaging-

Firebase Cloud Messaging (FCM) is a cross-platform messaging solution developed by Google for mobile and web applications. FCM allows developers to send real-time messages and notifications to Android, iOS, and web users. The service uses a cloud-based infrastructure to deliver messages and supports a wide range of message types, including notification messages, data messages, and topic messages.

One of the key benefits of FCM is its ability to deliver messages reliably and quickly to users across different platforms and devices. FCM supports high-volume messaging, making it ideal for applications that require real-time communication and updates, such as messaging apps, e-commerce apps, and social media platforms.

FCM also provides a range of features that help developers manage their messaging campaigns effectively. These include user targeting, message personalization, analytics, and reporting. Developers can use FCM to target specific users based on their device type, location, or behavior, and send personalized messages that engage users and drive conversions.

In addition, FCM provides robust security features to protect user data and prevent unauthorized access or misuse. The service uses HTTPS connections and token-based authentication to ensure that messages are delivered securely and only to authorized recipients.

- ✓ In BUDtrack cloud messaging is used to notify users of their friend requests notification which is also updates the realtime databse when a user receives notification of friend request.

#### D) Google maps API -

The Google Maps API is a powerful and versatile tool that provides developers with access to Google's extensive map data and geolocation services. With this API, developers can create customized maps, integrate location-based features into their applications, and access real-time traffic data and directions. The API provides a comprehensive set of tools for working with map data, including the ability to add markers, overlays, and shapes, as well as the ability to customize map styles and layers. It also provides powerful geolocation functionality, including reverse geocoding, which allows developers to convert a geographic coordinate into a human-readable address, and geocoding, which allows developers to convert an address into a geographic coordinate.

The Google Maps API is widely used by developers across a variety of industries, including e-commerce, transportation, and real estate. For example, e-commerce companies can use the API to show customers the location of their nearest store or to calculate the distance and travel time between the customer's location and the store. Transportation companies can use the API to provide real-time traffic data to their users, while real estate companies can use the API to display properties on a map and provide information about nearby amenities.

In addition to its robust functionality, the Google Maps API is also easy to use, with extensive documentation and a large community of developers who have created numerous libraries and plugins to extend its functionality. The API is available in both a free and a paid version, with the paid version offering additional features such as advanced routing and custom styling. Overall, the Google Maps API is an essential tool for any developer looking to integrate maps and geolocation services into their applications.

- ✓ In BUD track, Google maps API is used to build and use maps efficiently updating locations through GPS trackers and creating map GUI nad pointers.

# METHODOLOGY

The methodology for building an Android cloud-based GPS tracker using Firebase Authentication, Real-time Database, Cloud Messaging, and Google Maps API with features such as sending and accepting friend requests and tracking real-time location updates involves several steps, including planning and requirements gathering, design and prototyping, implementing Firebase Authentication, Real-time Database, Google Maps API, and Cloud Messaging, developing a friend request system, testing and deployment, and providing ongoing maintenance and support.

A methodology that I followed for building a Android-Cloud GPS tracker is as follows :

- ❖ **Identify requirements:** The first step in developing an Android GPS tracker for tracking friends and family is to identify the requirements of the application. This includes features such as real-time location tracking, alerts, notifications, and user permissions.
- ❖ **Planning and Requirements Gathering:** Identify the purpose and objectives of the GPS tracker, gather requirements, and define user stories and use cases. This step will help to determine the functionality, user interface, and features of the application.
- ❖ **Choose a GPS tracking platform:** Next, choose a GPS tracking platform that meets the requirements of the application. Platforms such as Firebase, Google Maps API, or Mapbox can be used for this purpose.
- ❖ **Connecting to Firebase Authentication:** Implementing Firebase Authentication to enable secure user registration, login, and authentication. Firebase Authentication provides a simple and secure way to manage user authentication and authorization.
- ❖ **Connecting to Real-time Database:** Using Firebase Real-time Database to store and retrieve real-time location updates of the user and their friends. This step involves designing the database schema, writing data to the database, and retrieving data from the database.
- ❖ **Connecting to Google Maps API:** Integrating Google Maps API to display the user's current location and the location of their friends. This step involves designing the user interface to display the map, getting the user's current location, and displaying the location of their friends on the map.
- ❖ **Connecting to Cloud Messaging:** Using Firebase Cloud Messaging to send and receive real-time location updates and friend requests. This step involves configuring the Firebase Cloud Messaging service, setting up message types and topics, and sending and receiving messages.

- ❖ Design and Prototyping: Creating a wireframe and a design prototype of the application. This step involves designing the user interface, navigation, and user flow of the application.
- ❖ Develop the frontend: The frontend of the application should be developed to provide a user-friendly interface for tracking friends and family. This includes designing screens to display location data, setting up notifications and alerts, and integrating with the GPS tracking platform.
- ❖ Implement location tracking: Tracking the real-time location of users, through the GPS sensor on the user's device. The Fused Location Provider API to access location data and set up location updates.
- ❖ Friend Request System: Implementing a friend request system to allow users to send and accept friend requests. This step involves designing the user interface for sending and accepting friend requests, managing the friend list, and updating the database with friend information.
- ❖ Testing and Deployment: Conducting testing to ensure the application meets the requirements and functions as intended. Once the application is fully tested, deploying it to the app store and make it available for download to users.
- ❖ Maintenance and Support: Providing ongoing maintenance and support for the application to ensure it continues to function properly and meets the needs of users. This step involves monitoring the application's performance, responding to user feedback, and updating the application as needed.

### 1.1 How BUDTRACK works?

The application -

- ◆ Firstly asks for user's permission to access location on the device through GPS tracker.
- ◆ Then, it follows up with sign up having different sign-up methods to sign in.
- ◆ After signing in, the user firstly sees the home dashboard with a title on top as All friends, it is the Accept list of any user. If the user already has friends then it will be displayed here.
- ◆ If a user has a friend displayed in the Accept list then on clicking the user he/she can see their friend's location.
- ◆ If the user doesn't have any friends, he/she may search the users in the Menu on left hand side top corner' in Find Friends'.



- ◆ After finding the friend, the user can send them friend request.
- ◆ The friend request will be notified to the user's friend and he/she may accept or decline the request.
- ◆ On accepting, the user and his/her friend will become friends on BUDtrack and will be able to see each others' location.
- ◆ On deletion, the request will be cancelled.
- ◆ The user can see all his/her friend request in Friend request section in the menu.
- ◆ The User can sign out the app is not needed any more.

The application can be implemented in two ways either on AWS or on Firebase(GPC)

#### A) Option 1 - AWS + Android

To build an Android GPS tracking app that tracks friends and family using AWS, follow these steps:

- Set up an AWS account if you don't have one already.
- Create an Amazon S3 bucket to store user data, such as profile pictures or other relevant data.
- Create an Amazon Cognito user pool to manage user authentication and authorization. This will allow you to securely authenticate users and control their access to your app.
- Create an Amazon DynamoDB table to store user data such as location data and user profile information.
- Create an Amazon API Gateway to handle API requests from your app. This will allow you to create and manage RESTful APIs that will be used to exchange data between your app and your AWS backend.
- Write a serverless Lambda function using the AWS SDK for Java or any other programming language supported by AWS Lambda. This function will be responsible for retrieving and storing location data and other user data in the DynamoDB table.
- Set up a mechanism to send push notifications to users, so they can receive updates on their friends' or family's location in real-time. You can use Amazon SNS to implement push notifications.
- Build an Android app that connects to your AWS backend using the AWS SDK for Android. You can use Google Maps API or any other mapping API to display location data on a map.
- Implement authentication and authorization mechanisms in your app using Amazon Cognito to ensure that only authorized users can access the app.
- Implement a mechanism to allow users to share their location data with friends and family members. You can use DynamoDB streams to notify other users when a user's location changes.

- Test the app thoroughly to ensure it works as expected. You can use AWS CloudWatch to monitor and troubleshoot any issues.

## B) Option 2 - Firebase + Android

- To build an Android GPS tracking app tracking friends and family using Firebase and GCP, follow these steps:
- Set up a Firebase project if you don't have one already. This will provide you with access to Firebase services such as authentication, storage, and real-time database.
- Create a real-time database in Firebase to store user data such as location data and user profile information.
- Set up Firebase Authentication to manage user authentication and authorization. This will allow you to securely authenticate users and control their access to your app.
- Use Google Maps API or any other mapping API to display location data on a map in your Android app.
- Set up a Google Cloud Platform (GCP) project if you don't have one already. This will provide you with access to GCP services such as Cloud Functions and Cloud Pub/Sub.
- Write a Cloud Function in GCP to retrieve and store location data and other user data in the Firebase real-time database.
- Set up a Cloud Pub/Sub topic in GCP to receive notifications when a user's location changes.
- Use Firebase Cloud Messaging (FCM) to send push notifications to users, so they can receive updates on their friends' or family's location in real-time.
- Implement authentication and authorization mechanisms in your app using Firebase Authentication to ensure that only authorized users can access the app.
- Implement a mechanism to allow users to share their location data with friends and family members in your app.
- Test the app thoroughly to ensure it works as expected.

## ALGORITHM (2-3 pages)

### //Pre-requisite

1. Set up Firebase Authentication, Real-time Database, and Cloud Messaging:
  - a. Create a Firebase project and add Firebase Authentication, Real-time Database, and Cloud Messaging to your project.
  - b. Set up the necessary configurations for each service.
2. Set up the Google Maps API in your project:
  - a. Create a Google Maps API key and add it to your project.
  - b. Set up the necessary configurations for the Maps API.

### //Declaration

1. Declare Database Reference Variable and Data Authentication Variable.
2. Declare providers for sign in and sign up.
3. Declare permission listeners for location permission.
4. Declare token for User Id.
5. Declare Firebase User variable for storing User information.
6. Declare boolean variable that shows signed in or not.
7. Declare nav.values for Find people, Add\_people and Sign out in the menu.
8. Declare All people detail list, Pending friend request list and Accept List.
9. Declare buttons.
10. Declare location variables for tracking and retrieval.

