Location Racing

Research Document

By

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1. Abstract

This report was commissioned to investigate the possibility of creating a racing game that has the ability to detect a players GPS location and to produce an interactive race track for them to race around that is modelled on the real life streets surrounding the player.

Consideration has also been given to detecting any additional players in your area and creating a multiplayer experience by using cloud technologies to achieve this.

Many mobile platforms, map data providers, development tools and cloud computing products have been investigated to determine which combination of these applications will produce the best possible experience for the player.

After investigation is has been discovered that the correct combination of Open Source and free applications seems to be the best choice to develop the application.

- Android Platform
- Eclipse IDE + LibGDX game engine
- OpenStreetMaps map data
- Google App Engine

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2. Introduction

Have you ever played a racing video game like Gran Turismo, Project Gotham Racing or Forza motor sport? Well if you have you will notice that these games include real life tracks and street circuits from various locations around the world.

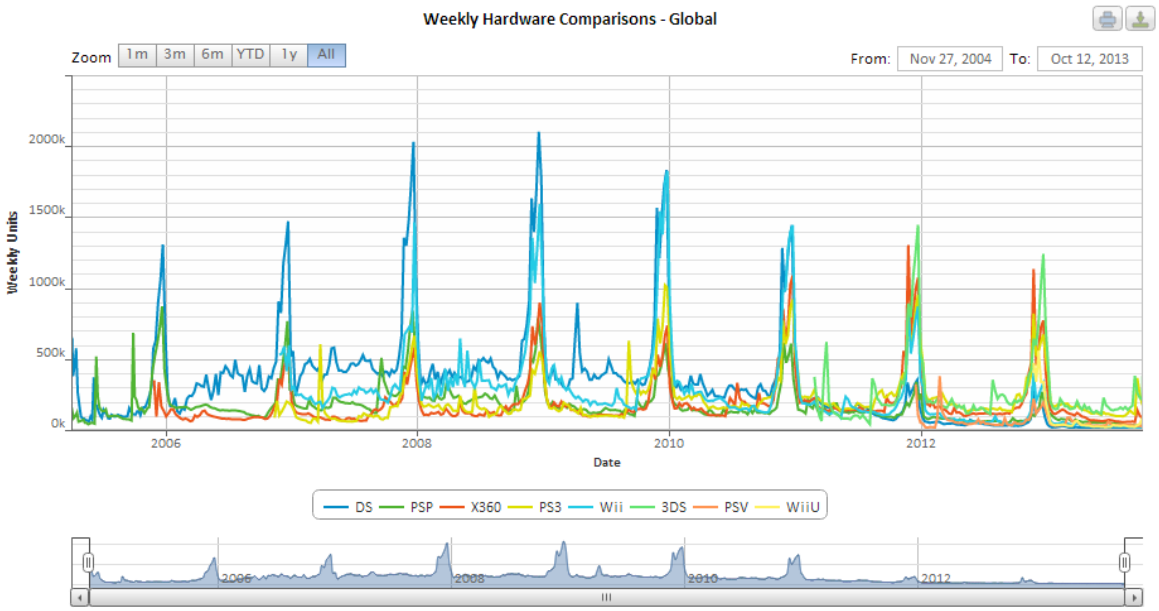
Some of these famous circuits from Forza Motorsport 4 are Nürburgring Nordschleife, Silverstone Circuit, Indianapolis Motor Speedway and Hockenheimring. (Forza, 2013) While some of these famous street circuits of Project Gotham 4 are taken from the streets of Tokyo, New York, Las Vegas and Shanghi. (Gotham, 2013)

The problem here is that most people that are playing these games have never been to these real life locations. That means that there is a pretty steep learning curve when a player is trying to get to know these circuits so that they can race against others competitively on these circuits. Imagine if you were playing online against guys who live in these locations. These guys would have a competitive advantage over you because they know the street circuits inside out.

What if we levelled the playing field? What if there was a game developed which detects your location and generates racing circuits based on the real streets around you? Now you will be able to race around your own street circuits based on your own streets.

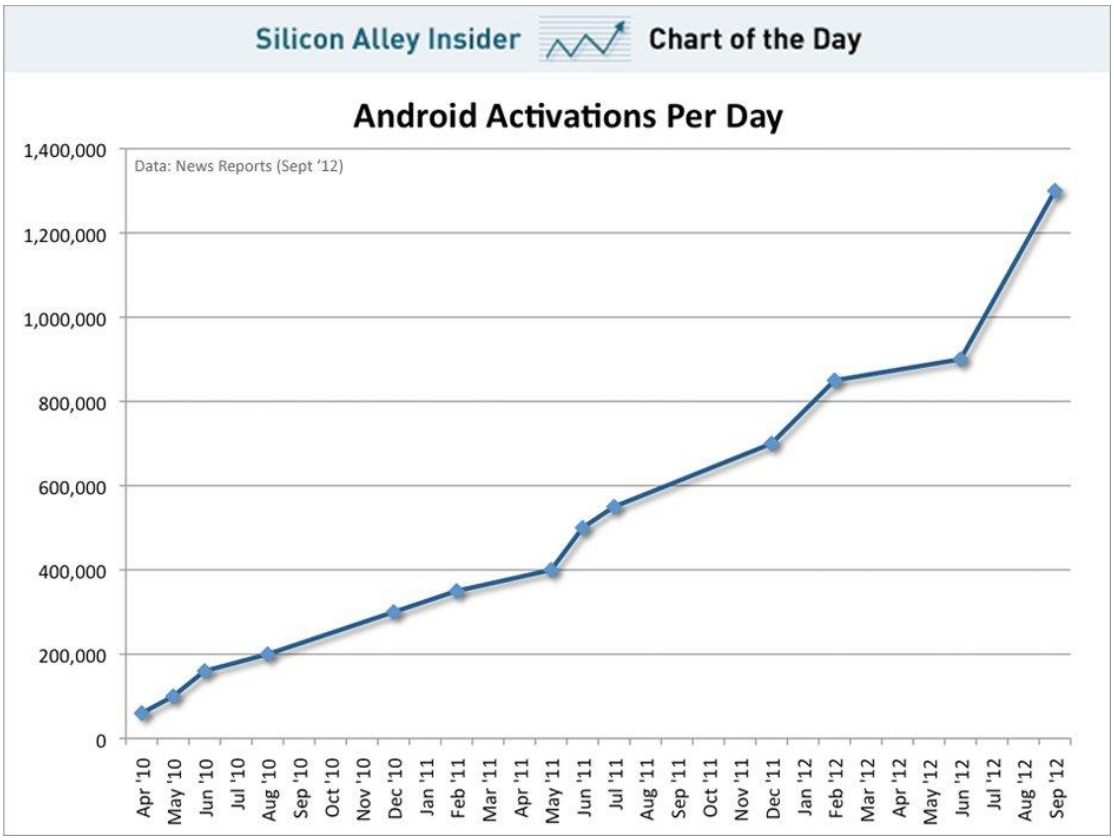
This will level the playing field and so that players can the most important part of racing, who will be the winner.

