**Athlone Institute of Technology**

18

**Geo-fencing Thesis**

**Msc In Software Engineeing**

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# Introduction

# Research

## What is GeoFencing?

Geo-fencing is a feature in a software program that uses the global positioning system or better known as [GPS](http://searchmobilecomputing.techtarget.com/definition/Global-Positioning-System) or radio frequency identification to define geographical boundaries.

Geo-fencing allow an administrator to set up [triggers](http://searchsqlserver.techtarget.com/definition/trigger) so when a device enters or exits the boundaries defined by the administrator, an alert is issued. Many geo-fencing applications incorporate Google Earth and its API’s, allowing administrators to define boundaries on top of a [satellite](http://searchmobilecomputing.techtarget.com/definition/satellite) view of a specific geographical area.  Other applications define boundaries by longitude and latitude or through user-created and [Web-based maps](http://whatis.techtarget.com/definition/Virtual-Earth).

* Geofence virtual barriers can be active or passive.
* Active geofences require an end user to opt-in to [location services](http://searchnetworking.techtarget.com/definition/location-based-service-LBS) and a mobile app to be open.
* Passive geofences are always on; they rely on [Wi-Fi](http://searchmobilecomputing.techtarget.com/definition/Wi-Fi) and [cellular data](http://searchmobilecomputing.techtarget.com/definition/cell) instead of GPS or RFID and work in the background.  (1)

## What are API’s (Application Programming Interfaces)

An API is a set of [subroutine](https://en.wikipedia.org/wiki/Subroutine) definitions, [protocols](https://en.wiktionary.org/wiki/Protocol), and tools for building [application software](https://en.wikipedia.org/wiki/Application_software), they are also a set of clearly defined methods of communication between various software components. A good API makes it easier to develop a [computer program](https://en.wikipedia.org/wiki/Computer_program) by providing all the building blocks, which are then put together by the [programmer](https://en.wikipedia.org/wiki/Programmer). An API may be for a web-based system, [operating system](https://en.wikipedia.org/wiki/Operating_system), [database system](https://en.wikipedia.org/wiki/Database_system), [computer hardware](https://en.wikipedia.org/wiki/Computer_hardware) or [software library](https://en.wikipedia.org/wiki/Library_(computing)). An API specification can take many forms, but often includes specifications for [routines](https://en.wikipedia.org/wiki/Subroutine), [data structures](https://en.wikipedia.org/wiki/Data_structure), [object classes](https://en.wikipedia.org/wiki/Class_(computer_programming)), [variables](https://en.wikipedia.org/wiki/Variable_(computer_science)) or [remote calls](https://en.wikipedia.org/wiki/Remote_procedure_call). [POSIX](https://en.wikipedia.org/wiki/POSIX), [Windows API](https://en.wikipedia.org/wiki/Windows_API) and [ASPI](https://en.wikipedia.org/wiki/Advanced_SCSI_programming_interface) are examples of different forms of APIs. Documentation for the API is usually provided to facilitate usage. (2)

API’s are an alternitive to the user interface of an application, software needs an interface that makes it easy to concume data hence where API’s come in handy. So API’s are user interfaces just with different users in mind, they are used by software applications in the same way that interfaces for apps and other software are used by people. (3)

## What is Google Earth

Google Earth is a geobrowser that accesses satellite and aerial imagery, ocean bathymetry, and other geographic data over the internet to represent the Earth as a three-dimensional globe. Geobrowsers are alternatively known as virtual globes or Earth browsers. Google also refers to Google Earth as a geographic browser. Google Earth is available on the web for free as well for purchase in more advanced versions. While the free version offers numerous features that are useful in educational settings, the Pro version offers additional capabilities such as higher resolution printing and saving of images and the ability to open ESRI shapefiles. (4)

## What is Google Cloud Messaging (GCM)

This is a mobile [notification service](https://en.wikipedia.org/wiki/Notification_service) developed by [Google](https://en.wikipedia.org/wiki/Google) that enables third-party application developers to send notification data or information from developer-run servers to applications that target the [Google Android](https://en.wikipedia.org/wiki/Android_(operating_system)) Operating System, as well as applications or extensions developed for the [Google Chrome](https://en.wikipedia.org/wiki/Chrome_(browser)) internet browser. It is available to developers free of charge. The GCM Service was first announced in June 2012 as a successor to Google's now-defunct [Android Cloud to Device Messaging](https://en.wikipedia.org/wiki/Android_Cloud_to_Device_Messaging) (C2DM) service, citing improvements to authentication and delivery, new API endpoints and messaging parameters, and the removal of limitations on API send-rates and message sizes. It has been superseded by Google's [Firebase Cloud Messaging](https://en.wikipedia.org/wiki/Firebase_Cloud_Messaging) (FCM).

