**Capture the Campus!**

**Interim Report**

Submitted for the BSc in

Computer Science

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By

**Alexander C Whitehead**

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# Introduction

Capture the Campus! is a game based on a combination of; the classic 80’s arcade game Qix-wherein players control a character around a box taking squares of area while avoiding enemies (System 16, 2014). This can be seen in the image below (Figure 1)-Pokémon GO (Niantic, 2016), and Ingress (Niantic, 2016).

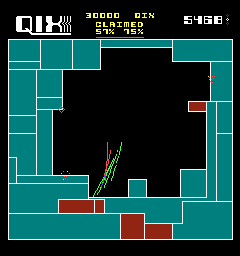


Figure : This is an image showing the gameplay of Qix (The International Arcade Museum, Museum of the Game, 2016).

The objective of the game will be to either in teams or individually capture parts of a definable area by physically traveling through it, the game-running on a mobile device in the player’s possession-will then track the player’s movements, this movement data will then be used to assign a score to the area captured by the player. Players can be ‘killed’ by their paths being intercepted by either another player or a computer controlled entity.

The game will end after either a predetermined total area has been captured or a time limit has been reached.

This is a report describing the interim design, research stages and project management issues of the project to build Capture the Campus!.

This report includes; A section covering the aims and objectives of the project, a section discussing background research conducted and creative and contextual decisions made thusly, a section further discussing the design of the project and creative and contextual decisions made regarding the system design, the UI design and the test design and a section discussing the management of the projects resources thus far.

# Aim and Objectives

The aim of this project is to create a mobile platform based, augmented reality, Qix like, area control game

This aim will be achieved by completing the following objectives:

1. Create a Client Library
2. Create a TCP Server
3. Create a UDP Server
4. Add Multithreading to TCP Server
5. Add Logging to TCP Server
6. Create a Simple Map Based GPS Locator
7. Add None Player Entities
8. Add Single Player Gameplay
9. Add Multiplayer Gameplay
10. Add Team Based Multiplayer Gameplay

### Objective 1 – Create a Client Library

Before a server can be created a basic client library must first be developed to test the prototype server with. The client should be able to send messages using UDP and TCP protocols. Development of the client shouldn’t end until both it and the server are completed.

The client library can be integrated into the game once completed and reused in future projects.

### Objective 2 – Create a TCP Server

The TCP server will store all of the locations for each player and when traversing the playing area also their path, this information will be retrievable by other players to map their locations.

The TCP server should be able to run from a phone if necessary for local multiplayer.

This will be discussed further in the Networking (‎3.3) section of the Background.

### Objective 3 – Create a UDP Server

The UDP server will be used as an initial contact point for the client, after receiving a UDP request the UDP server should respond with the IP address of the TCP server.

The UDP server should be able to run from a phone if necessary for local multiplayer.

This will be discussed further in the Networking (‎3.3) section of the Background below.

### Objective 4 – Add Multithreading to TCP Server

The TCP server will have multithreading capabilities added as the TCP server should be able to accept multiple TCP requests at once to support several players simultaneously.

### Objective 5 - Add Logging to TCP Server

The TCP server should be able to write a log of all connections for debugging.

The TCP server should be able to rebuild itself after a fatal error, for instance a crash, from this log file.

### Objective 6 – Create a Simple Map Based GPS Locator

Before the game is created a simple map based GPS locator application should be developed, this should display the current player’s location on a map. The map should translate, scale and rotate.

This application can then be transformed by the addition of gameplay into the intended product.

This will be discussed further in the Design (‎3.2) and Tracking (‎3.4) sections of the Background.

### Objective 7 – Add Single Player Gameplay

Gameplay for a single player version of the game should be added including; a definable playing arena, area controlling mechanics, and scoring.

### Objective 8 – Add Non-Player Entities

A non-player entity should be added that moves following a randomly generated meandering path.

This will be discussed further in the Design (‎3.2) and Tracking (‎3.4) sections of the Background.

### Objective 9 – Add Multiplayer Gameplay

The client and server should be used to track the location of player in an online multiplayer session and apply killing mechanics to those who cross paths, the server should also track score.