The recession has hit many industries hard but the video game industry seems be one area where people are still willing to spend money. The graph below shows that even when the recession hit in 2006 the sales in gaming consoles steadily increased and peaked in 2009. The rate of decline up to the present day has only come back down to the sales figure of 2006. (VGChartz, 2013)



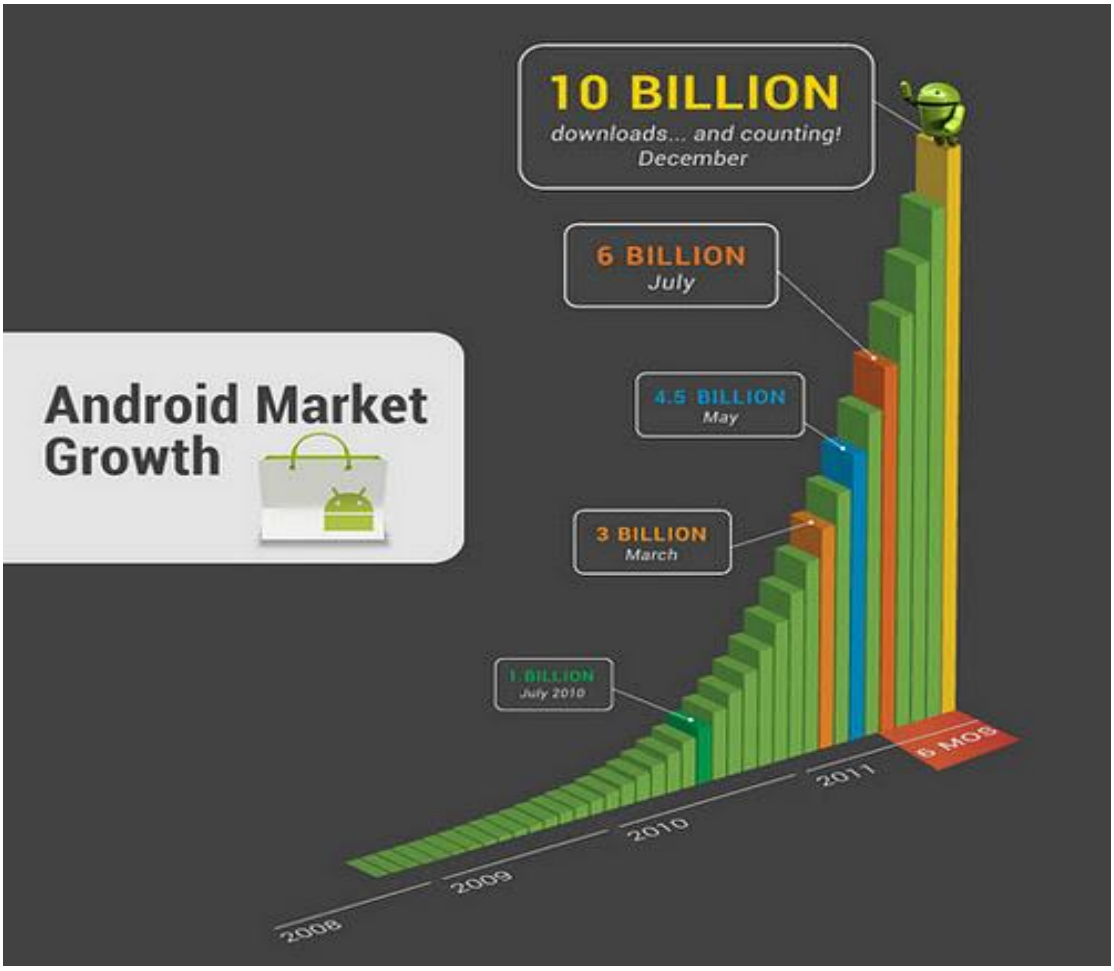
The reason for this decrease is more to do with the fact that the current generation of consoles are nearing the end of their lifecycle rather than the recession being a major factor. The new Wii U has been released, the Xbox One has been announced and is going on sale in 22nd of November 2013 (Xbox_One, 2013) and the PlayStation 4 is release is being staggered and its earliest release date 15th of November 2013. (PlayStation_4, 2013)

Also, the demand for so called "casual gaming" is increasing at a phenomenal rate. This is due to the exponential sales of Android phones and iPhones. In September 2012 Google announced that 1.3 million new Android devices are being activated every day. (Yarow, 2012)



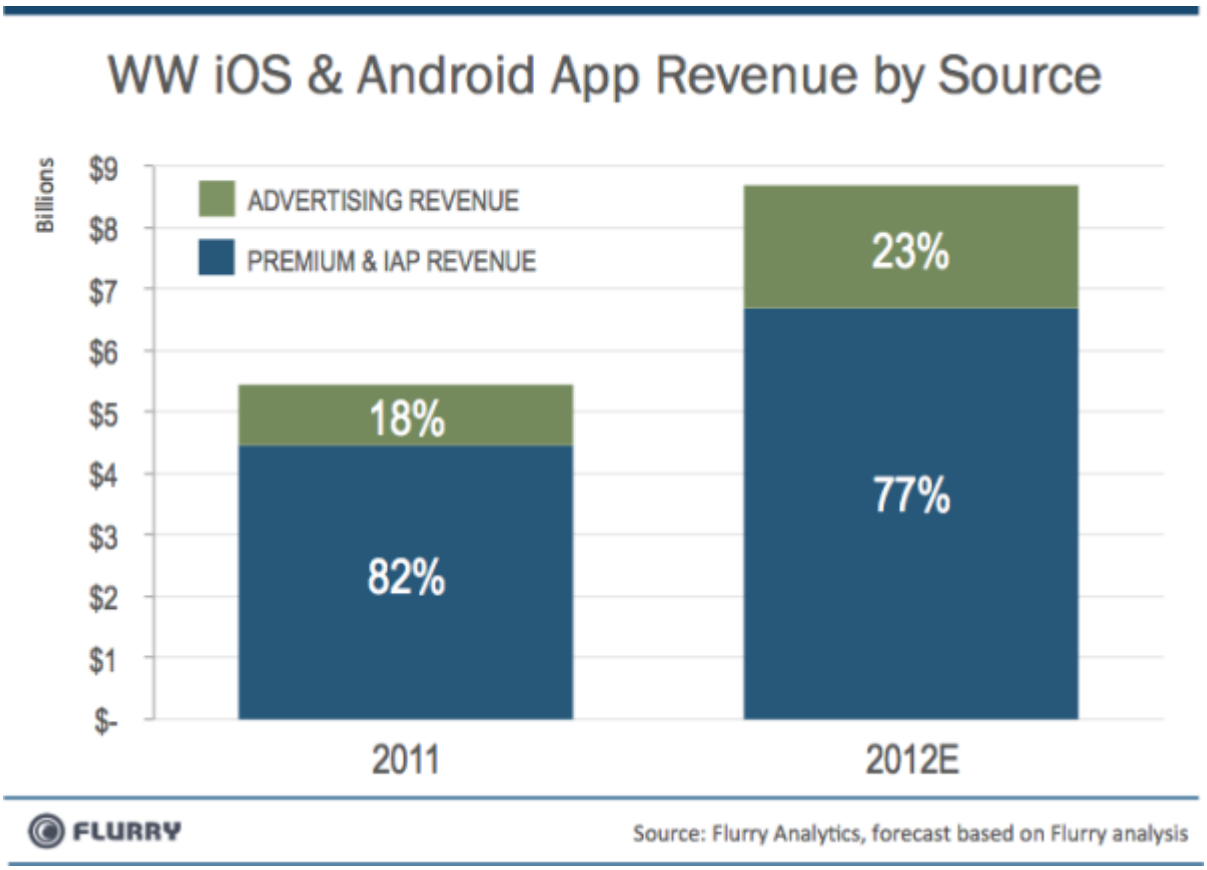
In September 2012 Google announced that 500 million Android devices had been activated. The figures that are in now claim that a whopping 1 billion devices have been activated. That means that in the space of a year the amount of Android devices that have been activated have doubled in a year. (Reed, 2013)

With that many Android devices being activated per day it's safe to say that the amount of downloads from the Google Play Store is going to increase massively also. The graph below only shows the amount of downloads up to 2011. (Chaffin, 2011)



The figures from July 2013 say that the amount of downloads from the Google Play Store topped 50 billion downloads. If you look at the figures it shows that it took over 3 years for the download count to reach 10 billion whereas in the following 1.5-year period the download count increased to 40 billion downloads. This rate of growth is phenomenal. The amount of apps available to download from the Play store topped 1 million. (Play, 2013)

To sum up this information up the number of app downloads are increasing at an exponential rate. Even if an application is developed and distributed free of charge, there is still a great opportunity to make money from in-app advertising. Flurry.com reported that “Advertising is the fastest growing revenue category with growth forecasted at more than 100%, from 716.16€ million in 2011 to 1.46€ billion in 2012, delivering 23% of 2012 total revenue.” (Gordon, 2013)


WW iOS & Android App Revenue by Source
Billions
$9
$8
$7
$6
$5
$4
$3
$2
$1
$-
ADVERTISING REVENUE
PREMIUM & IAP REVENUE
18%
82%
23%
77%
2011
2012E
FLURRY
Source: Flurry Analytics, forecast based on Flurry analysis

3. Similar Applications

There are many applications on the market that use Google maps as the main feature of their application. These uses can range from an app that can show you the location of all the earthquakes that occurred on earth on a particular day to an application for a restaurant franchise that can give you a list of the closest stores based on your location.