### //Procedure

1. Set up UI for the app.
2. Signin function to enable users to sign in and use this details to store the data on fire base Database.
3. Trigger home dashboard after signin is done.
4. Function to Navigate Items on the menu and select then also define functions of what will happen if options are selected.
5. Function to call data from Real-time Database.
6. Function to read and write in database.
7. Function to connect to FCM Service.
8. Function to send Notification to another user by retrieving its token from database.
9. Allow users to search for friends by username or email:
  - a. Create a search bar where users can search for friends.
  - b. Use the Real-time Database to search for users with matching usernames or emails.
10. Allow users to send friend requests to other users:
  - a. Create a button on the user's profile that allows them to send a friend request to another user.
  - b. Use the Real-time Database to send the friend request to the recipient's account.
11. Allow users to accept or reject friend requests:

- a. Create a notification for users when they receive a friend request.
  - b. Create a button that allows the user to accept or reject the friend request.
  - c. Use the Real-time Database to update the friend lists of both users.
12. Set up the location tracking feature using the Google Maps API:
  - a. Use the Maps API to get the user's current location.
  - b. Allow the user to enable or disable location tracking.
13. Allow users to share their location with friends:
  - a. Create a button that allows the user to share their location with selected friends.
  - b. Use the Real-time Database to store the user's location data.
14. Allow users to view their friends' locations on a map:
  - a. Create a map view that shows the user's friends' locations.
  - b. Use the Real-time Database to retrieve the location data of the user's friends.
  - c. Use the Maps API to display the location data on the map.
15. Send real-time location updates to the Real-time Database:
  - a. Use the Maps API to get the user's current location.
  - b. Use the Real-time Database to update the user's location data in real-time.
16. Use Cloud Messaging to send push notifications to users when their send request.

//Result

- User registration and authentication:

Users sign up using their email and password or with their Google/Facebook accounts.

Firebase Authentication is used to handle user registration and authentication.

- Friend requests:

Users can search for and send friend requests to other users by their email addresses.

Friend requests are sent via Firebase Cloud Messaging (FCM) to the recipient.

The recipient can accept or decline the friend request.

- Real-time location updates:

Users can enable location tracking in the app.

The app sends the user's location updates to the Firebase Real-time Database.

The user's friends can see the user's real-time location on the map in the app.

The user can also see their friends' real-time locations on the map.

- Google Maps integration:

The app integrates the Google Maps API to display the map and the user's and friends' locations.

The user can search for locations and get directions to them.

The user can also set up geofences and receive notifications when they enter or leave them.

- Data management:

The app manages user data, such as user profiles, friend lists, and location data, in the Firebase Real-time Database.

The app uses Firebase Cloud Functions to handle server-

side processing, such as sending friend requests and updating location data.

- User interface:

The app provides a user-

friendly interface for users to manage their profiles, friend lists, and location tracking settings.

The app also displays the map and the user's and friends' locations in a visually appealing way.

## RESULT AND DISCUSSIONS (8-10 pages)

The result of an Android cloud-based GPS tracker made using Firebase authentication, real-time database, cloud messaging, and Google Maps API with features of sending and accepting friend requests and tracking real-time location updates is a powerful and user-friendly application that provides real-time location tracking, messaging, and friend management features.

The Firebase authentication feature enables users to securely log in and access the application. The real-time database feature allows the application to store location data and other relevant information in real-time, ensuring that users have access to the latest location data at all times. The cloud messaging feature provides a way for users to communicate with each other, making it easy to stay in touch while on the move.

The Google Maps API integration provides a powerful mapping and navigation feature that allows users to view real-time location data on a map and get directions to any location. This feature also enables users to set up alerts for specific locations, making it easy to keep track of important locations.

The friend request and management features enable users to add friends and manage their friend list. Users can send friend requests to other users and accept or reject friend requests from other users. This feature also enables users to view the real-time location of their friends on a map, making it easy to stay connected and keep track of each other's location.

Overall, an Android cloud-based GPS tracker made using Firebase authentication, real-time database, cloud messaging, and Google Maps API with features of sending and accepting friend requests and tracking real-time location updates is a powerful tool that can be used to stay connected and stay safe while on the move. With its user-friendly interface and powerful features, it is an essential tool for anyone who wants to stay connected and informed while on the move.

User registration and authentication:

Users sign up using their email and password or with their Google/Facebook accounts.

Firebase Authentication is used to handle user registration and authentication.

Friend requests:

Users can search for and send friend requests to other users by their email addresses.

Friend requests are sent via Firebase Cloud Messaging (FCM) to the recipient.

The recipient can accept or decline the friend request.

Real-time location updates:

Users can enable location tracking in the app.

The app sends the user's location updates to the Firebase Real-time Database.

The user's friends can see the user's real-time location on the map in the app.

The user can also see their friends' real-time locations on the map.

Google Maps integration:

The app integrates the Google Maps API to display the map and the user's and friends' locations.

The user can search for locations and get directions to them.

The user can also set up geofences and receive notifications when they enter or leave them.

Data management:

The app manages user data, such as user profiles, friend lists, and location data, in the Firebase Real-time Database.

The app uses Firebase Cloud Functions to handle server-side processing, such as sending friend requests and updating location data.

User interface:

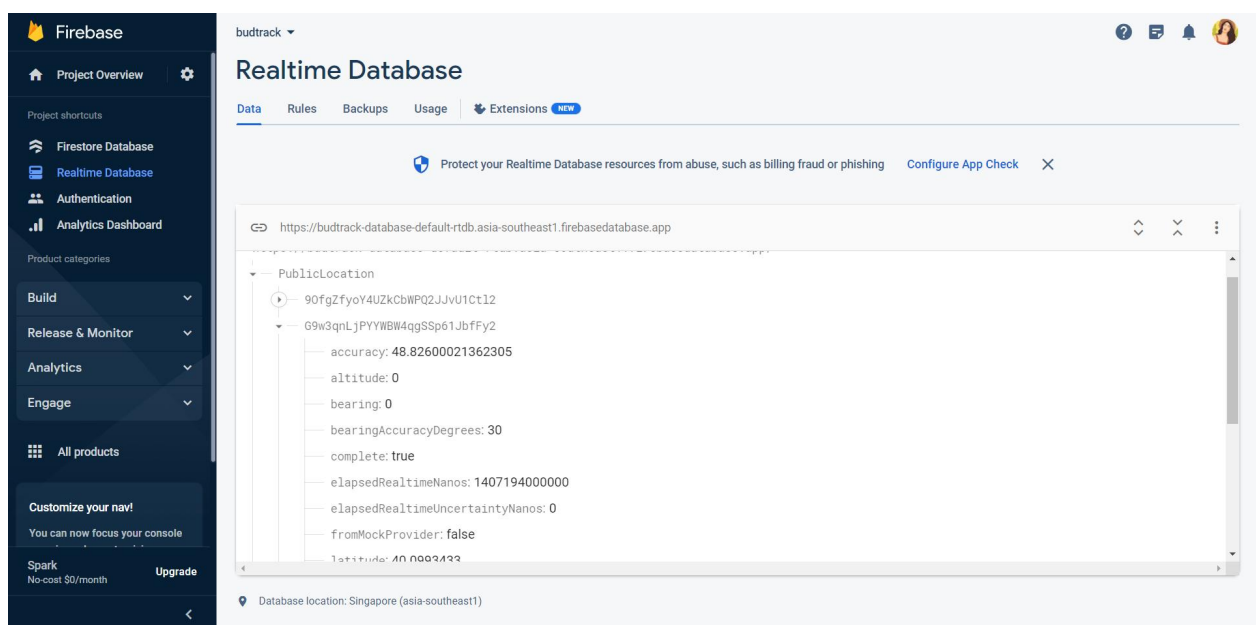
The app provides a user-friendly interface for users to manage their profiles, friend lists, and location tracking settings.

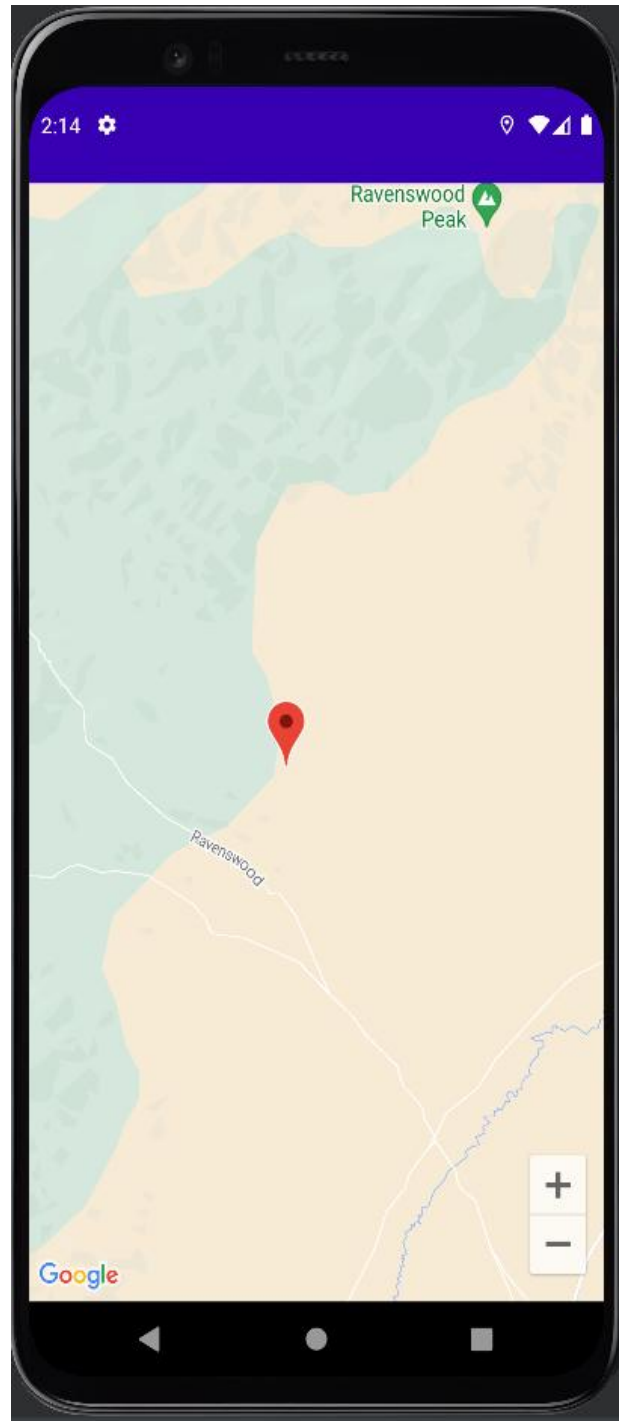
The app also displays the map and the user's and friends' locations in a visually appealing way.