Google Cloud Messaging functions using server [APIs](https://en.wikipedia.org/wiki/Application_programming_interface) and [SDKs](https://en.wikipedia.org/wiki/Software_development_kit), both maintained by Google. The GCM has the ability to send [push notifications](https://en.wikipedia.org/wiki/Push_technology), deep-linking commands, and application data. Larger messages can be sent with up to 4 KB of [payload](https://en.wikipedia.org/wiki/Payload_(computing)) data. Upon allowing the application permission to receive and display notifications, the client application sends a registration API request to the Google Cloud Messaging interface to begin the registration process. The GCM Service receives and acknowledges the request and responds by giving the device a GCM Registration ID, a unique identifier that the developer later uses to send a notification to the individual device. The identifier is stored onto the device, and is typically sent to the developer's application server to be stored. The GCM Registration ID is a randomly-generated identifier that does not contain any personal or device information that could allow a developer to discover the personal identity of the user. When the developer wishes to send a notification event to a device, the process begins with an API POST request being sent to the GCM Authentication Service. The POST request includes the GCM Registration ID, priority, optional values and links, and the information that is to be displayed on the device upon its arrival. Upon successful verification of the GCM Registration ID and other credentials, an authentication token is returned. Both identifiers are then sent to the GCM Service to be enqueued and delivered to the device. (5)

## What is Vancouver Referencing

This is a numbered referencing style commonly used in medicine and science, and consists of; citations to someone else's work in the text, indicated by the use of a number which in turn then gets added to a sequentially numbered reference list at the end of the document providing full details of the corresponding in-text reference. It follows rules established by the International committee of Medical Journal Editors, now maintained by the U.S. National Library of Medicine. (6)

## Raw Enviroment

### Android studio

Android studio was developed by Google for the development of applications to run on there android operating system, it is there official IDE(Integrated Development Enviroment). It was built on the JetBrains Intellij IDEA software designed spacifically for Android development. It is a replacement for the [Eclipse Android Development Tools](https://en.wikipedia.org/wiki/Eclipse_(software)#Android_Development_Tools)(ADT) as primary IDE for native Android application development. It supports all the same programming languages of [IntelliJ](https://en.wikipedia.org/wiki/IntelliJ), [Python](https://en.wikipedia.org/wiki/Python_(programming_language)) and [Kotlin](https://en.wikipedia.org/wiki/Kotlin_(programming_language)) with Android Studio 3.0 supports Java 7 language features and a subset of Java 8 language features that vary by platform version. (7)

### Emulators

#### What is an emulator?

An emulator or Android Virtual Device(AVD) is a software device that represents a specific Android device such as phone or a tablet that can be used as a target platform to run and test your Android applications on your PC. (8) An Android emulator is installed by default during the installation of android studio. Alternitively there are other forms of emulators that can be used such as Genymotion.

#### AVD in Android studio

An installed version of Android SDK includes a virtual mobile device emulator pre installed in the program so there is generally no need for and external emulators just some settings changes depending on if the user is using an Intel processer or an AMD processer machine. This tends to be quite a slow emulator if the machine has slow processing power which is why some people use other external emulators such as Genymotion.

#### Genymotion

Genymotion is an external Android emulator that is not already built into Android Studio, it requires the user to download Genymotion on their pc and to set up the android device enviroment on that and then after the device is picked and set up they would have to then go onto Android studio and set up the plugin on there so that they would be able to use Genymotion as the emulator for their Android development project.

### GitHub

GitHub is a web based hosting service for version control using git, it is mostly used for users to upload and store source code. It can provide access control and several collaboration features such as bug tracking, feature requests, task management and wikis for every project. Users can set up their own private free accounts which can be used to host their open source code on. (9)

# User Stories

## Introduction

User stories are part of an agile approach that help shift the focus from writing about requirements to talking about them. They are short, to the point and simple descriptions of a feature told from the perspective of either the customer, developer or user of the system benn made. They are usually written like;

As a <?user, customer, developer?>, I want to <?what you wish to achieve?> so that <?reason for wanting to do that?> (10)

These are generally wrote out at the start of a project and then the are segragated into jobs that need ton be completed for each scrum, they are normally wrote on post-its or pages and stuck on a wall where the whole team are able to see what is done or needs to be done, they are put into catagories such as; To Do, In progress or Complete.