These types of applications can run on a lot of different devices as long as the map data provider has developed an Application Programming Interface (API) for the technology that the host device is going to use.

3.1.Endomondo

Platform:

- Web Application
- Android
- iOS
- Windows Phone 7
- Windows Mobile
- Blackberry
- Symbian
- Java

(Endomondo Platforms, 2013)

Endomondo is a fitness application which takes advantage of the Google Maps API. The application allows a user to create an account on the website and map out a route that they want to run.

The user can use www.endomondo.com or their mobile device to mark out any route they like in any part of the world just as long as that area of the world has been mapped out by Google Maps. The route that the user picks can be a road or a track of some sort that Google Maps can recognise. For instance, if the user wants to stay on roads that have been logged by google then they can choose an option “Snap to road”. This will keep their route confined to the roadway. If the user creates a route on the website, the route will be automatically synced to their account on their mobile device and vice versa.

Alternatively if the user wants to play golf or go swimming in a river the can deselect the “Snap to road” option to map a route that is off the beaten track and that is not marked as a road in Google Maps. This will allow them to map a route up a river or across a mountain.

Also the user can upload various types of file formats to Endomondo through their file upload process. Some of the file formats are .gpx, .tcx and .fit.

Endomondo also allows the user to see the total distance of the route that they have mapped out and also the elevation of the route at each point of the journey. The application caters for

many different sports enthusiasts buy allowing them to plan routes for a vast range of sports. Some of these sports include running, cycling, mountain biking, golfing, kayaking, etc.

When the user wants to run the route that they have created they can choose to use the mobile application to record their effort. The mobile application will keep track of their location, the length of time it took them to run the route, the amount of steps they have taken, the fastest kilometre, average speed per kilometre, calories burned, hydration, minimum and maximum altitude and total ascent and descent.

Endomondo focuses on the social side of fitness. You can link your account to your friends account so the both of you can see how each other's progress is going. Also, when a friend of yours is out running you have the option to give them a pep talk. Endomondo allows you to type a message to your friend and the mobile application will read the message to your friend.

By using the social approach this application allows you to see any routes that have been created by other users. You can choose to try and beat the other user's time or just simply run the same route as the other user. (Endomondo, 2013)

3.2.Hailo

Platform:

- Android
- iOS

Hailo is a mobile application which allows a user to hail a taxi. The Hailo application uses GPS and makes it easy for a user to hail a taxi by displaying all of the taxis in the area of the user on a map and by displaying a real-time estimate of how long it will take for the taxi to arrive.

Each user of the application has to create an account in order to use the service. The reason for this is so that the user can choose to pay for a fare through the application using their credit card and also to build up a profile as a reliable customer.

The user can see who the driver of the taxi is and view the drivers name, their rating, their door number and a photo of the driver. The user can save their credit card information in the application so that they can pay for the fare all through the application. The payment option makes it easy for someone to pay for a taxi when they have no cash on them.

The application uses real-time locations of both the user and the taxi driver to inform both parties of each other's locations. When the user has requested a taxi a message is displayed on the screens of all of the drivers in the area to inform them that someone has requested a taxi. (Hailo, 2013)

When the request is displayed on screen, the drivers can see where the customer is and how the distance they are from the driver. If the driver accepts the fare then they make their way towards the customer. The driver's location is displayed to the customer while he approaches the customer. When the driver is outside of the customer's location the driver presses an "Arrived" button to inform the customer.

A message displays on the customers phone to inform them that the taxi has arrived. When the journey is complete both the taxi driver and the customer can rate each other so that everyone is given the best possible experience. (Hailo, 2013)

3.3.Real World Racer

Platforms:

- Web Application

Real World Racer is an application that has been developed by a man called Tom Scott. The application allows users to choose two destinations in Google Maps and then race from the starting point to the finish point against three computer generated opponents. The application also allows the player to select from some pre-defined routes in locations like Boston, Spain, France and Sydney.

When the player chooses a start point and an end point for the race, the route is calculated by determining the shortest distance from point to point. This route is calculated and plotted onto the map by Google Maps.

When the map is displayed the starting point of the route is loaded to the screen. This is a static screen and the view of the map is an overhead view. This is the standard view that Google Maps provides. The player cannot see the finish point on the screen because the zoom level has been set to show only a small bit of the course at a time. Four cars are also displayed on the screen at the starting point.

The player must use the arrow keys on the keyboard to control their car. Up accelerates the car, down brakes while left and right steer the car.

The map displays in satellite view so that the user can see the buildings and landmarks on the map. The race is mapped out like any other route would be mapped out when using Google Maps. As the player drives along the street they have to stay on the road. In order to guide them there are a number of check points set along the route that the player's car has to drive through.

Because the screen is static the car drives along the road without the camera view being constantly centred on the car. This means that the car can drive anywhere on the screen without the screen having to change. Once the user follows the route off of the screen, the screen is refreshed to display the next section of the route. This keeps happening until the finishing point is displayed on the screen.

The winner is the car who is the fastest to negotiate all of the check points and to reach the finishing point. One of the drawbacks to this application is that there is nothing to prevent the player car from driving off of the track. The player can drive through buildings and they can drive through water without it having any negative impact to the game. (Scott, 2013)

3.4.2D Driving Simulator on Google Maps

Platform:

- Web Application

The 2D Driving Simulator on Google Maps application is very similar to the Real World Racer application except that it is not a race. This is a single player driving experience. The player must use the arrow keys on the keyboard to control their car. Up accelerates the car, down brakes while left and right steer the car.

The idea behind this application is to drive freely around anywhere in the world without paying a cent for petrol. The application was developed using the Google Maps API for Flash. Google have announced that they will be dropping support for Google Maps API for Flash so using this technology is not a viable option. (Google Blog, 2013)

The view of the car in this application is also an overhead top down view. By using the Google Maps API for Flash the application could run at 40 frames per second. Also the camera could stay centred on the car. This means that he player could drive around for as long as they like without ever having to drive off of the screen to refresh the map. This feature makes this game a lot more enjoyable to play and far more visually appealing than Real World Racer.

Another difference between this application and 2D Driving Simulator on Google Maps is that in this application the player cannot specify a beginning and end point for their journey to take place. They can only pick a location and drive around it without having the ability to race against anyone, whether they are computer generated or human opponents. (Kobayashi, 2013)

3.5.3D Driving Simulator on Google Maps

Platform:

- Web Application

3D Driving Simulator on Google Maps is created by the same team that brought you 2D Driving Simulator on Google Maps. The only major difference between 3D Driving Simulator on Google Maps and 2D Driving Simulator on Google Maps is the angle of which the players view is set at. The view in 3D Driving Simulator on Google Maps isn't directly overhead. The view looks down on the map at about a 60 degree angle.

This gives the player the impression that they are playing a 3D game even though it is still in 2D. (Kobayashi, 2012)

3.6.3D Driving Simulator on Google Earth

Platform:

- Web Application

This application is also brought to you by the same developer. Because Google announced that they were not going to support Google Maps API for Flash in the future, the developer of the previous two games decided to port his driving game so it will run in the Google Earth plugin.