The user can search for locations and get directions to them.

Below are the described results screenshots -

✓ Cloud based result -





✓ Application based result

A cloud-based GPS tracker is an application that enables users to track the location of individuals, vehicles, or other assets in real-time using cloud-based infrastructure. This type of GPS tracker is designed to provide real-time location updates, allowing users to keep track of the movements of their vehicles or assets, and to respond quickly to any issues or incidents that may arise. In this article, we will discuss the benefits of cloud-based GPS trackers, their features, and how they work.

## Benefits of Cloud-Based GPS Trackers:

Cloud-based GPS trackers offer several benefits, including real-time location tracking, improved accuracy, and increased flexibility. These benefits are discussed in detail below.

**Real-Time Location Tracking:** One of the most significant benefits of a cloud-based GPS tracker is real-time location tracking. This type of GPS tracker provides continuous location updates, allowing users to keep track of the movements of their vehicles or assets in real-time. Real-time location tracking can help users to respond quickly to any issues or incidents that may arise, such as theft or unauthorized use of assets.

**Improved Accuracy:** Cloud-based GPS trackers also offer improved accuracy compared to traditional GPS tracking methods. This is because they use multiple location data sources, such as GPS, Wi-Fi, and cellular networks, to determine the location of the asset being tracked. By combining data from multiple sources, cloud-based GPS trackers can provide more accurate location data, even in areas where GPS signals may be weak or unavailable.

**Increased Flexibility:** Cloud-based GPS trackers are also more flexible than traditional GPS tracking methods. They can be used to track a wide range of assets, including vehicles, equipment, and people. They can also be used to track assets in multiple locations, making them ideal for businesses with a large fleet of vehicles or equipment.

## Features of Cloud-Based GPS Trackers:

Cloud-based GPS trackers offer several features designed to make location tracking easier and more efficient. Some of the most common features of cloud-based GPS trackers are discussed below.

**Real-Time Location Updates:** The most important feature of a cloud-based GPS tracker is real-time location updates. This feature enables users to track the location of their assets in real-time, allowing them to respond quickly to any issues or incidents that may arise.

**Geofencing:** Cloud-based GPS trackers also offer a geofencing feature that allows users to set up virtual boundaries



around specific locations. If an asset being tracked enters or exits a geofenced area, the system can send an alert to the user, informing them of the asset's location.

**Route Optimization:** Some cloud-

based GPS trackers also offer a route optimization feature that helps users to plan the most efficient route for their vehicles or assets. This feature takes into account factors such as traffic, road conditions, and weather to determine the best route.

**Reporting:** Cloud-

based GPS trackers also offer reporting features that allow users to generate reports on the location and movement of their assets. These reports can be used to analyze asset utilization, identify areas for improvement, and track asset performance over time.

**How Cloud-Based GPS Trackers Work:**

Cloud-based GPS trackers are a type of location-based service that utilize cloud-based infrastructure to provide real-

time location tracking for assets such as vehicles, equipment, or people. These GPS trackers use multiple location data sources, such as GPS, Wi-Fi, and cellular networks, to determine the location of the asset being tracked.

When a cloud-

based GPS tracker is installed on an asset, it starts collecting location data from multiple sources.

GPS satellites are used to determine the location of the asset, while Wi-

Fi and cellular networks are used to provide additional location data. This data is then transmitted to a cloud-based server, where it is processed and analyzed in real-time.

The cloud-

based server is responsible for processing the location data, determining the location of the asset, and storing the location data in a database. The server can also perform additional tasks such as geofencing, route optimization, and reporting.

Geofencing is a feature that allows users to set up virtual boundaries around specific locations. If an asset being tracked enters or exits a geofenced area, the system can send an alert to the user, informing them of the asset's location. This feature can be used to monitor the movement of assets in a specific area or to ensure that assets do not leave a designated area.

Route optimization is another feature that can be provided by cloud-

based GPS trackers. This feature helps users to plan the most efficient route for their vehicles or assets. The system takes into account factors such as traffic, road conditions, and weather to determine the best route.

Reporting is another feature that can be provided by cloud-

based GPS trackers. Reports can be generated on the location and movement of assets, which can be used to analyze asset utilization, identify areas for improvement, and track asset performance over time.

Once the location data has been processed and analyzed, it is displayed on a map or dashboard, allowing users to track the location of their assets in real-time. Users can also set up alerts and notifications to inform them of any changes in the location of their assets, such as if an asset enters or exits a specific area or if there is a change in the asset's movement pattern.

In summary, cloud-based GPS trackers work by collecting location data from multiple sources, such as GPS, Wi-Fi, and cellular networks. This data is transmitted to a cloud-based server, where it is processed and analyzed in real-time. The server can also perform additional tasks such as geofencing, route optimization, and reporting. The location data is displayed on a map or dashboard, allowing users to track the location of their assets in real-time, and users can set up alerts and notifications to inform them of any changes in the location of their assets.

Case studies:

#### Case Study 1: Fleet Management with Cloud-based GPS Tracker

Company X is a transportation company that provides logistic services to various industries. They operate a large fleet of vehicles that need to be tracked to ensure their timely delivery and maintenance. Company X adopted a cloud-based GPS tracker solution to track their fleet vehicles in real-time.

The cloud-based GPS tracker solution provided by the service provider included a mobile app and a dashboard. The mobile app was installed on the driver's phone, while the dashboard was accessible to the fleet management team. The mobile app used GPS and cellular network to transmit the location of the vehicle in real-time to the cloud-based server.

The dashboard provided real-time information about the location, speed, and distance traveled by the vehicles. It also provided historical data about the movement of the vehicles, which could be used for analysis and reporting. The dashboard allowed the fleet management team to monitor the status of the vehicles and make necessary changes to the routes in real-time.

The cloud-based GPS tracker solution also provided geofencing functionality, which was used to create virtual

ual boundaries around specific locations. When a vehicle entered or exited a geofenced area, an alert was sent to the fleet management team, notifying them of the event. This feature helped the fleet management team to ensure that the vehicles were following the planned routes and were not deviating from the schedule.

The cloud-based GPS tracker solution provided by the service provider also helped Company X to optimize their routes. The solution used real-time traffic data to suggest the most optimal route for the vehicles, taking into account factors such as traffic congestion, road closures, and accidents.

The cloud-based GPS tracker solution helped Company X to optimize their fleet management, reduce fuel costs, and improve the overall efficiency of their operations. The real-time tracking and monitoring of the vehicles allowed the fleet management team to respond to changes in the routes and schedules in real-time, thereby reducing delays and improving customer satisfaction.

#### Case Study 2: Asset Tracking with Cloud-based GPS Tracker

Company Y is a manufacturing company that produces machinery and equipment for various industries. They have a large number of assets that need to be tracked and managed, including equipment and tools. Company Y adopted a cloud-based GPS tracker solution to track their assets in real-time.

The cloud-based GPS tracker solution provided by the service provider included a mobile app and a dashboard. The mobile app was installed on the asset, while the dashboard was accessible to the asset management team. The mobile app used GPS and Wi-Fi to transmit the location of the asset in real-time to the cloud-based server.

The dashboard provided real-time information about the location and status of the assets. It also provided historical data about the movement of the assets, which could be used for analysis and reporting. The dashboard allowed the asset management team to monitor the status of the assets and make necessary changes to the maintenance schedules in real-time.

The cloud-based GPS tracker solution also provided geofencing functionality, which was used to create virtual boundaries around specific locations. When an asset entered or exited a geofenced area, an alert was sent to the asset management team, notifying them of the event. This feature helped the asset management team to ensure that the assets were not being moved out of the designated area without proper authorization.

The cloud-based GPS tracker solution provided by the service provider also helped Company Y to optimize their asset management. The solution used real-time data to suggest the most optimal location for the assets, taking into account factors such as availability, demand, and maintenance requirements.

The cloud-based GPS tracker solution helped Company Y to optimize their asset management, reduce costs, and improve the overall efficiency of their operations. The real-time tracking and monitoring of the assets allowed the asset management team to respond to changes in the asset status and location in real-time, thereby reducing downtime and improving productivity.

## **PUBLIC CLOUD DEPLOYMENT (4-5 pages)**

Public cloud deployment is an essential part of an Android GPS tracker as it provides a secure, scalable, and cost-effective way to host the application and its associated data. In this article, we will discuss the benefits of public cloud deployment and why it is necessary for an Android GPS tracker.

Public cloud deployment refers to the use of cloud infrastructure provided by third-party service providers such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP) to host applications and data. The cloud provider is responsible for managing the infrastructure, including servers, storage, and networking, while the user is responsible for deploying and managing the application.

One of the key benefits of public cloud deployment is scalability. As an Android GPS tracker, the application needs to be able to handle a large number of users, each with their own location data. Public cloud providers offer a scalable infrastructure that can easily handle the growing needs of the application. For example, if the application experiences a sudden surge in usage, the cloud provider can automatically add more servers to handle the load.

In conclusion, public cloud deployment is essential for an Android GPS tracker as it provides a secure, scalable, cost-effective, and reliable infrastructure to host the application and its associated data. Cloud providers offer a wide range of tools and services that can be used to store, manage, and analyze location data, making it easy for developers to build and deploy applications that meet the growing needs of their users. With the advantages offered by public cloud deployment, businesses can focus on building great applications without worrying about the underlying infrastructure.

Another advantage of public cloud deployment is cost-effectiveness. Hosting an application on-premises requires significant capital expenditures in terms of hardware, software, and maintenance. Public cloud providers, on the other hand, offer a pay-as-you-go model where users only pay for the resources they use. This makes it easy for small and medium-sized businesses to deploy their applications without incurring significant upfront costs.

Security is also a key concern for any application that deals with sensitive data, such as location data in the case of an Android GPS tracker. Public cloud providers offer a range of security measures to protect against cyber threats, including firewalls, intrusion detection and prevention systems, and data encryption. Additionally, cloud providers are required to comply with various industry standards and regulations such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA).