### Objective 10 – Add Team Based Multiplayer Gameplay

A game type should be implemented where gameplay is team based with score being cumulative and ending with a winning team rather than a wining individual.

# Background

## Example

Pokémon GO is a game developed by Niantic, the objective of which is to move around the real world attempting to capture virtual pets-which spawn randomly-faster than other real life people also playing the game (Niantic, 2016). The user interface of this game shows a player character which moves around a map the likes of which would work well in Capture the Campus!. Ingress-the predecessor to Pokémon GO-also uses map data and landmarks in a capture the flag style game (Niantic, 2016). This can be seen in the image below (Figure 2) (Figure 3).



Figure : This image shows a standard game screen for Pokémon GO (Wikipedia, 2017).

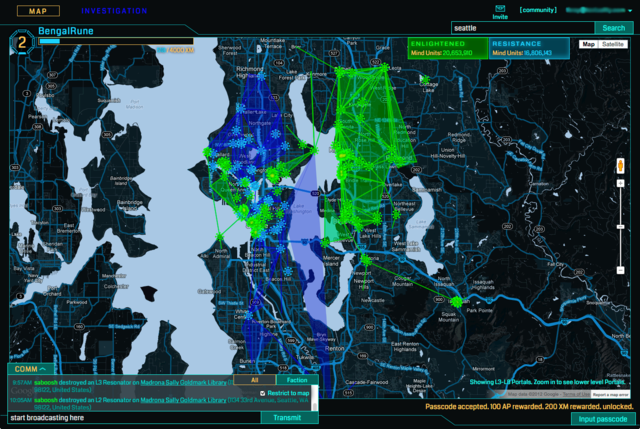


Figure : This image shows a standard game screen for Ingress (Wikipedia, 2017).

One useful critique of Pokémon GO would be that even though the appeal of this game is as an augmented reality experience, there should be some none augmented reality or single player content so as to aid in accessibility for those that cannot get out and about to play the game (Credits, Extra, 2016).

## Design

## Platform

Firstly, it must be decided which platform the application will be run on. In this case it must be a mobile platform as it would be impossible to move something like a desktop computer around in order to play, also they do not usually contain GPS tracking hardware.

The options for mobile platforms which contain GPS tracking hardware are limited, they include; Android phones, iOS phones, Windows phones, and GPS trackers.

Out of the choice of mobile platforms GPS trackers can be disregarded almost immediately as the software should ideally be easily distributed, in order to run the software with dedicated GPS trackers the trackers would probably have to come bundled with the software which is infeasible and expensive.

This leaves the choice of the three main mobile phone operating systems; Android, iOS, and Windows. Windows can be eliminated because it has such a small market share (Statista, 2016) This can be seen in the image below (Figure 4).