Again, in this application the player is allowed to drive around any location on earth. Some of the bigger cities in google are represented in 3D. This is a great application for driving around but there is no option to define a route or race against any opponents. Also, if you are going to drive a small town like Wexford, most of the buildings are still in 2D form. Goole Earth is very good at giving the landscape depth but not all of the buildings. (Kobayashi, 2012)

4. Development Tools

4.1.Game Engines

What is a game engine? A game engine is a framework that developers can use to help them to build video games for mobile devices, web browsers, home computers and game consoles. The game engine provides the developer with a selection of tools that will help them to create a game in the quickest time possible.

"The core functionality typically provided by a game engine includes a rendering engine ("renderer") for 2D or 3D graphics, a physics engine or collision detection (and collision response), sound, scripting, animation, artificial intelligence, networking, streaming, memory management, threading, localization support, and a scene graph." (Wikipedia_Game_Engine, 2013)

Programmers practice the abstraction technique. Abstraction is when a complicated task is hidden by a simple interface. An analogy of abstraction is when someone drives a car. They don't need to know how the engine works in order to drive the car; all they need to know is how to operate the controls of the car. A game engine provides abstraction for the developer by hiding all of the complicated data processing from the developer.

The game engine will take care of all of the 'heavy lifting' so to speak. What is meant by the term heavy lifting is that the game engine will take care of the implementation of all of the complicated tasks like physics. This lets the developer concentrate on more important things like, actually creating the game rather than trying to program the complicated functions to replicate physics within the game.

The same game engine can be used to develop many different games while allowing all of the games to be completely different from each other. An example of this would be the Unreal Engine 3. This is a very popular game engine and has been used to create a multitude of blockbuster games including:

- Batman: Arkham Asylum
- Batman: Arkham City
- Bioshock
- Bioshock 2
- Bioshock Infinite
- Transformers: Fall of Cybertron
- Mass Effect
- Mass Effect 2
- Mass Effect 3
- Gears of War 3
- … and many more

(Unreal, 2013)

Game engines come in three different varieties. Open Source, Freeware and Commercial. Some game engines can only develop games for one platform. An example of this would be melonJS. MelonJS only develops games that can run inside a web browser. The main programming language of this engine is JavaScript and the platform that it runs on is HTML5. (Biot & Oster, 2013)

While other game engines can develop games to be played on a variety of formats. LibGDX is an example of such an engine. LibGDX is a Java based game engine which allows a developer to write a game using the Java programming language. The code is written once and then LibGDX can port the game to many different platforms. LibGDX can port to Windows, Linux, Mac OS X, Android, iOS, Java Applet and HTML5 Web Browsers i.e. Chrome, FireFox, Safari, etc.

There are hundreds of game engines available for developers to use. Www.moddb.com hosts a list of the 100 most popular game engines on that day. (ModDB, 2013)

4.2.Open Source

Open source game engines are exactly what they are called. The source code for these engines is publically available to anyone who wants it. The user is free to view the code, modify the code and to redistribute the code to whomever they choose. The advantages to open source software are that the software is free to use and it is generally developed in public. This means that anyone who would like to contribute to the development of the project is free to do so.

Because open source projects are generally a combined effort from a community of people, many bugs and security issues are quickly found and patched. This is because these projects would be contributed to by users with varying levels of technical skill. (Wikipedia_Game_Engine, 2013)

Some of the open source game engines that are available are:

- Cocos2D
- Ogre3D
- LibGDX
- ID Tech 4

4.3.Commercial

During the 1990's video game developers, ID Software created Doom and Quake. These games proved to be popular so other developers licenced some of the core parts from the game. These core parts became known as the game engine. ID Software realised that this was a great way to generate revenue by selling licences.

From then on more companies started to create game engines so that they could sell licences to developers. This has also made the development of games quicker and easier. (Wikipedia_Game_Engine, 2013)

Some of the game engines that are commercially available are:

- Unity
- Unreal Development Kit
- Source
- CryENGINE 3
- Game Maker Studio

(ModDB, 2013)

4.4.Freeware

Freeware game engines are a little bit difficult to define exactly because the can have some varying characteristics. Freeware can mean that the game is available for free to use but that the source code is not available. This means that the developer that is using the freeware game engine is not authorised to modify the game engine.

Many of these freeware game engines have been developed commercially but they have a free version that is available to anyone. These free versions can come with varying regulations for use.

For example, the DX Game Studio game engine provides users some basic features. In order to unlock more features the user would be required to upgrade to the licenced version of the game engine. While Unreal Engine 3 provide a free version of their game engine called Unreal Development Kit (UDK). The UDK is available to anyone who wants to use it and it is a complete game engine. If a developer creates a game using the UDK then the can obtain a licence by paying $99 and agreeing to pay Unreal a 25% royalty when they earn over $50,000 from game sales. (Wikipedia_Game_Engine, 2013) (Webster, 2011)

Some of the freeware game engines are:

- CryENGINE 3
- Unity
- Unreal Development Kit
- Stencyl
- Game Editor

4.5.Game Engines Considered

4.5.1. LibGDX

LibGDX is an open source game engine which allows a developer to write games for many platforms. The code can be written by the developer once and LibGDX can port the game to Windows, Linux, Mac OS X, iOS, Android, Java Applet and HTML5 Web Browsers.

LibGDX can be set up to develop on many platforms – Windows, Mac OS X and Linux.

LibGDX is written in Java uses Java as its main development language. Some of the features of using LibGDX include:

- Cross Platform Development & Deployment

- Open Source
- 3rd Party Support For Multiplayer and Leader boards
    - Swarm
    - Next Peer
- Box2D Physics Engine Support (popular physics engines)
    - Games Made Using Box2D
        - Angry Birds
        - Tiny Wings
        - Crayon Physics Deluxe
        - Rolando
- Bullet Physics Support
- File System Abstraction for all Platforms
- OpenGL Graphics
- Community Forums & Support
- Documentation
- Java

(LibGDX, 2013)

4.5.2. Cocos2DX

Cocos2DX is an open source game engine which allows developers create cross platform games. The development environment for Cocos2dX can be setup on many different operating systems – Windows 7, Windows 8, Mac OS X and Linux.

Cocos2DX can port games to many different platforms including Android, iOS, Windows, Mac OS X, Samsung BADA, Blackberry, etc. (Cocos2d, 2013)

Cocos2DX is written in C++ and it also uses C++ as its main development language. Some of the features in Cocos2DX include:

- Cross Platform Development & Deployment
- Open Source
- Scripting Language Support
- Extendable With Plugins and Tools
- 24hr Support
- 25% of All Mobile Games Made Using Cocos2DX
- C++

4.5.3. Unreal Engine

Unreal Engine 3 is a commercial game engine which also offer a freeware version of the engine called Unreal Development Kit (UDK). Unreal Engine 3 is available to developers if they purchase a licence whereas UDK is available to anyone for free. UDK allows people to experiment with the game engine. If a developer produces a game that they want to sell then they may buy a $99 licence. If sales of the game exceed $50,000 the developer will have to pay 25% royalties to Unreal.

This is a great agreement because it allows small indie developers (independent developers) to experiment with this development tool without having to spend big money on a licence.

Porting games to Android from the UDK is not possible. If a developer wants to buy a licence for Unreal Engine 3 then they will be provided with a licence to port their games to Android. (Epic Games, 2013)

Unreal Engine is written in C++ and it also uses C++ as its main development language. Some of the features in Unreal Engine include:

- Cross Platform Development & Deployment
- Free to use
    - Android and iOS porting requires a licence
- C++

4.5.4. Unity3D

Unity3D offers both a free and pro version of their game engine. The free version includes many of the features that are included in the pro version.

Any developer could get experience using the Unity3D game engine for free and if they decided that they would like access to the extra features then they could pay for the extra features. (Unity, 2013)

The price of the pro version is $1500 dollars. Unity3D can be used to develop both 2D and 3D applications. Unity included a set of 2D tools in the latest 4.3 build of Unity3D. (Unity Store, 2013)

Unity3D provide a lot of tutorials to help developers to get started with their projects. Also there is an Asset Store where there is access to lots of tools and packages that have been created for the Unity3D engine.