Public cloud deployment also offers improved reliability and availability. Cloud providers offer a highly available infrastructure with redundant servers, storage, and networking components to ensure that applications remain available even in the event of a hardware failure. Cloud providers also offer disaster recovery and backup services to protect against data loss.

Another advantage of public cloud deployment is the ability to leverage a wide range of tools and services provided by the cloud provider. For example, cloud providers offer database services such as Amazon Relational Database Service (RDS) and Azure SQL Database, which can be used to store and manage location data. Additionally, cloud providers offer analytics services such as AWS Lambda and Azure Functions, which can be used to process location data and provide insights to users.

The applications' deployment is on Google Play Store.

Google Play is a digital distribution platform developed and managed by Google, which allows Android app developers to deploy and distribute their applications to Android users worldwide. It serves as the official app store for Android devices, providing users with a wide range of apps and games for download, from free and open-source software to paid applications.

The platform offers a simple and user-friendly interface, where users can easily search, browse, and install apps based on their preferences and requirements. It also features a review and rating system, which allows users to rate and review the apps they have downloaded, helping other users to make informed decisions.

For developers, Google Play offers a powerful and efficient way to distribute and monetize their apps. To get started, developers need to create a Google Play Developer account and pay a one-time registration fee. Once registered, developers can upload their apps to the Google Play Console, where they can manage and update their apps, track their performance, and monitor user feedback.

Google Play also provides developers with a range of tools and services to help them optimize their apps for better visibility and user engagement. These include app analytics, A/B testing, app indexing, and app promotion campaigns. Additionally, developers can leverage Google Play's in-app purchase and advertising features to monetize their apps and generate revenue.

Google Play is an essential tool for Android developers, offering a convenient and efficient way to distribute, promote, and monetize their apps to a global audience. With its vast reach and powerful features, Google Play remains the go-to platform for Android app deployment and distribution.

The steps for deploying an Android application on Google Play:

1. **Create a Google Play Developer account:** To deploy an Android app on Google Play, you need to have a Google Play Developer account. If you don't have one already, create a Google Play Developer account by visiting the Google Play Console website, and follow the instructions to sign up.
2. **Prepare your app for release:** Before uploading your app to Google Play, you need to ensure that your app is properly prepared for release. This includes testing your app, signing your app with a release key, and preparing the necessary graphics and promotional materials.
3. **Upload your app to Google Play:** Once your app is ready for release, log in to your Google Play Developer account, and click on the "Create Application" button to upload your app. Follow the on-screen instructions to upload your app, and enter the necessary details, such as the app name, description, screenshots, and pricing.
4. **Set up app pricing and availability:** Next, you need to set up your app pricing and availability. Choose whether you want to offer your app for free or charge a fee, and select the countries and regions where you want your app to be available.
5. **Publish your app:** Once you have set up your app pricing and availability, you can publish your app to Google Play. Click on the "Publish App" button to release your app to the public.
6. **Promote your app:** Finally, promote your app to increase its visibility and downloads. Use Google Play's promotional tools, such as app store optimization (ASO), in-app advertising, and social media to reach your target audience and drive installs.

But, due to cost of Google Developer app I won't be using Google play to deploy it here. This is the procedure I will follow:

Here are some of the most common methods:

**Direct download from a website:** You can host your Android app on your own website and provide a download link to users. This method is commonly used for beta testing, where you want to limit access to a specific group of users.

**Over-the-**

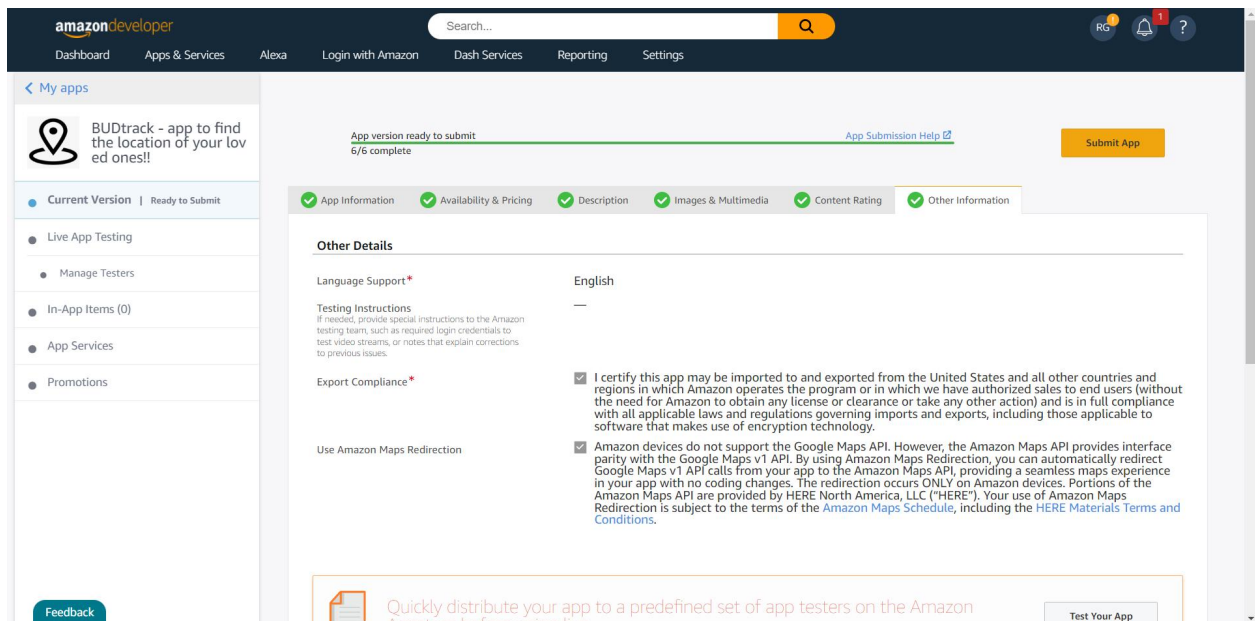
**air (OTA) installation:** OTA installation is a method of distributing an app over the air via a web link, email or text message. Users can simply click on the link and install the app without going through an app store.

**Sideload:** Sideload is the process of installing an app on an Android device manually, without using an app store. This method is typically used for installing apps that are not available o

n app stores or for testing purposes.

**Enterprise app stores:** Organizations can create their own enterprise app store to distribute apps to their employees. This method is commonly used for internal apps that are not meant for public distribution.

**Third-party app stores:** There are several third-party app stores available that can be used to distribute Android apps. These app stores may have different requirements and policies compared to Google Play or other app stores.



Application deployed on AWS developer service

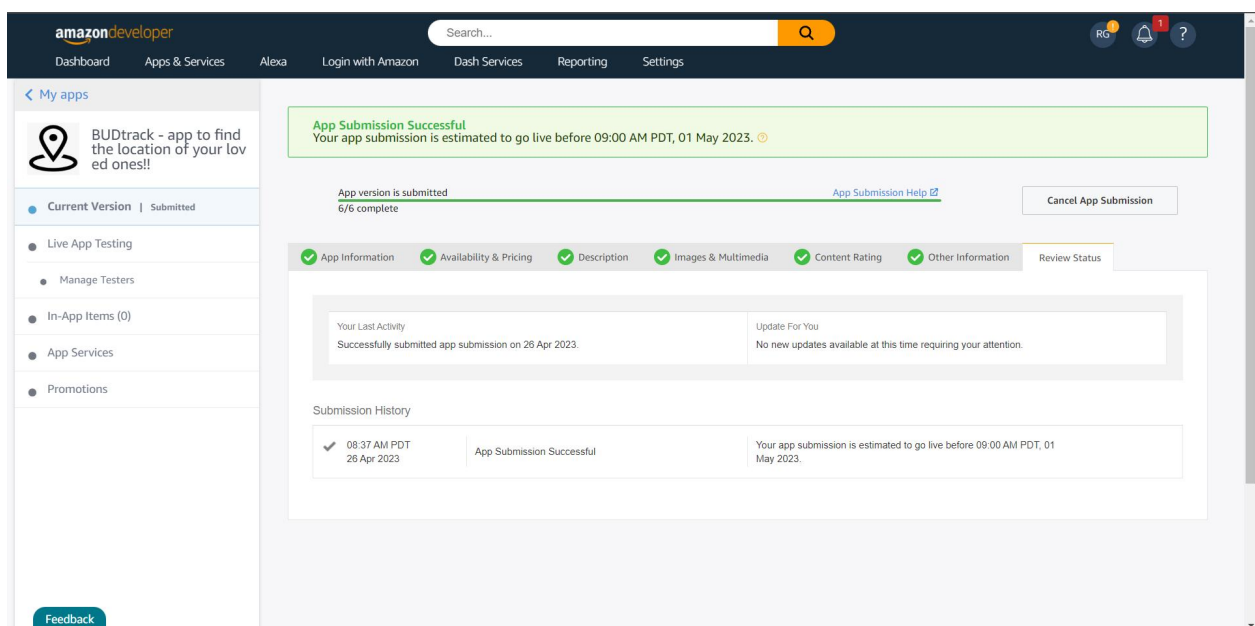
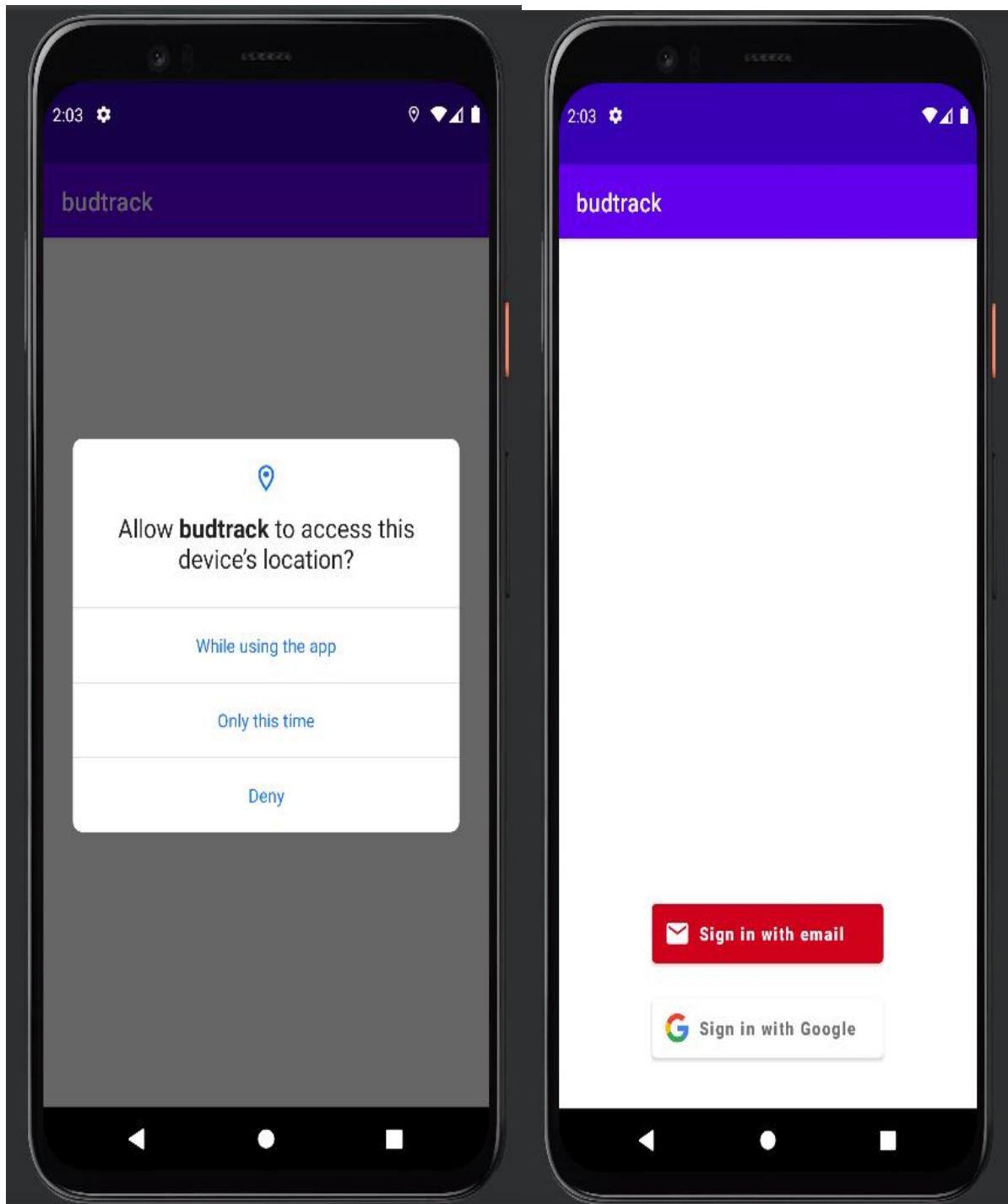