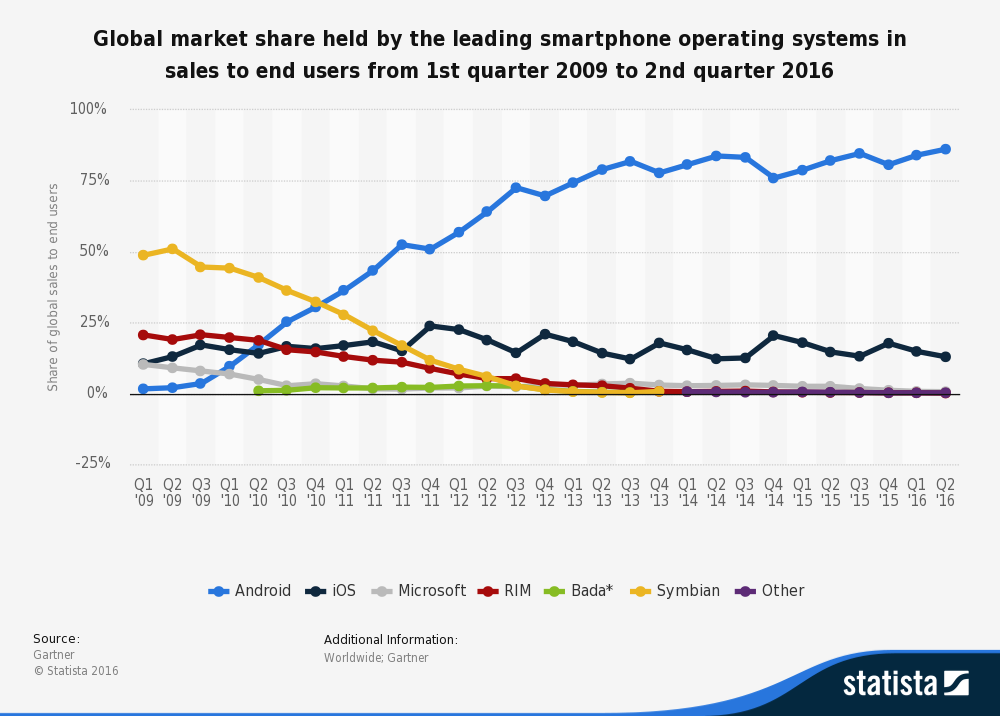


Figure : This image shows the current market share of mobile operating systems (Statista, 2016).

This leaves Android and iOS.

The market share for Android is greater than iOS. However, iOS users tend to on average spend more money on content (Sinicki, 2016). If the goal of this project was mass distribution, then Android would be the best choice. However, if the goal was to make money, then iOS would be the best choice.

It can be said that Android is much easier to design, develop and publish for because; the terms used to convey design ideas in Android are less convoluted, and the Google play store is easier to publish games to, as anyone can upload their Android application package and be approved in minutes, whereas Apple insists on testing all apps on real-life humans which takes time (Sinicki, 2016).

Currently the features of both operating systems are too close to call a superior platform.

## Language

In order to begin designing a project a language must be chosen to develop it in, for Android there is the option of developing in Java using Android Studio, in C# via Xamarin using Visual Studio or in a multitude of none native solutions. This can be seen in the image below (Figure 5) (Figure 6). for iOS there is the option of developing in Swift using Xcode or in C# via Xamarin using Visual Studio. This can be seen in the image below (Figure 7) (Figure 6).