These tools and packages add extra features to Unity3D which can save developers time and effort while creating their games. (Unity, 2013)

Unity3D supports files from other modelling software like Blender.

Unity3D uses C#, Boo and a form of JavaScript as its main development languages. Some of the features in Unity3D include:

- Cross Platform Development & Deployment
- Free to use
    - Extra features unlocked in pro version
- External files supported
- Multiple programming languages
    - C#, Boo, JavaScript

5. Programing Languages

Programming languages are what computers read to process and manipulate data. These languages are used to create programs that a computer can interpret. By writing programs for computers the developer can manipulate the computer to perform tasks for them.

These tasks can be anything that the developer can imagine. The one limiting factor to the developer imagination is the limits of what the hardware is capable of. In simple terms a program is a set of instructions that a computer executes until the program is completed.

There are many different programming languages available for developers to use but the choice of programming language may be limited depending on what hardware the programmer wants to use.

Different types of computer hardware run on different types of programming languages. This will affect what type of programming language will be used to develop the project. For instance if the project was to be developed on an iPhone then the Objective C programming language would have to be used because this is the primary language that is used to develop applications for the iPhone. And if the project was to be developed on an Android device then the Java programming language would have to be used because Java is the primary programming language that is used to develop Android applications.

(Wikipedia_iOS, 2013) (Wikipedia_Android, 2013)

5.1.Java

Java is an object orientated programming language which is designed to run on any computer whether it is Windows, Mac or Linux. Java has been in use since 1995.

Java can be written once and run on any of these platforms. The reason that Java can run the same code on each of these different systems is because Java runs inside its own virtual machine. This is called the Java Virtual Machine (JVM). (Wikipedia Java, 2013)

Java is the main programming language for the Android operating system even though it is not the full Java language. The Java that runs on Android devices does not use all of the libraries that are available to Java. (Wikipedia_Android, 2013)

Java doesn't run as fast as C or C++ because Java is a high level language. This means that it is easier for humans to understand whereas C is a low level language. The machines processor can understand this language easier than Java so it process faster than Java. (Mallett, 2013)

5.2.Objective-C

Objective-C is a subset of the C programming language. Unlike C, Objective-C is an object orientated language. iOS and Mac applications are all made using the Objective-C programming language. (Wikipedia_Objective-C, 2013)

Apple acquired Steve Jobs' computer company called NEXT Computers. The operating system from these computers was used as the foundation of the Mac and iOS operating systems. (Wikipedia NEXT, 2013)

Objective-C is the main programming language for the development of applications on any iOS device. Objective-C does not run on an Android device.

5.3.C#

C# is the main programming for developing Xbox 360 and Windows games. C# was developed by Microsoft as an object orientated language and it was released in 2000. It was developed as part of the Microsoft .NET framework. (Wikipedia C#, 2013)

Microsoft provides an Integrated Development Environment (IDE) called Visual Studio. This IDE together with a framework called XNA allows developers to create games for the Xbox 360 and Windows platform. (Wikipedia XNA, 2013)

5.4.HTML5

HTML5 is covered extensively in the game engine section.

6. Integrated Development Environment (IDE)

There are many different IDE's to help develop applications for any type of computer whether it is a games console, a PC or a mobile device. The IDE is essentially a tool box for a developer which contains tools to help the developer to complete their job as quickly as possible while making the development process easier.

These IDE's can be loaded with libraries that are filled with functions and functionalities to help the developer with specific tasks. These libraries will differ depending on what type of programming the developer is doing. If a developer is writing a piece of accounting software then they will need completely different libraries to that of a developer that is creating a game.

Which IDE will be picked to develop the game for this project will depend on which platform is chosen to host the application. There are a number of different platforms to consider for the development of this project.

6.1.Eclipse

Eclipse is a very popular IDE which is commonly used among Java developers. It can be used to develop many other programming languages too. There are many plugins available for the Eclipse IDE to assist developers.

Eclipse is the standard IDE for Java development. Eclipse is free to use and it is Open Source. There are many plugins available for android development within the Eclipse environment. (Wikipedia Eclipse, 2013)

6.2.Visual Studio

Visual Studio (VS) is developed by Microsoft to develop console and graphical user interface applications. VS supports many programming languages including C, C#, C++ and Visual Basic to name a few.

VS combined with XNA framework allows for the development for Xbox 360 and Windows games. This is the main development environment for these game platforms. (Wikipedia Visual Studio, 2013)

Visual Studio is a commercial product which is made available to students for free. There is also a free version available. (Microsoft Visual Studio, 2013)

6.3.Sublime Text 2

Sublime Text 2 is not an IDE but it is a very powerful text editor. Sublime is able to support a vast range of programming languages which makes it very easy to develop HTML code.

Sublime Text is a commercial product but you can use the product for free. From time to time you will be prompted to purchase a licence for the product for $70. (Sublime Text, 2013)

6.4.Xcode

Xcode is designed and distributed by Apple for development of Apple applications on the Mac OS X operating system. Apple provides the software for free but it can only be run on Apple computers.

Since Xcode is designed for the development of Apple product applications it supports most variants of the C programming language including Objective-C. (Apple Developer, 2013)

7. Platforms

There many different platforms to consider for the development of this project. A platform for a game is also known as a system. Each system is different because for the most part they are all made by different companies. The reason they are different is because each company has different ideas about how to design their systems.

Each system can have the exact game titles which will all play exactly the same as each other but they could be developed completely different from each other because of the platforms operating system (OS) and the hardware that the OS is running on.

The selection has been narrowed to four choices.

- Android
- iOS
- Windows
- Xbox

These four gaming platforms are some of the most popular platforms at the moment for gaming. They are a mixture of platforms that cater for the likes of hard-core gamers to casual gamers.

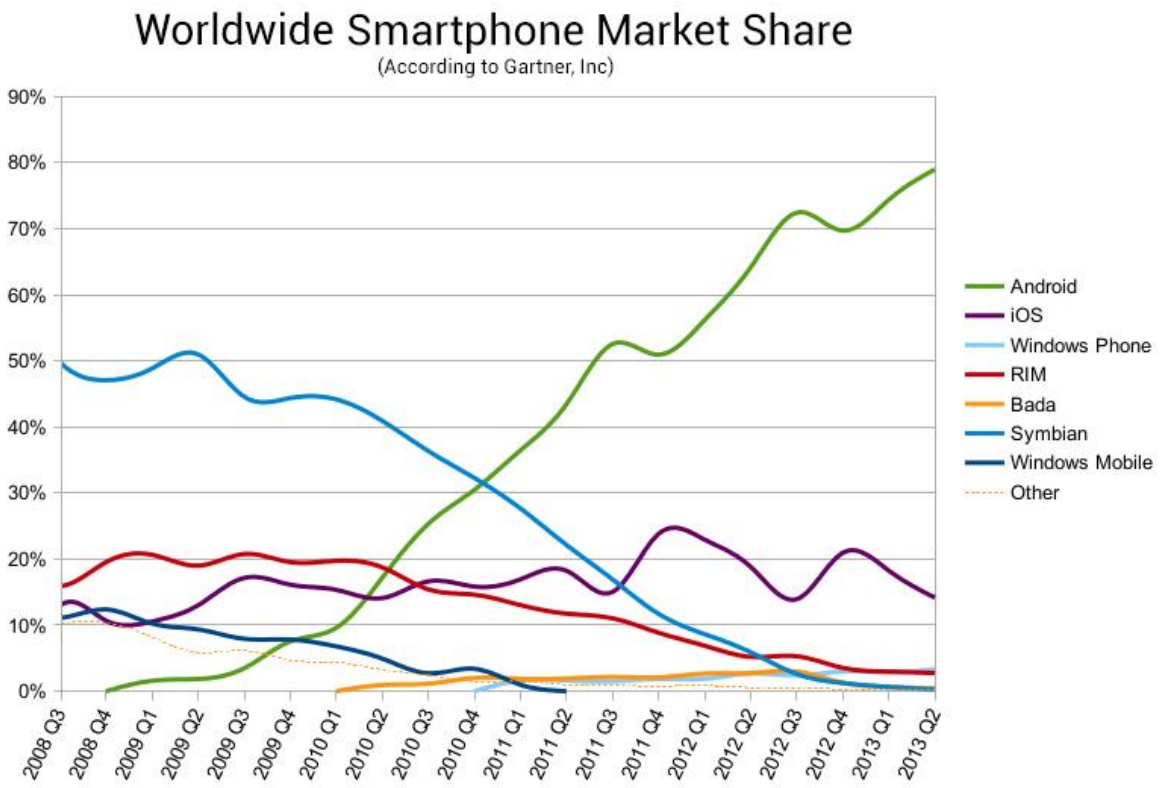
7.1.Android

Android is proving to be a very popular mobile OS so it goes with saying that this platform will be considered for developing this application.