## User stories implemented

|  |  |  |  |
| --- | --- | --- | --- |
| **User Story** | | **Acceptance Criteria** | |
| As Unregistered user  I want to See a sign-up link or button  So I can Enter my details to create my own profile | | a) Form to enter personal details b) Button to go back to sign-in page c) Button to confirm details | |
| As A user  I want to Be able to create my own account  So I can Have my own private user account | | a) Necessary to keep each users data separate and private b) HQ or office can track each users activity | |
| As A user  I want to login to the website  So I can access my account and use its features | | a) Email and password is required b) Login is visible on home screen c) Error message appears when email or password is incorrect | |
| As A user  I want to create a geofence  So I can keep my area safe | | a) pick boundries b) set up secure location c) set up push notification message | |
| As A user  I want to Use a search bar  So I can Search for specific locations | | a) Have a search bar to look up location to place barriers | |
| As A user  I want to Pick barrier locations easily  So I can Have my location safe quickly | | a) Quick GPS location on device b) Updated software on device c) Pick 3-4 barriers | |
| As A user  I want to Store my barrier locations  So I can Easily set them in the future | | a) Store locations in user profile to be used again | |
| As A user  I want to Use my stored locations  So I can Know in the future where there has been less activity | | a) Store location details in a log b) Have a menu to access the logs | |
| As A user  I want to Receive notifications  So I can know if the area im entering is safe to do so | | a) allow all push notifications  b) monitor activity to know if area is safe or not | |
| As A user  I want to Send notifications  So I can Keep my team safe in our location | | a) Set up push notifications b) let on comers know there is divers in the area | |
| As A user  I want to store safest Geolocations in a log  So I can check in the future which location is the safest | | a) store locations in a log b) store how many times the boundry has been breached c) keep account of which location has the least amond of breaches | |
| As A Developer  I want to store login details in a database  So I can keep track of all users accounts for safety reasons | a) Log Username Passwords  b) keep personnel information safe so users can use the app safe and securely | |
| As A Developer  I want to set up pages for register and login  So I can make it easier for the user to create there own accounts | a) set up home page with area to login and have a sign up button b) set up register page so the user can create there own account | |

# Architecture and Design

The users of this app will have it downloaded on there device firstly, they would be brought to a Login page, if they are unable to login it means that they will need to register on this app to create their own account after registering they will be brought back to login again where this time there attempt will be successful. Upon logging in they will be prompted to pick the boundries around their geo-location if they are a returnning user and do not wish to pick new boundries it means then they may want to look at stored geofences in their database, once either one of these steps are completed they will move forward to set up the Push notification that will be sent out if the boundry is breached, this step is a must and the user will not be able to move on to the next step unless this is done, when this step is been done in the background steps 1 – 3 are been completed of the push notifications chart;

1. The android device will send its sender id and application id to GCM server for registration.
2. When Registration is complete, GCM server issues registration id to android device.
3. After receiving registration id, the device will send registration id to the database for further use.

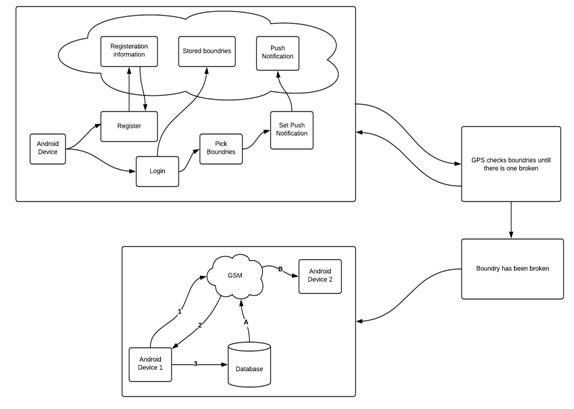
After the Push notification have been set up and boundries are all picked the GPS on the device monitors the location, it keeps checking to see if the boundries have been broken and if they have not been it keeps going in a loop until it has been broken, this then triggers the Push Notification to be sent out to the device that has broken the boundry, this is done by completing step A & B of the push notification chart;

1. Whenever push notification is needed, our database sends a message to GCM server along with device registration id
2. GCM server will deliver that message to the android device using the device registration id.

Once this step is then done the app automatically jumps back up to monitor the area and thus going in a constant loop untill the user logs out of the app.

## How Push notifications work

1. The android device will send its sender id and application id to GCM server for registration.
2. When Registration is complete, GCM server issues registration id to android device.
3. After receiving registration id, the device will send registration id to the database for further use.
   1. Whenever push notification is needed, our database sends a message to GCM server along with device registration id
   2. GCM server will deliver that message to the android device using the device registration id. (11)



## What I expect to see as a cutomer of this product?

As a customer of this product and an active member of the Sub Aqua Club what I would like to to see from this product is if I was out diving with the Sub Aqua Club and there was a group of us Diving in a built up area maybe a wreck for instance that we could set up a geo-location boundy around us so if any other boats come into that boundry it will send an alert to the other vesile so they know there is divers in the water.

## How it is going to be implimented and programs needed?

Firstly I will check that i have all the necessary pre-requisites. These include will:

* Android Studio
* An Android device that runs Android or a configured Android emulator. However in order to test entering and leaving a GeoFence, a real device that can be moved around is needed
* The latest version of the Android SDK including the SDK tools component.
* The Google Play Services SDK.

After I have done this step I will then go on to setting up my Android studio and beginning to write my code

## What OS and Why?

The Operating System (OS) im going to be implimenting is Android, there is no clear winner as to which OS is better they are both very evenly matched I have just choosen Adroid as I am an Android OS phone/tablet user and also because I have coded in Android studio before so I will be comleting this project in Android

## What is an API and what ones will be used in the implimentation of the program?

An API (Application Programming Interface) is a set of methods and tools that can be used for building software applications.

Google Maps API will be used in the implimentation of theis project they allow you to display maps on your web site.

Google Cloud Messaging (GXM) will be used to store information needed for push notifications to be sent out

# Test and Code Examples

# Future work and Conclusion

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