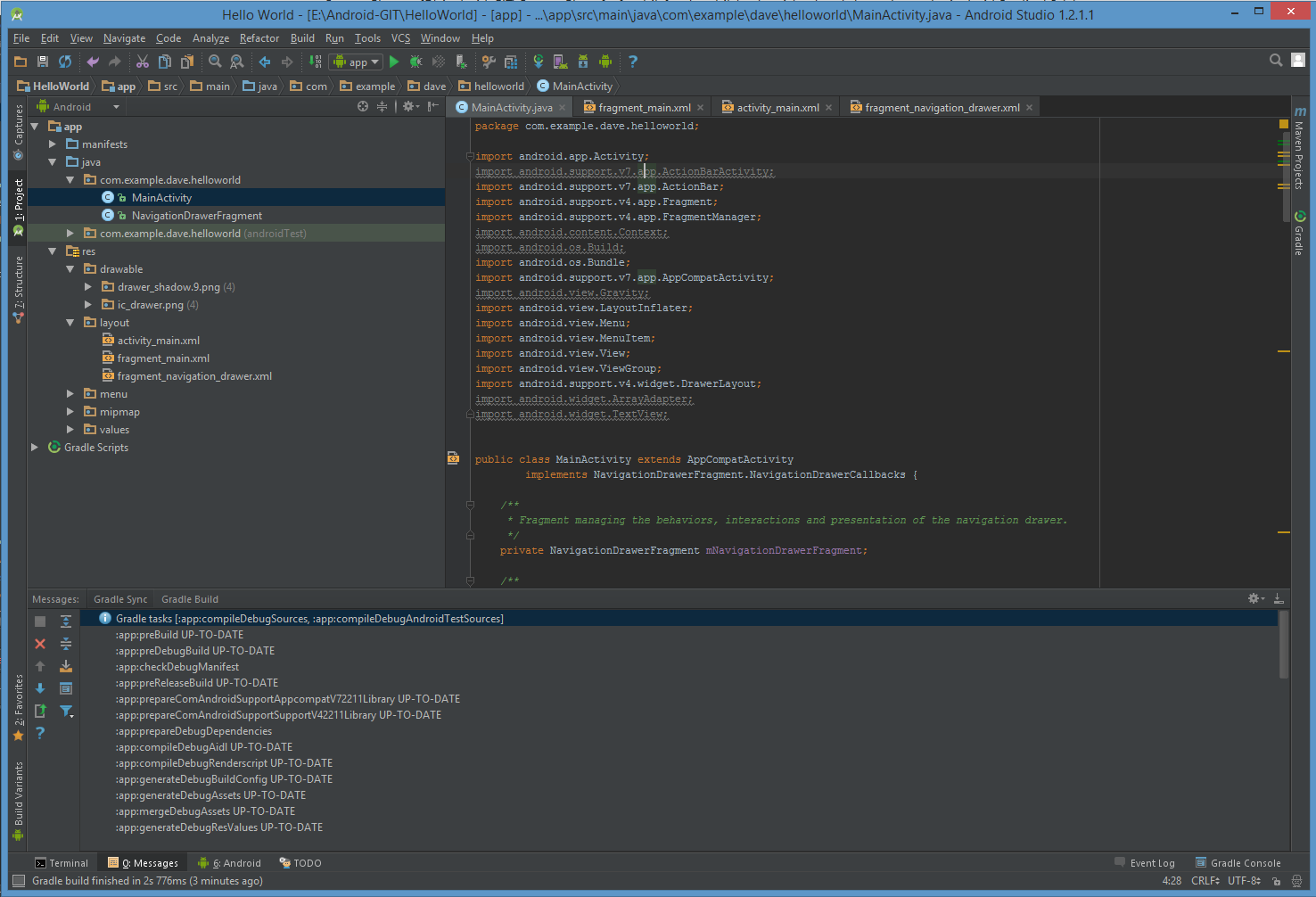


Figure : This image shows an example of a standard Android Studio integrated development environment window (Wikipedia, 2017).