The Android OS is an open source mobile OS which is developed by Google. The Android OS is based on the Linux kernel and it is designed to be run on many devices. Android powers mobile phones, tablets, smart watches, media players and game consoles.

Google design the Android OS and they distribute it freely to the manufacturers of devices whether they are smart phones, tablets, media player's games consoles etc.

Android has grown to become the mobile platform that holds the highest market share to date.



(Amadeo, 2013)

Android is easy to develop for because there is a big Android community for support and the documentation is very comprehensive. The openness of the open source OS allows developers to access any part of the OS that they wish.

Google have developed Android so there is great integration between Android and the rest of Googles products like Google Maps, Google Earth and Google Drive. All this is made possible from the API's that Google provide to developers.

Android allows developers to develop an application to do what they want it to do and however they want to do it with no restrictions imposed on them my google.

The programming language used to develop Android applications is Java. Java is a more attractive to beginner developers because it is easier for them to get their head around. Other programming languages that are used to develop on other mobile platforms can be more complicated to grasp than Java. (Kim, 2013)

It is also easy for a developer to release an application onto the Google Play Store. The developer has to register for a developer's account which only costs a onetime fee of $25. As soon as they have registered they are free to release an application on the Google Play Store. Also when a developer submits an application to the Google Play Store there is no strict approval process that the application is subjected to. (Google, 2013)

A developer may choose to develop Android applications on Windows, Mac OS X or Linux. All of the software that is needed to develop Android applications is available to download for free on any of these platforms. (Android_Developer, 2013)

Main points to consider when developing on Android:

- Easy for beginners to develop
- Open source means less restrictions
- Open source means less restrictions
- Java programming language
- Onetime fee for developers licence - $25
- No application approval process
- Good documentation
- Good community support
- Wide list of devices supported
- Google App Integration
- Free software for developers to use
- NFC supported on some handsets

7.2.iOS

iOS is the OS that powers all of Apples mobile devices. It currently runs on the iPhone, iPod Touch, Apple TV and iPad. iOS is designed by Apple exclusively for Apple products. Apple do not licence their iOS software to any other manufacturer. iOS powered devices like the iPhone are also very popular and currently hold second place in today's market share. (Amadeo, 2013)

iOS is built from OS X. OS X is the OS that powers Apples computer range and it is very successful. It is regarded as one of the most secure OS's in the world. (Secpoint, 2013)

Apple allows developer to create applications for their iOS devices as long as the pay for a developers licence. The developers licence costs $99 per year. (Apple_Developer_Fee, 2013)

All of Apples iOS devices are mainly developed using the Objective-C programming language. The Objective-C programming language is difficult for a beginner to learn. It is based on the C programming language. (Wikipedia_Objective-C, 2013)

iOS is a very popular platform to develop applications on. Currently it holds the second highest market share in the world so many developers are attracted to it. (Amadeo, 2013)

Also because iOS is developed by Apple there is a very strong support community and very good documentation. Apple actually hosts a developer support centre where each developer has access to a vast collection of resources, videos, software downloads and code samples. (Apple_Developer_Support, 2013)

Apple's iOS platform is a very tightly controlled eco system. Apple have stipulated very strict guidelines for what a developer can and can't do while creating an iOS application. This guideline process tries to prevent new applications from being released on the App Store that have to potential to cause harm to the user or to ruin the user experience. (Apple_App_Review, 2013)

These strict guidelines have come under fire in recent times. Even well-known legitimate applications have fallen victim to Apple's strict guidelines. Recently an application called AppGratis was removed from the App Store without a warning to the developer for violation of the App Guidelines.

"Dawlat wrote that his team had worked closely with two of Apple's developer relations representatives to make sure AppGratis met the App Store guidelines." (Kovach, 2013)

Also it can be a lengthy wait while Apple put an application through the App Review process.

iOS is supported by a high number of API's. Google for instance provide API's for the majority of their most popular products like Google Maps and Google Drive. (Wikipedia_Google_Products, 2013)

In order to develop an iOS application a developer has to use a Macintosh computer. If a developer has a Macintosh computer then all of the software that they need to develop iOS applications is available to download for free. (Apple_iOS_Development, 2013)

Main points to consider when developing on iOS:

- Not very easy for beginners to develop for
- Closed eco system
- Lack of freedom in what the developer can do
- Objective-C programming language
- Yearly fee for developers licence - $99
- Strict app review process
- Good documentation
- Good community support
- Apple only devices
- Google app integration
- Need a Macintosh to develop for iOS
- Free software for developers to use

7.3.Xbox 360

The Xbox 360 is a console that has been designed and built my Microsoft. The Xbox 360 is regarded as one of the best games consoles on the market. The Xbox 360 is the successor the original Xbox known as Xbox.

Developing a game for the Xbox 360 is not as straight forward as developing a game for a mobile platform such as Android or iOS. If a developer would like to get their hands on an Xbox Development Kit then they would have to pass Microsoft's qualification process in order to get

one. To pass this process the developer would have to have a history in the video game development industry and to have a proven track record. (Xbox.com_Developers, 2013)

If a student wants to develop an Xbox 360 game then they have to download the Visual Studio IDE and XNA Game Studio. Microsoft provides students with a free licence to download any development software that they may require. This licence lasts for 12 months. Visual Studio runs on the Windows OS so this means that Xbox 360 games can be developed on any Windows based PC. (Microsoft_Student, 2013)

It is worth mentioning that Microsoft XNA has been discontinued. (RogueCode, 2013)

Games are developed for the Xbox 360 using the .NET framework. The language that is used for development on the Xbox 360 is C#. C# is an object orientated language which is similar to the Java programming language.

Games cannot be released onto Xbox Live unless you pay for membership to the Creators Club. (Xbox_Membership, 2013)

Main points to consider when developing for Xbox 360:

- C# programming language
- Visual Studio software is free to students
- Popular gaming console
- Creators Club Online premium membership - $99
- Good documentation
- Good community support

7.4.Windows

Pretty much anything that has been said for Xbox 360 game development can be said for Windows game development because the developing games for both platforms is pretty similar. There are some small differences but all in all they are very similar. (Microsoft Xbox, 2013)

In order to deploy a game to either Windows or Xbox 360, the code has to be compiled differently for each machine.

7.5.HTML5

HTML stands for Hyper Text Markup Language and is the standard programming language for creating webpages and displaying content in web browsers. HTML was the first version and it was developed in the 1990's. Since then there has been 5 revisions of the language. (Wikipedia_HTML, 2013)

HTML5 is the latest version of HTML. HTML5 has been developed to handle the latest multimedia applications while also trying to keep the language readable by humans and to make the language compatible across all types of devices and computers no matter which company makes them.