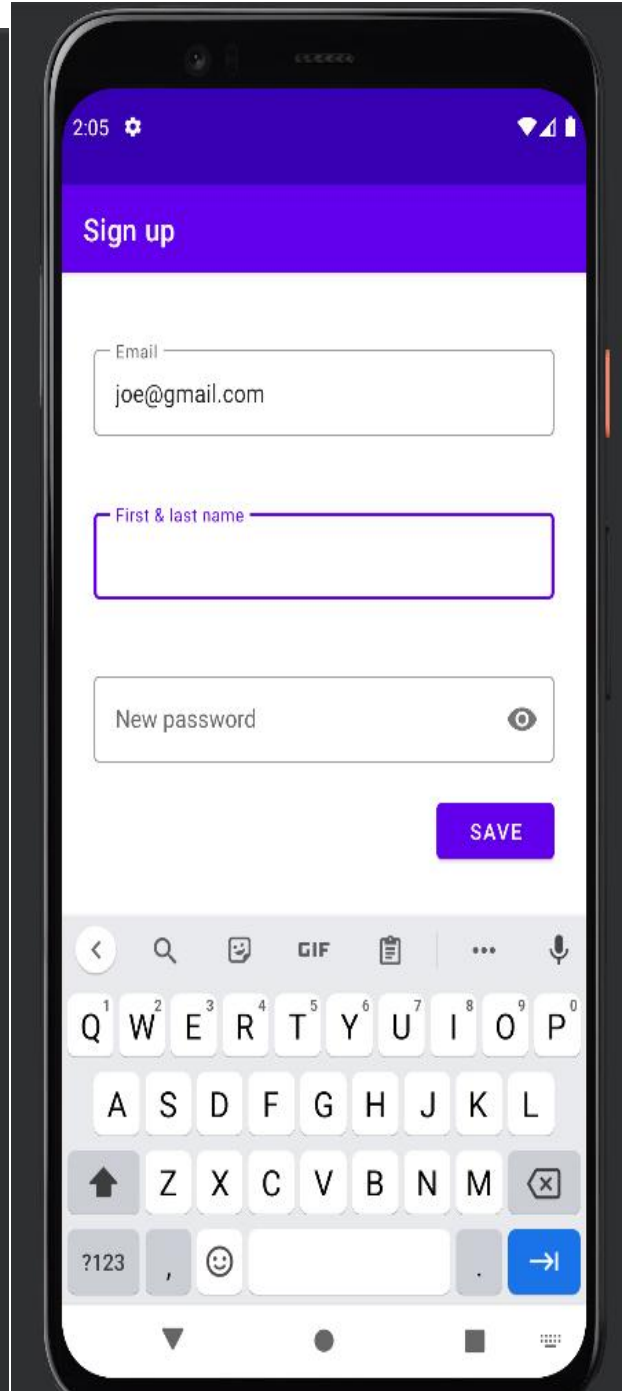
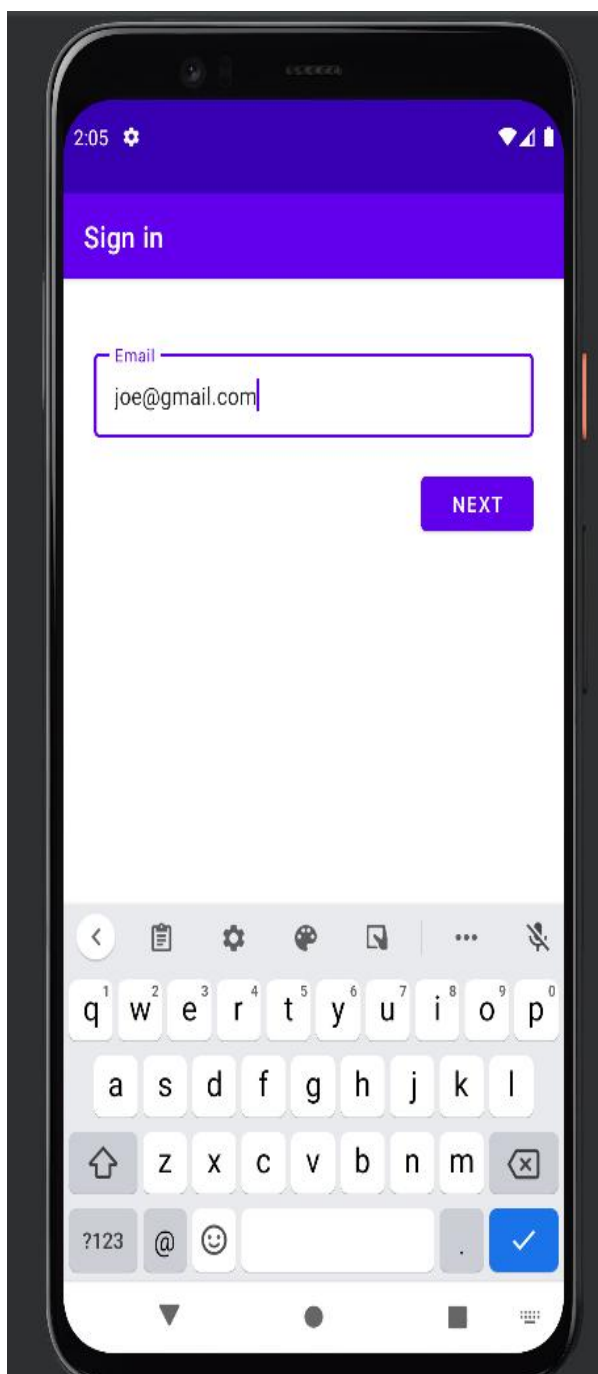
Image 1 - App to be available from 1st May