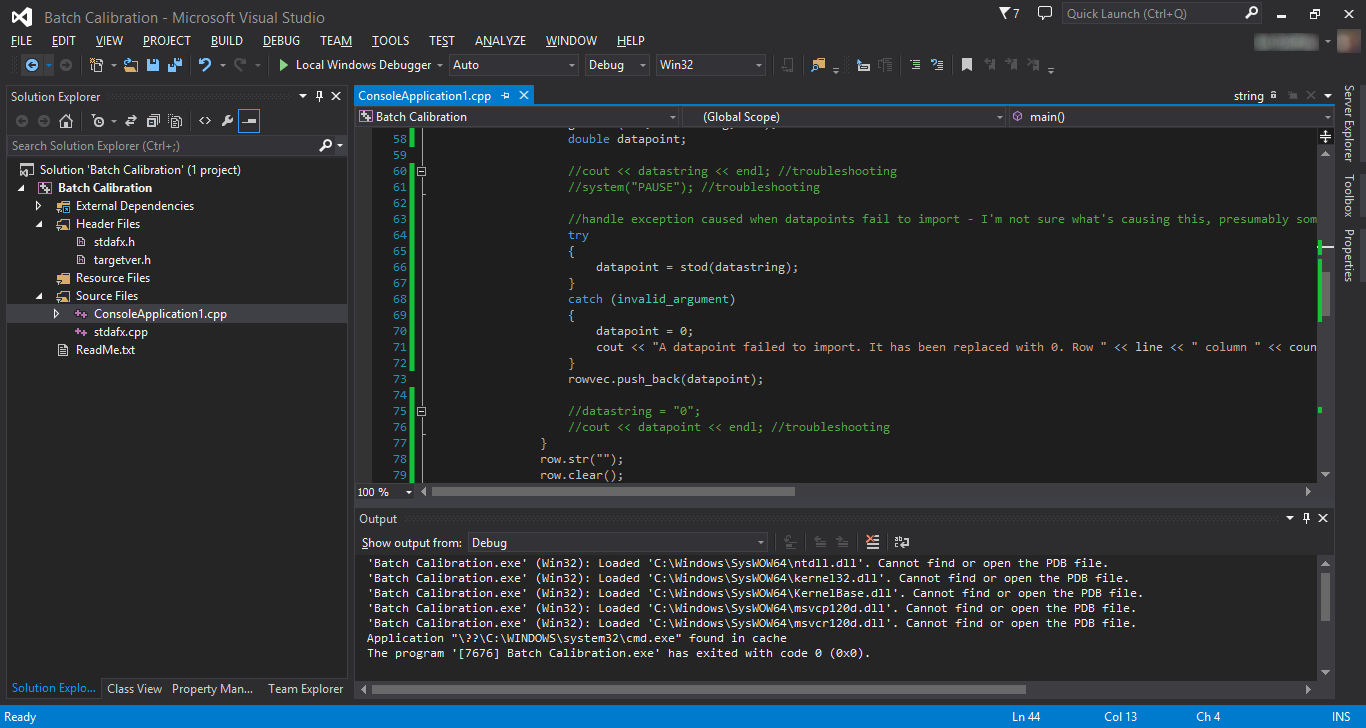


Figure : This image shows an example of a standard Visual Studio integrated development environment window (Wikipedia, 2017).

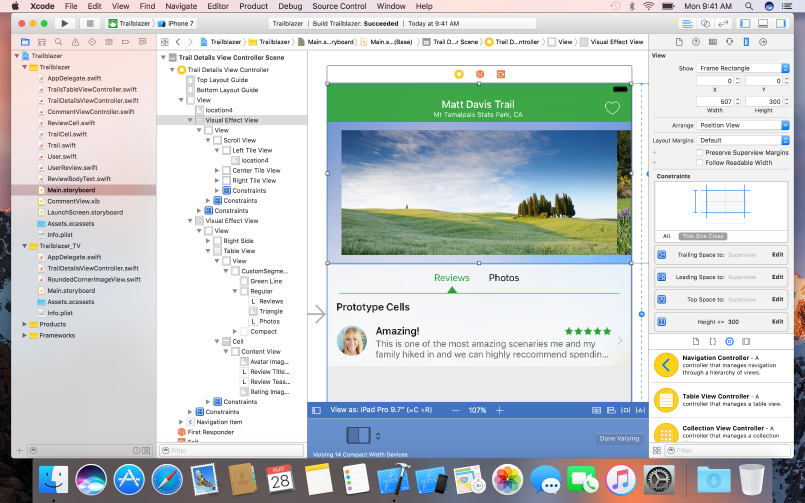


Figure : This image shows an example of a standard Xcode integrated development environment window (Apple, 2017).

Both Java and Xamarin take advantage of native features of the Android operating system (Google Inc., n.d.) (Xamarin Inc., 2016) and are therefore more suitable than none native solutions but no more suitable than each other for native Android development. However, Xamarin does allow for the use of standard .NET libraries (Montemagno, 2016) thus increasing the speed and efficiency of work flow due to developer knowledge of the standard .NET libraries.

Both Swift and Xamarin take advantage of native features of the iOS operating system (Apple, 2016) (Xamarin Inc., 2016) and are therefore no more suitable than each other for native iOS development. However, as previously discussed Xamarin allows for the use of standard .NET libraries (Montemagno, 2016).

Although as Xamarin allows for the porting of its code to both Android and iOS devices there is no need to choose one platform over another as the project can be created with both operating systems in mind thus opening up the theoretical user base that the product can appeal to from 86.2% to 99.1% (Xamarin Inc., 2016) (Statista, 2016). Therefore, C# via Xamarin using Visual Studios is the superior language in this use case.

## Networking

To implement online multiplayer game functionality a networking component should be created. The network component will be created using Xamarin as it allows for the development of a cross platform solution that is easily debugged for rapid prototyping (Xamarin Inc., 2016). Xamarin will also allow for the network component to be run from both a desktop or mobile device, this is desirable as it allows the use of a predefined external server or alternatively a local server run from the client’s mobile device.

There are a number of models of how and where a network component can be implemented and how and what will send and receive information where. Models include; peer-to-peer whereby each instance on a network shares its files equally with each other, with no central storage or authentication (Posey, 2000), and client/server where there are separate dedicated servers and clients (Posey, 2000). This can be seen in the image below (Figure 8).