YouTube for instance has moved away from using Flash as its main standard for streaming videos over the internet to a web browser. They have begun to allow users to opt in to consume content in HTML5 format while using certain web browsers, where HTML5 format is possible, if they wish. (YouTube, 2013)

Almost every modern web browser is able to run HTML5 code. This includes desktop computer web browsers like Chrome, Firefox, Safari and Internet Explorer. Also tablets and mobile devices like smartphones, tablets and the next generation of video game consoles are all optimised to run HTML5. (Wikipedia_HTML5, 2013)

There are many HTML5 game engines available for the development of games. These engines are available commercially and for free. This will allow many people to get into HTML5 development at no cost. (Clay.io, 2013)

HTML5 code can be written in using complicated IDE's like Eclipse, WebStorm and Visual Studio but they can also be written in plain text editors like Notepad++ and Sublime Text 2. These different tools are also available both commercially and for free.

In order to develop HTML5 games it would help the developer if they had some knowledge of the following programming languages:

- HTML
- HTML5
- JavaScript
- CSS

HTML5 is replacing Flash technology because flash doesn't run on mobile platforms and mobile devices very efficiently. Flash consumes more power than HTML5 and Flash is not compatible with touch screen devices either whereas HTML5 is. These two reasons are two pretty good reasons why HTML5 is the next breakthrough in web page design. (Page, 2013)

Also the developers of Flash, Adobe, announced that they were withdrawing support for Flash on mobile devices in November 2011. (Wikipedia_Flash, 2013)

Main points to consider when developing for HTML5 browsers:

- Compatible across all modern browsers across all platforms
- Multiple languages need to be understood
- Free development tools
- Reasonably new development environment
    - Not as much support as with other platforms
- Google app integration
- Possible $5 fee to release in Chrome Store

8. Positioning

In order to program a game to race around the actual location that the player is in, the game is going to need to know where the player is and what area they are located in. The location source can be determined using three methods:

- Global Positioning System (GPS)
- Wireless Network (WiFi)
- Cell tower ID (Cell ID)

8.1.GPS

GPS is probably the most common location tracking technology. GPS uses satellites that orbit the earth to pinpoint anyone's location on earth as long as they are in possession of a GPS receiver. In order to receive a GPS signal the GPS receiver needs to have a line of sight to 4 or more GPS satellites. (Wikipedia GPS, 2013)

8.2.WiFi Location

WiFi location is technically known as Wi-Fi-based positioning system. WiFi positioning is used where GPS location services cannot be used. This tends to happen when GPS receivers are inside a building. Buildings block the direct line of sight between GPS satellites and GPS receivers.

WiFi positioning is determined by analysing the strength of the signal received from the wireless access point and by using a technique called fingerprinting.

8.3.Cell ID

Cell ID triangulation is a technique that is used to acquire the location of something by calculating the distance from the Global System for Mobile Communications (GSM) cell receiver to the cell tower. Each cell tower has a unique ID assigned to it so by tracking which cell ID's that the cell receiver is connected to you can determine the location of the receiver. (Wikipedia Mobile Phone Tracking, 2013)

The technique behind determining the location of the GSM receiver is called Multilateration.

"Multilateration is a navigation technique based on the measurement of the difference in distance to two or more stations at known locations that broadcast signals at known times." (Wikipedia Multilateration, 2013)

8.4.Position Conclusion

GPS will be the main way to try and determine the player's location. WiFi location may also be used where GPS location is not an option for determining location.

9. Map Data

Once the location of the payer has been determined then the application will have to retrieve the information for the location from some map data database. This is so that the application can build the actual road network in the player's location into the game.

9.1.Google Maps

Google Maps is probably the most popular and well known mapping service. Google provide developers and users with a large source of information from general directions to business listings.

Google Maps provides developers with APIs so that they can interact with Google Maps to create new features to add to their web pages or to take advantage of the Google Map data to create new features for mobile applications. Google provide APIs for Android, Web and iOS.

The Android APIs come in the form of Google Maps Android API v2. Web APIs come in the form of Google Maps JavaScript API v3 and iOS APIs come in the form of Google Maps SDK for iOS. (Google Developers Maps, 2013)

Google Maps allows users to create routes and maps personalised maps. The user can then export the map data as a .kml file. If the user has created more than one map then they can export them all in one .kmz file. These types of files can also be exported using a tool provided by google called Maps Engine Lite and Pro. (Google Support, 2013)

These files can be opened in Google Sketch Up, Google Maps and Google Earth. The .kml file stores all of the information about the map including the location of the area that the map was made for and the GPS coordinates of any route that is stored in the map.

Google allow developers to access their map database up to 25,000 times a day for no extra charge. If the developer exceeds this limit then they are charge accordingly per 1,000 excess map loads. The fee is either $0.50 or $1.00 depending on which API the developer is using. (Google Developers FAQ, 2013)

Main points to consider when using Google Maps APIs:

- Multiple APIs for multiple platforms
    - iOS, Android, Web
- Export .kml and .kmz file types
- Google applications to read .kml files
- Up to 25,000 map loads for free
    - Small fee of $0.50 - $1.00 in excess of 25,000 map loads

9.2.OpenStreetMaps

OpenStreetMaps does exactly what it says on the tin. It is an Open Source map database which claim to allow users to use their mapping data for many different purposes with very few restrictions. (OpenStreetMap Using, 2013)

OpenStreetMaps have a pretty substantial set of APIs for developers to work with. If a developer wants to work with OpenStreetMaps and Android then they will have to use a third party API called Osmdroid API. (Osmdroid, 2013)

There are many libraries available to help developers use OpenStreetMaps on iOS devices. (OpenStreetMap iOS, 2013)

OpenStreetMaps allows a user to export an entire area of their map information. This map data can be easily used to make a graphical 3D representation of the map by using a tool called OSM2World. OSM2World can then export the 3D model into an .obj file which can be used by other 3D graphic application

Main points to consider when using OpenStreetMaps:

- .osm files include enough information to recreate an area graphically
- .osm file can be easily converted to a .obj file
- Many tools available to manipulate .osm files
    - OSM2World
    - JOSM
- Open Source
- APIs available for many platforms
    - Android
    - iOS
    - Web
- Good documentation
- Good community support

9.3.Bing Maps

Bing Maps is the Microsoft version of a mapping solution. Bing offers a 90 day free trial. The trial key provided allows a developer up to 10,000 billable transactions for free for 3 months. Students can and non-profit public websites can avail of a free basic key. (Microsoft Bing Maps, 2013)

The APIs for Bing Maps seem to be pretty limited. They don't seem to be very useful for this project. Bing seems to provide pretty good documentation for their APIs but the support forums seem to be pretty limited. This is purely based on my experience spending 20 minutes googling information on Bing Maps. (Microsoft Bing API, 2013) (Bing Maps Documentation, 2013)

Bing can export limited map information in the form of .kml, .gpx and . geoRSS file formats.

- Limited community support
- Ok documentation
- Multiple file export options
    - Limited information
- Underwhelming APIs
- Export data in multiple file types
    - .kml
    - .gpx
    - .geoRSS

10. Cloud Platform & Backend

A cloud platform is a term which describes a network infrastructure of computers which are all capable of operating and working together. Cloud Computing is one of the latest buzz words in the computer science area. It has been around for years already but with the latest advancements in broadband internet speeds (which are due to next generation networks such as 4G and Fibre powered broadband) and the advancement in computer hardware Cloud Computing has taken off on a scale that has never been seen before. (Warren, 2013)

The concept of Cloud computing dates back to the 1950's but where the term 'Cloud Computing' came from is unclear. People have been using Cloud Computing for years but they have been unaware that they have been using it. (Wikipedia Cloud Computing, 2013)

An example of this is Gmail, Google's Email application. The user logs into their account through a web browser. All of the storage and processing of the emails happens on the server side (Google's servers) of Gmail. All that the user does is control what the application does to the emails from the client side (user's web browser). (Pinola, 2013)

Cloud services are broken into three categories:

- Infrastructure as a service (IaaS)
- Platform as a service (PaaS)
- Software as a service (SaaS)
- Network as a service (NaaS)

(Wikipedia Cloud Computing, 2013)

Cloud Computing aims to provide a service to a customer that can react to the customer's needs. Here is an example of IaaS. For instance if a customer runs a website which has times where the business is busier than others then they will benefit from cloud computing. Cloud Computing allows the customers website to scale up (i.e. increase storage, RAM, processing power) to handle surges in demand for their service and when the demand decreases then the customers website scales back down to a smaller size.