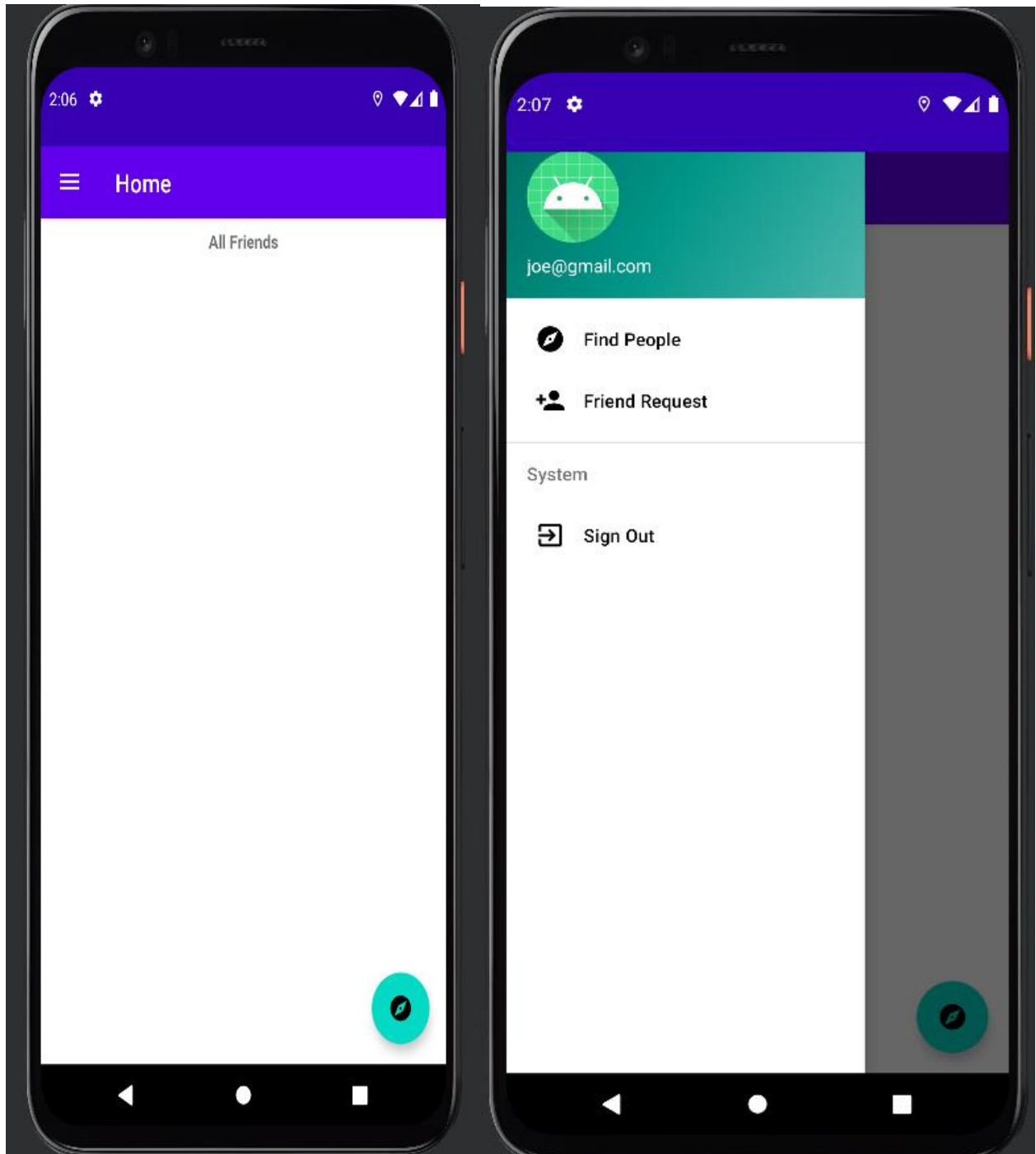
## SCREENSHOTS



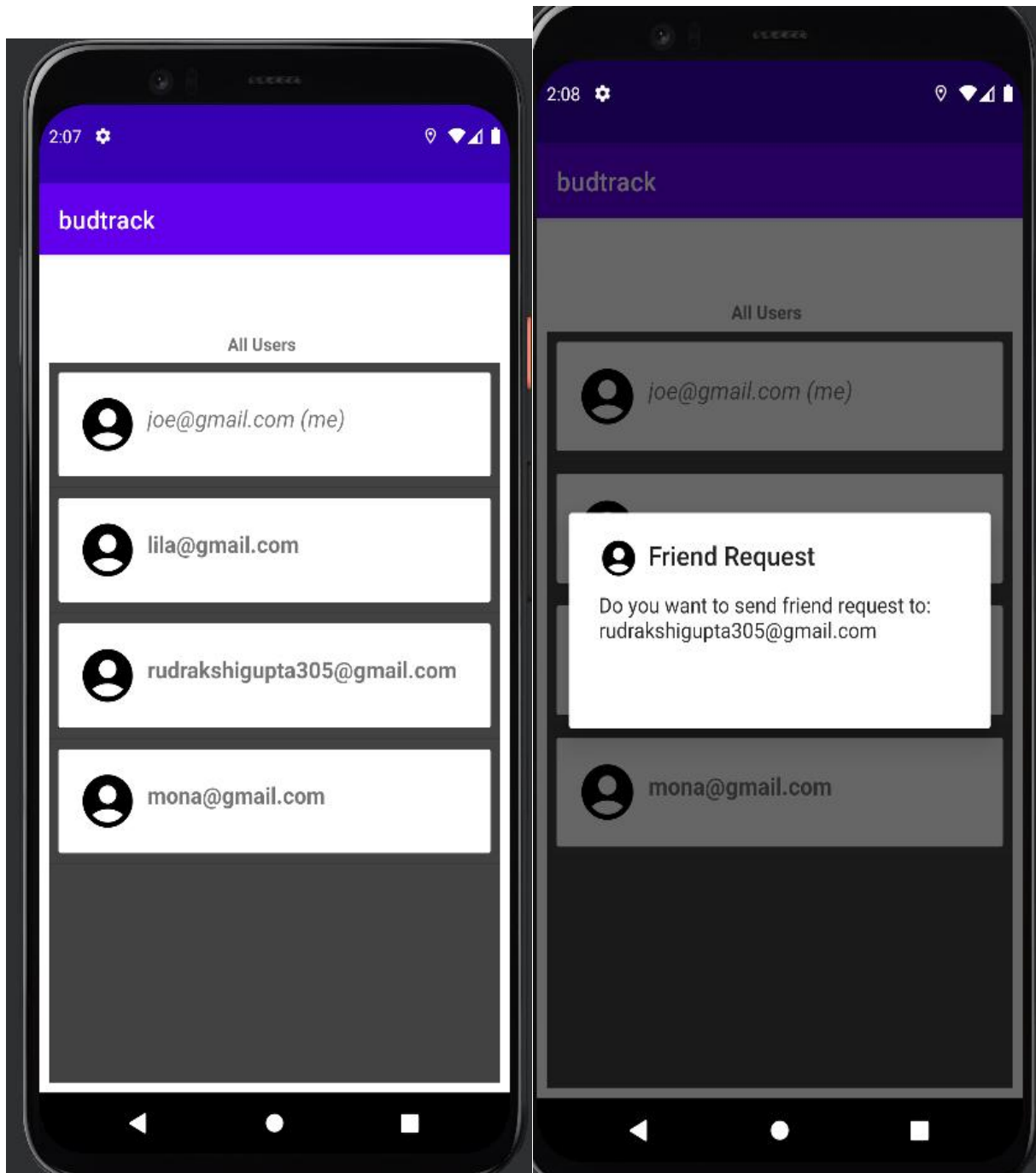
Img 1 and 2 . Asking user's GPS permission access and User Sign in providers.



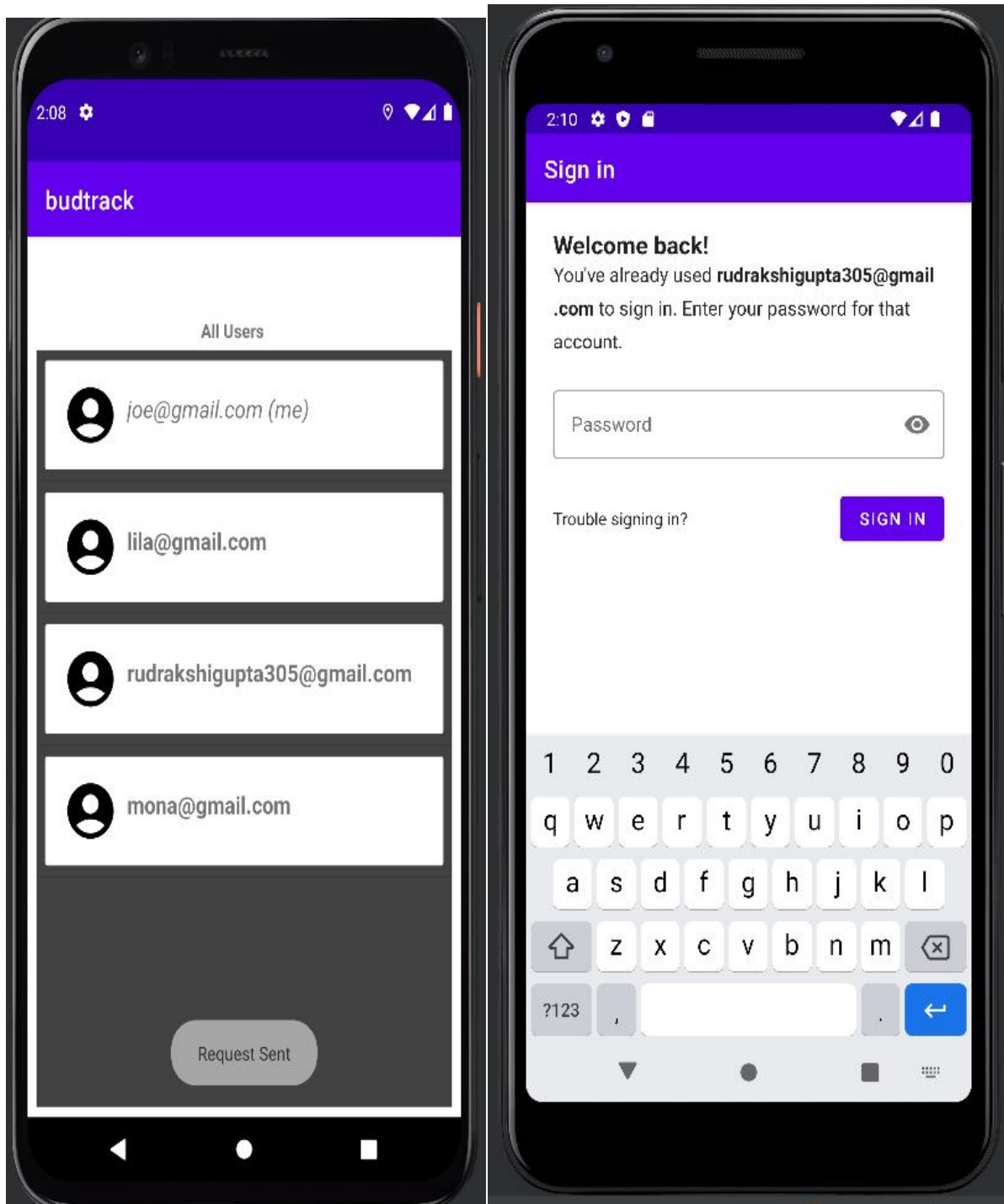
Img 3 and 4. Sign up page



Img 5 and 6. Home Dashboard and Navigation Menu and its options



Img 7 and 8 - ALL USER list and send Friend request to another user.