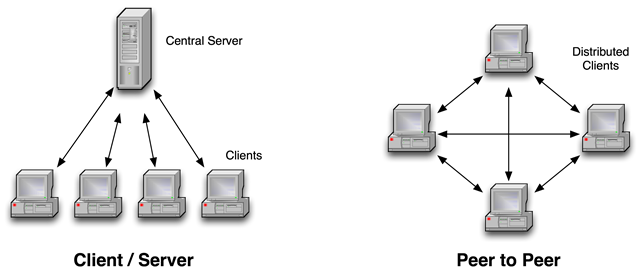


Figure : This image shows a visual model of the difference between a client/server model on the left and a peer-to-peer model on the right (Philips, 2014).

However, Peer-to-peer handles large numbers of users badly because, the whole network is bottlenecked by the slowest connection (François Baccelli, 2013). Conversely client/server handles larger numbers of users with ease as each person’s connection is only as slow as their own connection to the server, but for this to work it is usually required that an offsite server or servers be dedicated to the game 24/7.

For this project a client/server model would be most efficient as there could possibly be an infinite number of players at any one time and the lag caused by this would be astronomical under a peer-to-peer architecture, also most people will be connecting to the network using mobile data so drops in connection will occur regularly causing others gaming experience to be affected if a peer-to-peer model was adopted.

There are also a number of protocols that the client and server could be written to accept, each with its own advantages and disadvantages in a given scenario. Protocols include; UDP (User Datagram Protocol) a low latency, low reliability protocol (TechTarget, 2015) (Seguin, 2014), and TCP (Transmission Control Protocol) a high latency (compared to UDP), high reliability connection-oriented protocol (TechTarget, 2014) (Diffen, n.d.).

Because of its low latency and general broadcast ability UDP is perfect for gaining an initial connection to a network component (Mey, n.d.), TCP is then useful once the initial connection has been verified to pass sensitive game data.

## Tracking

## Pathfinding

# Designs

## System Design

## UI Design

## Test Design

|  |  |
| --- | --- |
| **Test** | **Result** |
|  |  |

# Project Management Review

Generally, progress on the project thus far has been stunted by multiple factors:

Firstly, the main computers that were chosen to be used to complete the project did not have the required development software installed to develop the project, in addition the development software has not been installed by the administrators of the computers as of the writing of this report, furthermore the backup computer-that was to be used in situations like this-that has the development software installed does not have the required specifications to run the development software to an adequate performance level. This means that anything that requires this development software has not begun development yet.

However, this does mean that the extra time available has been invested to fully optimise and add additional features-that would not have otherwise been added-to the areas of the project that could be developed without this development software.

Secondly, the initial time plan (‎Appendix C:) did not take into account other outside commitments when allotting time to this project. Time must be allowed to complete other compulsory projects on time, as such it appears that this project is behind schedule when in fact the initial time plan was inherently flawed and unachievable.

Thus a new task list (‎5.1) and time plan (‎‎‎5.2) has been created taking into account the issues mentioned above.

The tasks that require the specific development software mentioned above have been delayed until after this report has been completed, this should give enough time for a solution to the problem to be realised, either the instillation of the required development software on the main computers, an upgrade of the backup computer or a change of development software. These issues have been further amended to the risk analysis section of this report (‎Appendix D:).

Sections of time have been blocked out in order for the completion of extraneous compulsory commitments, this includes the reworking of the remaining time allocated to this project in order to ensure the smoothest development experience possible.

The addition of a multigame server has been abandoned since the initial report stage as the scope of the project has had to be reduced because of the issues mentioned above.