This saves the customer from having to buy and maintain expensive servers when they will only be used to their full potential a few times a year. Also by using Cloud Computing the customer's website will be able to scale up to handle unexpected surges in traffic to the website.

Cloud platforms can also be used as a backend for mobile application development. This can be beneficial because all of the heavy processing is done in the cloud where processing power isn't an issue and the data is then sent to the mobile device. This will allow user with low powered devices to use an application as efficiently as a user with a high end high powered device.

A backend can also send push notifications out to users of an application and allow interaction between users of the application. These features will to allow users of the racing application to communicate and compete with each other in the game. (Google Cloud Platform, 2013)

10.1. IaaS

IaaS provides customers with access to general computing infrastructure through the cloud. This allows the customer to access servers, operating systems and storage on demand. The customer can dynamically scale their needs by using a cloud service without the need to buy expensive hardware necessary. This saves the customer money because they don't have town the equipment and its saves them time because they don't have to setup and maintain the hardware.

The cloud provider takes care of all of the maintenance of the hardware leaving the customer to concentrate on their business. (Wikipedia Cloud Computing, 2013) (Rackspace Support, 2013)

10.2. PaaS

PaaS allows customers to take advantage of operating systems, databases and web servers without having to worry about what hardware the software is running on. This platform allows developers to create web applications quickly and easily without them having to worry about configuring and maintaining hardware to run them on. (Wikipedia Cloud Computing, 2013) (Rackspace Support, 2013)

10.3. SaaS

SaaS allows customers to access software on demand. This saves the customer from having to pay big money buying licences for software that they don't use very often. By using SaaS they customer can only pay for what they need when they need it resulting in cost savings. (Wikipedia Cloud Computing, 2013) (Rackspace Support, 2013)

10.4. Google Cloud Platform

The Google Cloud Platform is the general heading under which all of the Google Cloud products are categorised.

10.4.1. Google App Engine

Google App Engine is a cloud product developed by Google to allow a user to develop and deploy web applications to the internet using Google's architecture. By using the Google platform the web app can be easily scaled up to accommodate storage and traffic needs.

The user can use their own domain name or they can use a free domain name that is supplied by google. Also, access to your web app can be limited to whoever the user chooses.

Google App Engine supports several programming languages including Java, JavaScript, Ruby, Python, Go and PHP.

Google App Engine is free for users to get started. With the free package Google allow the user 1 GB of storage along with enough computer processing power and bandwidth to handle 5 million page views a month. The user can pay for any additional resources if so needed. (Google_Developers, 2013)

Main points to consider when using Google App Engine:

- Free to get started
- Several programming languages supported
- Scalability
- Tutorials to help get started
- Good documentation
- Good support

10.4.2. Google Cloud Messaging

Google Cloud Messaging (GCM) is a cloud product from Google which allows servers to send data to mobile devices and for mobile devices to send data to servers. This cloud service could be used to inform the application that there is a new track that is ready to be downloaded from the server.

It can also let the mobile application know that new messages have been received from other players so that the application could sync itself with the server. (Google Cloud Messaging, 2013)

10.5. Amazon Web Services

Amazon Web Services (AWS) provide a cloud platform full of products that can cater to the need of the individual customer. They have specific product designed to cater to the needs of specific users.

10.5.1. Amazon AppStream

Amazon AppStream is a new AWS product which aims to allow users to create resource intensive games and lets you stream them over the internet using Amazon AppStream. AppStream will allow a user's game to be streamed to almost any device that their customers.

By using a service like Amazon AppStream developers are giving themselves an opportunity to deliver their game content to customers on all platforms by streaming their content over the internet. They only have to write the code for the game once and it should run on all platforms simply by writing a small client to connect to the game.

Another feature of Amazon AppStream is by doing all of the heavy processing in the cloud you are not limited by the hardware or devices that your customers are using. (Amazon AppStream, 2013)

Main points to consider when using Amazon AppStream:

- Relatively new product
    - Must join waiting list
    - Free for < 20 hours of use by customers
    - AppStream Developer Guide Documentation release 13 November 2013 (AWS_Documentation, 2013)

- Support for iOS, Android, FireOS and Windows
- Application has to be streamed from Windows Server 2008 R2
    - Amazon provide SDK

10.6. Windows Azure

Microsoft Windows Azure is a cloud platform which allows users to develop, deploy and manage applications on an infrastructure which has been created by Microsoft. Azure provides PaaS and IaaS.

Azure provides a large range of products for customers to take advantage of. Some of these services are Virtual Machines, Data Management, Messaging, Media Services, Mobile Services and Business Analytics.

Azure also supports a variety of programming languages including .NET, Java, Node.JS and Python. There may be support for other programming languages by way of 3rd party Open Source applications. (Wikipedia Windows Azure, 2013)

Azure offers a 1 month free trial and after the trial the user is charged by processing power used per hour per month. There are many different pricing schemes targeted at various types of users. (Windows Azure, 2013)

Main points to consider when using Windows Azure:

- Only a 1 month free trial
- Multiple programming language support
- 3rd party Open Source applications
- Multiple products to choose from

11. Modelling Software

Modelling software can create graphics for video games. This type of software can show a mathematical representation as 3D graphics. Many game engines already have this type of software integrated into them but there are also some stand-alone applications that can be used.

11.1. Blender

Blender is 3D modelling software. It can produce 3D models for many purposes like gaming, film animation, visual effects and art. Blender also has a built in game engine but it would be more likely used in cooperation with another game engine.

Blender is a free and Open Source application which has a very active community. Support for the software is freely available on many user forums. Also the documentation provided with blender is very comprehensive.

Main points to consider when using Blender:

- Game engine built in
- Free
- Open Source
- Great Community Support
- Good documentation
- Blender file supported in the Unity3D game engine

11.2. CityEngine

CityEngine is a 3D modelling software suite which produces large scale 3D models of built up urban areas. These cities can be created within a few clicks and are very detailed models.

Main points to consider when using CityEngine:

- Commercial software

12. NFC

Near Field Communication (NFC) is available on many Android, Windows 8 and Blackberry phones. NFC is the latest technology for connecting devices together that are in very close range of each other. NFC is a radio communication which is general initiated when two devices are touched together or when they are close together.

NFC could be used to establish multiplayer games when players are within range of each other.

Main points to consider when using NFC:

- Not available on every device

13. Conclusion

After looking into all of the different platforms, game engines, IDE's and programming languages I have decided to develop an Android application.

The reason I have chosen Android is because there is a large support community available if I need any help finding out any information about various areas of Android application development.

Also, I have some previous experience of using the Java programming language to develop software.

I will use the LibGDX game engine because it will allow me to use my previous Java experience to develop the application. Also, LibGDX supports the option to port my application to a different format if I so choose.

There are also many tutorials available for the LibGDX game engine so I should be able to make good progress while I am developing my application. Also, LibGDX has been developed to work hand in hand with Eclipse which, at the time of writing this report, is the industry standard for developing Android applications.

I have found that the OpenStreetMaps map data provider is by far the best in terms of the amount of information can be exported from the map. By exporting the map and using the OSM2World application I can effortlessly create a 3D model of any area in the world that I choose.

I have also chosen to use google app engine as a back end for my application. I feel that because Android and Google Cloud products are all developed by Google there should by excellent cohesion between all of these systems.

By choosing this platform and these tools developing an Android application is not going to cost a cent. If I choose to release my application in the Google Play Store then I will have to pay a small onetime fee of $25.

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