Img 9 and 10 . Image showing Request sent and Signing in from another user that already has an account on Budtrack

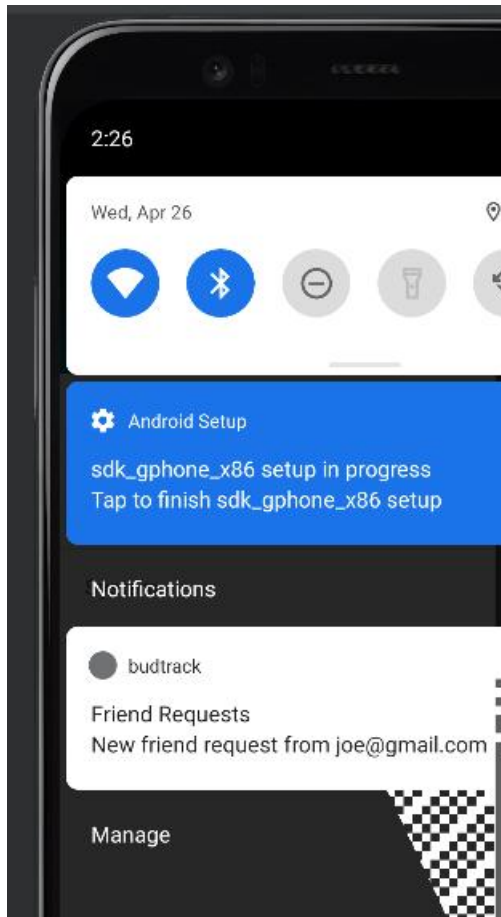
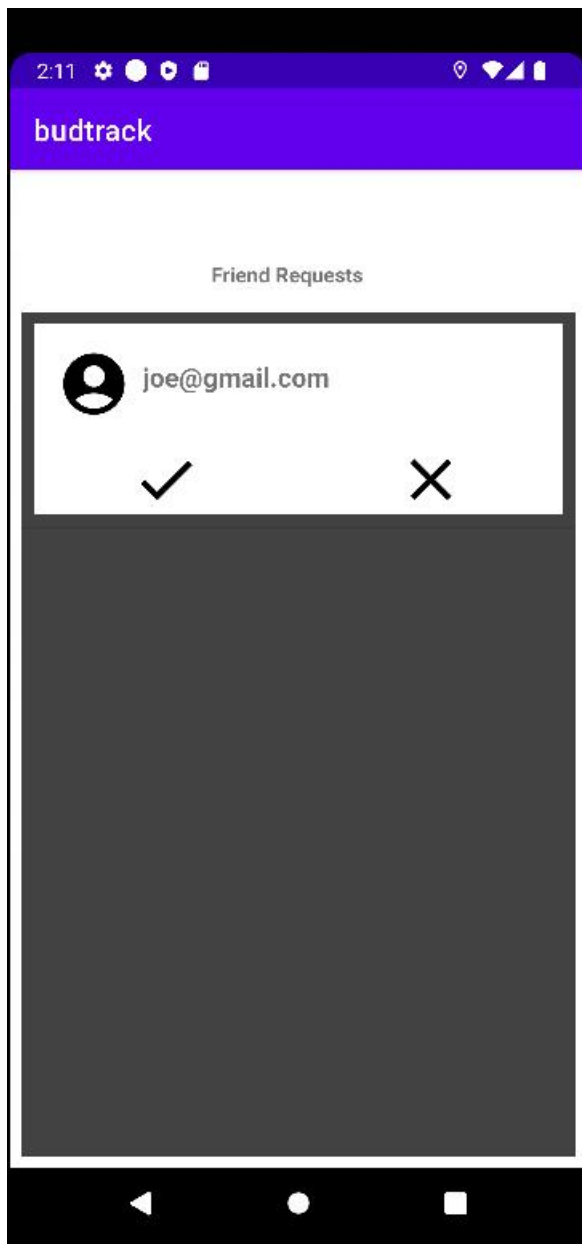
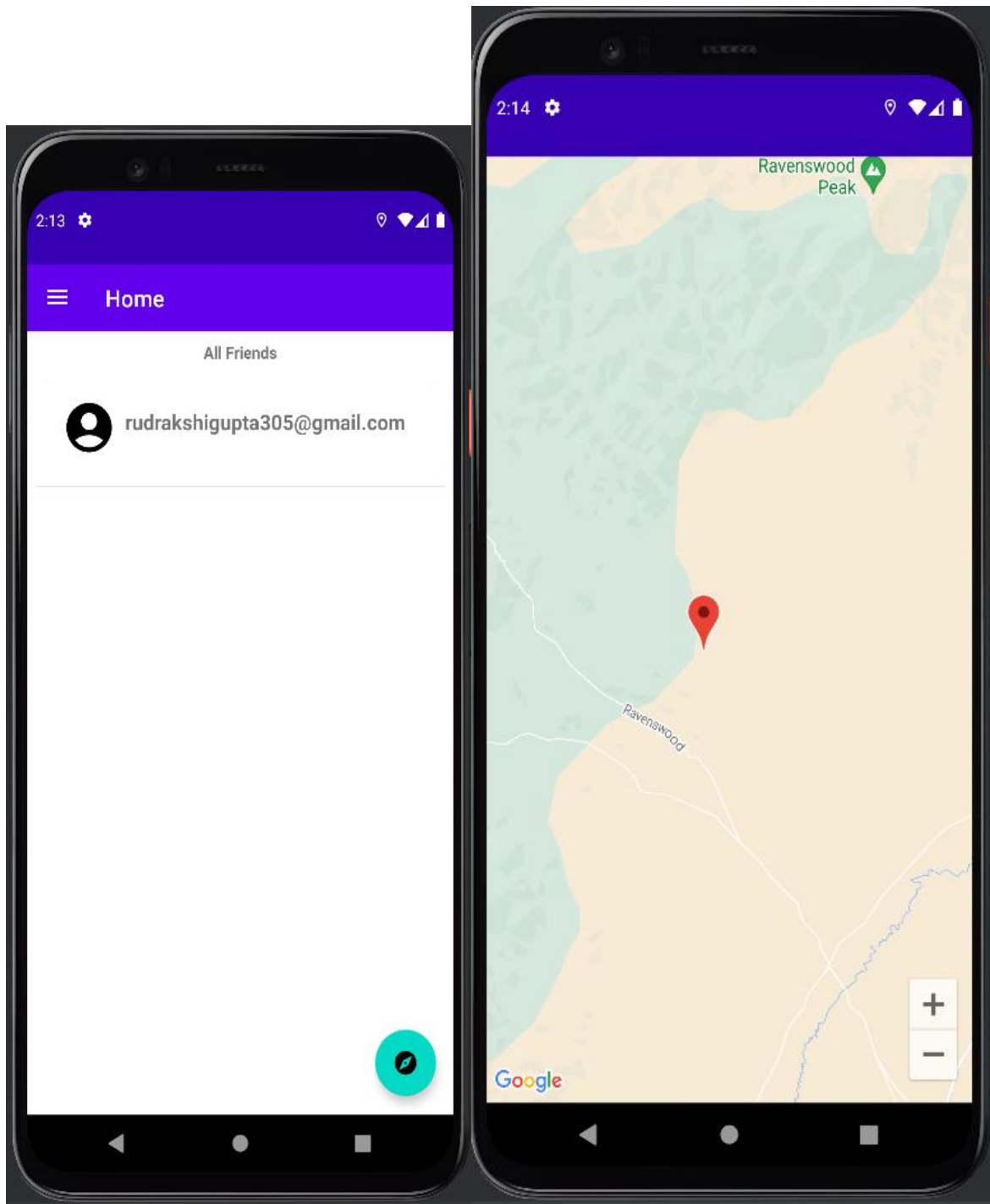


Image 11. Notifation of Friend request sent

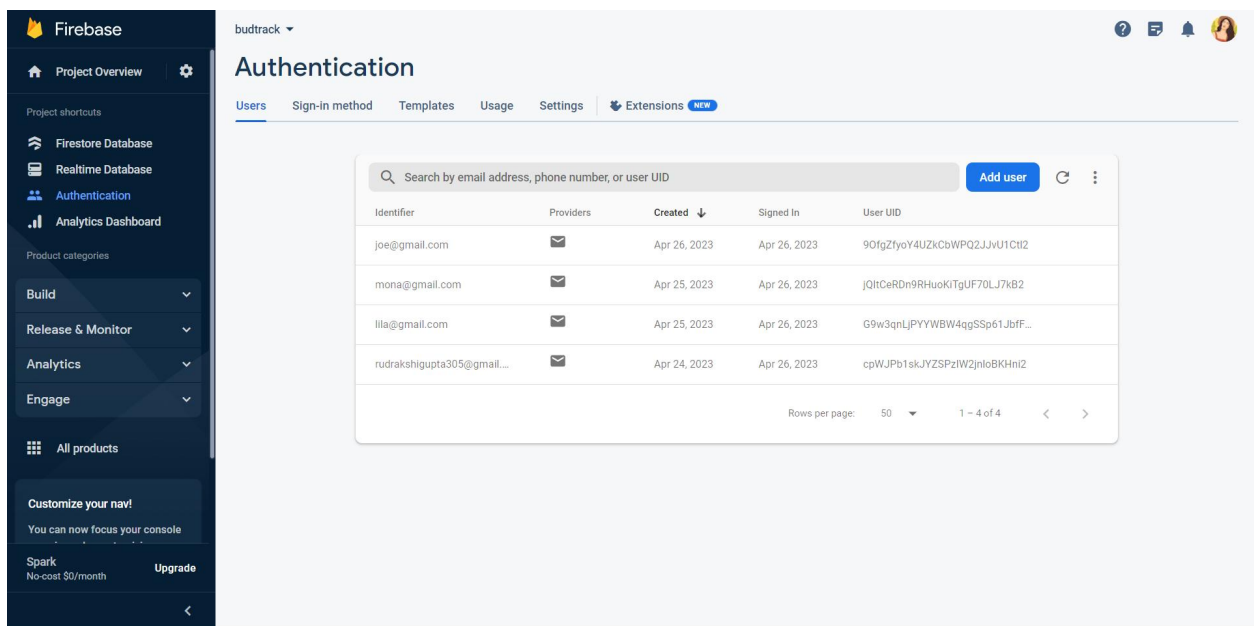


Img 12 nd 13. Friend request received in BUDtrack is being displayed and Friend request acception bein g disolayed in Friend list of an account.