## New Task List

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Task Name** | **Description** | **Duration**  **(weeks)** |
| 1 | Research | Conduct research that will aid in the writing of reports and initial designing of the project | 9 |
| 2 | Initial report | Write the initial report deliverable | 2 |
| 3 | Create server client library | Create a client library that is capable of interfacing with the server | 5 |
| 4 | Create TCP server | Create a TCP server that can accept TCP packets from the client | 2 |
| 5 | Create UDP server | Create a UDP server that can accept UDP packets from the client and can be used to identify the IP of the server | 1 |
| 6 | Add multithreading capabilities to server | Add multithreading to the server so that it is capable of accepting more than one client request at a time | 2 |
| 7 | Add logging capabilities to the server | Add logging to the server so that it is capable of recovering from a fatal error | 2 |
| 8 | Work on other projects | Time set aside to work on other projects | 6 |
| 9 | Interim report | Write the interim report deliverable | 3 |
| 10 | Create main menu for game | Create a main menu for the game that will be displayed when the game is started and between every game instance. The main menu should display all options for game types and settings | 1 |
| 11 | Add game screen and assets to game | Add a game screen to the game that is displayed once the play game option is selected and also add assets to the game to be used to display player characters | 2 |
| 12 | Add map to game screen | Add a suitable map to the game screen | 2 |
| 13 | Add translations and scaling to map | Add translations and scaling to the map so that it is possible to move the map around and zoom in and out | 2 |
| 14 | Add player character and movements to map | Make the player character move as the player moves, this should work via GPS | 2 |
| 15 | Add non-player entities | Add a non-player entity that is capable of killing the player, this entity should move following a randomly generated meandering path | 2 |
| 16 | Final report | Write the final report deliverable | 14 |
| 17 | Add client calls to store and recall player positions from server | Make the game send its current location to the server at a reasonable interval and also make it so that the game requests the location of every other player | 2 |
| 18 | Add tracking data and bounds of playing field to game | Make it so that the game then draws all the players at the correct locations and that it is possible to create the area of play | 2 |
| 19 | Add taking mechanics from tracking data to game | Make it so that when a player completes a run from one side of the playing area to another they take the smallest area for their own team | 2 |
| 20 | Add killing mechanics from tracking data | Make it so that if a player crosses the path of another active player one of the players dies | 2 |
| 21 | Add scoring data to game | Make it so that the score of all players is tracked based on the area of land taken | 2 |
| 22 | Work on other projects | Time set aside to work on other projects | 7 |
| 23 | Add team mode to game | Make it so that players can play in teams | 3 |

## New Time Plan

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Task Name** | **University Calendar Weeks** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| 1 | Research |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Initial report |  |  |  | D |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Create server client |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Create TCP server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Add UDP to server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Add multithreading capabilities to server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Add logging capabilities to the server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | Work on other projects |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Interim report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | D |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | Create main menu for game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Add game screen and assets to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Add map to game screen |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Add translations and scaling to map |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Add player character and movements to map |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15 | Add non-player entities |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 | Final report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | D |
| 17 | Add client calls to store and recall player positions from server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18 | Add tracking data and bounds of playing field to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19 | Add taking mechanics from tracking data to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 | Add killing mechanics from tracking data to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 21 | Add scoring data to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 22 | Work on other projects |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 23 | Add team mode to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. Capture the Campus!

Capture the flag is a well-known game (sub-) genre that requires players to capture the flag. Often there are two opposing teams each of which has a flag that must be defended from the other team.

<http://en.wikipedia.org/wiki/Capture_the_flag>

This project requires the student to design and develop an augmented reality game for a GPS-enabled mobile device (preferably Windows Phone 7). The details of the gameplay are open to negotiation, but a suggestion is that a number of flags (or capture points) are distributed in GPS locations around the campus. The players are required to visit the location for a specified time period to capture the location. The players accumulate score based on number of capture points held and time they are uncontested for. The status of the capture points should be persistent, with the game’s progress being able to be tracked over multiple (perhaps unlimited) days.

The project involves databases for storing flag locations and capture logs etc.

Project Code: DJP3

1. First Task List

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Task Name** | **Description** | **Duration**  **(weeks)** |
| 1 | Research | Conduct research that will aid in the writing of reports and initial designing of the project | 10 |
| 2 | Initial report | Write the initial report deliverable | 2 |
| 3 | Create server client library | Create a client library that is capable of interfacing with the server | 5 |
| 4 | Create TCP server | Create a TCP server that can accept TCP packets from the client | 2 |
| 5 | Add UDP to server | Add UDP to the server that can be used to identify the IP of the server | 1 |
| 6 | Add multithreading capabilities to server | Add multithreading to the server so that it is capable of accepting more than one client request at a time | 2 |
| 7 | Create main menu for game | Create a main menu for the game that will be displayed when the game is started and between every game instance. The main menu should display all options for game types and settings | 1 |
| 8 | Add game screen and assets to game | Add a game screen to the game that is displayed once the play game option is selected and also add assets to the game to be used to display player characters | 2 |
| 9 | Add map to game screen | Add a suitable map to the game screen | 3 |
| 10 | Add translations and scaling to map | Add translations and scaling to the map so that it is possible to move the map around and zoom in and out | 2 |
| 11 | Add player character and movements to map | Make the player character move as the player moves, this should work via GPS | 2 |
| 12 | Interim report | Write the interim report deliverable | 3 |
| 13 | Add client calls to store and recall player positions from server | Make the game send its current location to the server at a reasonable interval and also make it so that the game requests the location of every other player | 3 |
| 14 | Final report | Write the final report deliverable | 14 |
| 15 | Add tracking data and bounds of playing field to game | Make it so that the game then draws all the players at the correct locations and that it is possible to create the area of play | 2 |
| 16 | Add taking mechanics from tracking data to game | Make it so that when a player completes a run from one side of the playing area to another they take the smallest area for their own team | 2 |
| 17 | Add killing mechanics from tracking data | Make it so that if a player crosses the track of another active player one of the players dies | 2 |
| 18 | Add scoring data to game | Make it so that the score of all players is tracked based on the area of land taken | 2 |
| 19 | Add team mode to game | Make it so that players can play in teams | 3 |
| 20 | Add multigame server | Make it so that multiple game instances can run on one server | 3 |

1. First Time Plan

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Task Name** | **University Calendar Weeks** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| 1 | Research |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Initial report |  |  |  | D |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Create server client |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Create TCP server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Add UDP to server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Add multithreading capabilities to server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Create main menu for game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | Add game screen and assets to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Add map to game screen |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | Add translations and scaling to map |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Add player character and movements to map |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Interim report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | D |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Add client calls to store and recall player positions from server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Final report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | D |
| 15 | Add tracking data and bounds of playing field to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 | Add taking mechanics from tracking data to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 17 | Add killing mechanics from tracking data to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18 | Add scoring data to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19 | Add team mode to game |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 | Add multigame server |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. Risk Analysis

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Risk** | **Current Risk** | | | **How to Avoid** | **How to Recover** | **Residual Risk** | | |
| **Severity**  **(L/M/H)** | **Likelihood**  **(L/M/H)** | **Significance (Severity, Likelihood)** | **Severity**  **(L/M/H)** | **Likelihood**  **(L/M/H)** | **Significance (Severity, Likelihood)** |
| Data loss | H | M | HM | Keep backups | Reinstate from backups | L | M | LM |
| Loss of backups | H | L | HL | Keep multiple backups | Use alternate backup | L | L | LL |
| Underestimate workload | H | M | HM | Regularly review progress against Time Plan | Invest more time into work, possible reduction of objectives | H | L | HL |
| Critical error in deliverable | H | M | HM | Perform adequate research | Debug code | H | L | HL |
| Skill Risk | M | M | MM | Perform adequate training | Invest more time into research | L | L | LL |
| Scope Creep | M | H | MH | Fully define scope | Define scope at current point | M | L | ML |
| Inefficient Program Performance | H | L | HL | Spend time testing code | Remove extraneous features | M | L | ML |
| Server Crashes | M | M | MM | Attempt to optimize server code | Implement alternative servers | L | L | LL |
| Incompatible with target device | H | L | HL | Create program with target device specifications in mind | Create alternative version for target device | L | L | LL |
| Medical emergency | H | L | HL | Care for developers health | Comment code regularly so that it is well understood | M | L | ML |
| Development software unavailable during demonstration | H | H | HH | Place key files into a backup | Download key files | L | L | LL |
| Development software unavailable during development | H | L | HL | Ensure development software is installed on development computer | Keep a backup computer to use in the case that the development software cannot be installed on the main computers | M | L | ML |
| Backup computer insufficient to develop on | H | M | HM | Ensure development software is installed on development computer so the backup computer is unnecessary | Upgrade the backup computer | H | L | HL |
| Insufficient funds to upgrade backup computer | H | H | HH |  | Change the development software being used | H | H | HH |
| User injured while using application | H | M | HM | Only allow authorized access to application while in development and provide warning messages while in play | Medical attention may be required if a user is injured while using the application | H | L | HL |

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