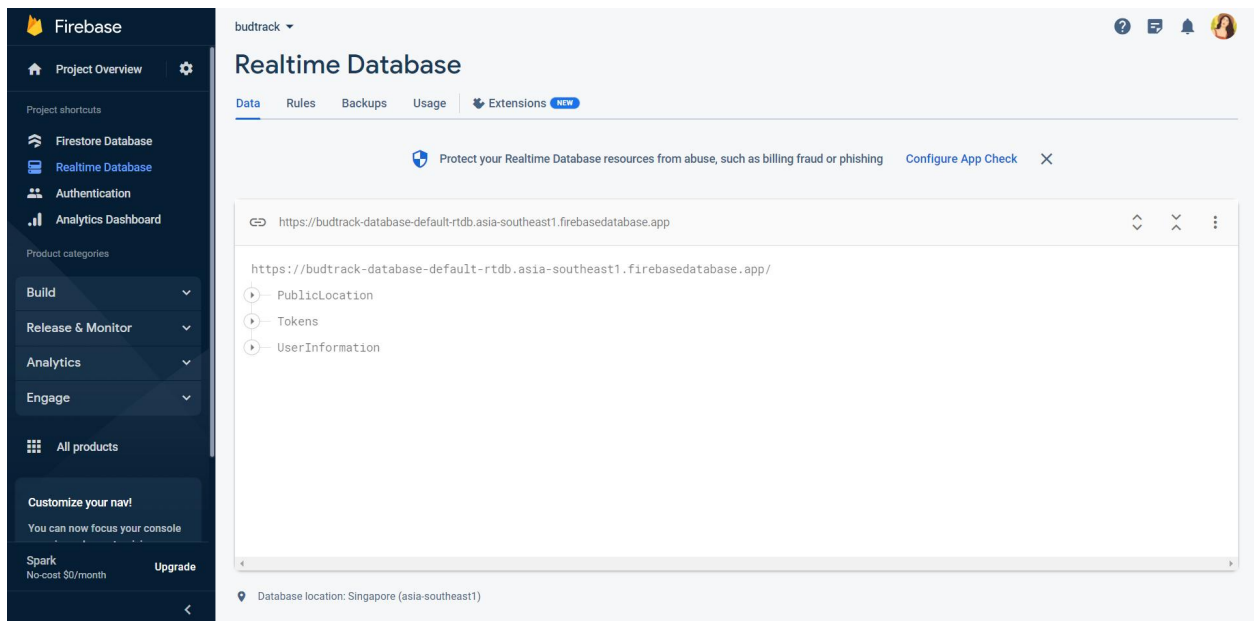


Img 14 and 15. Friend request accepted and location is being displayed on friend.

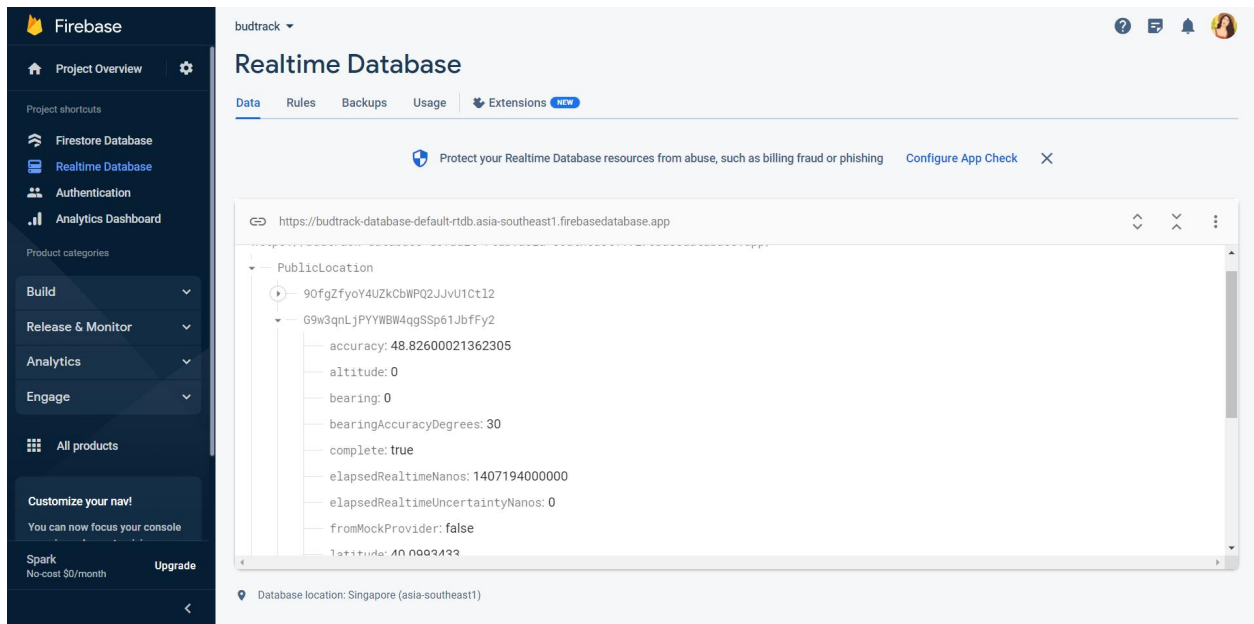




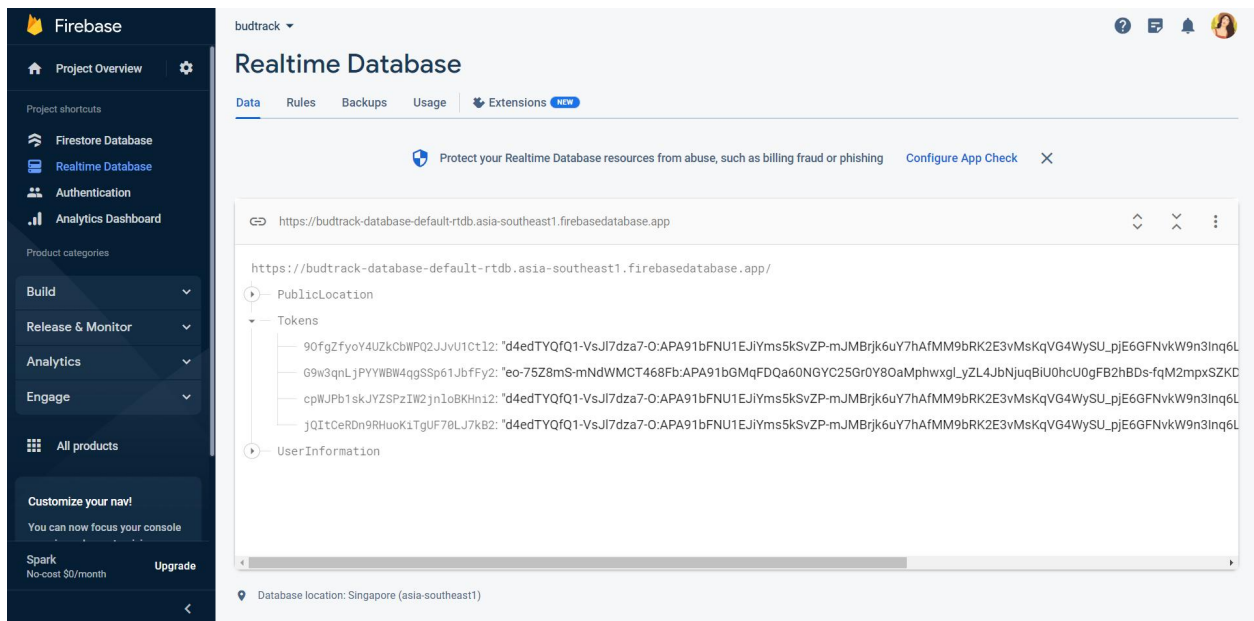
Img. 16. Firebase Authentication



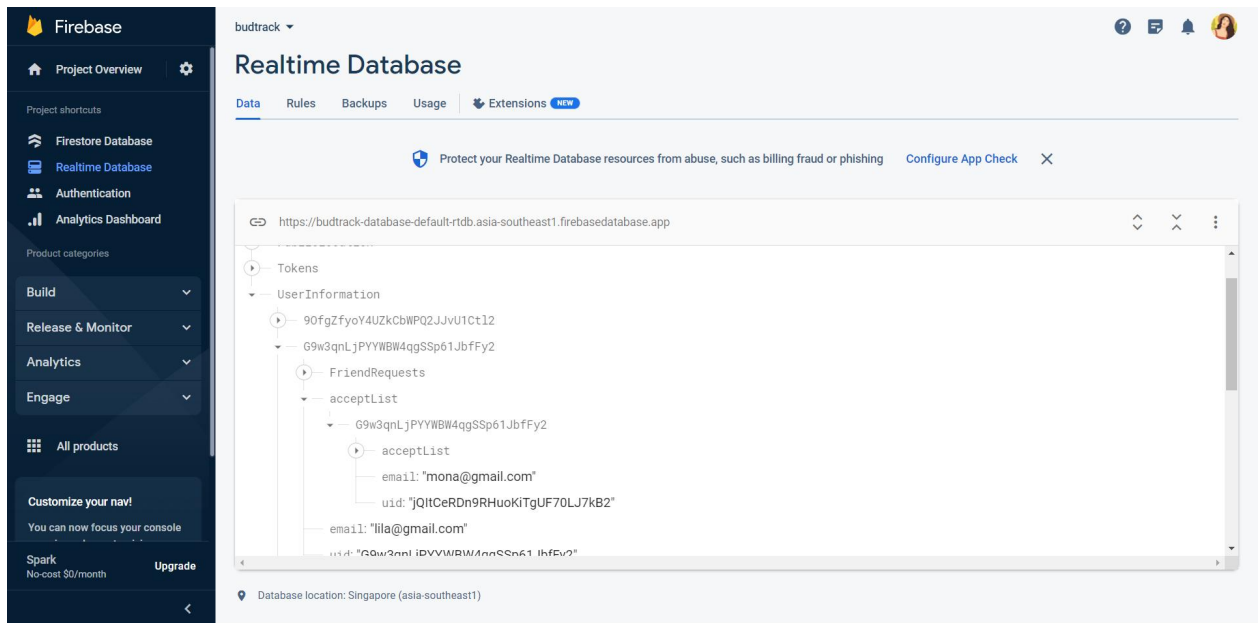
Img 17. Realtime Database



Img 18. Firebase database location data displayed.



Img 19. Firebase database tokens data displayed.



Img 20. Firebase database Friend list and accept list + user details displayed.

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