National College of Ireland

Software Project

Cyber Security

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Cyber Clash -an interactive game to learn cybersecurity

Technical Report

Contents

Executive Summary

The purpose of this document is to highlight the background, aims and technologies that will be implemented as well as give a visual system demonstration of the interactive card game cyber-Clash. Cyber clash is an off-line, turn-based, single player card game that aims to educate people about cyber-attacks and defences in a fun, and interactive.

1.0 Introduction

1.1. Background

The project's undertaking was mainly inspired by the need to educate and raise awareness of the importance of cybersecurity. Nowadays, people have grown accustomed to the growing need for technology such as smartphones, computer systems and video game consoles, and many have learned to utilize them for work, academics, and entertainment. However, many have yet to learn the risks involved with using said devices. The basis of this game is derived and inspired by an interactive card game called Hearthstone: Heroes of Warcraft. This free – to- play card game online card game was developed and published by Blizzard entertainment in 2014 and since then it has gained success with a wide audience from the ages of 12 upwards. For this reason, a considerable number of Hearthstones rules, features, game style and designed were used as a reference for the development of this game.

1.2. Aims

The projects aim is to educate and raise awareness of cybersecurity vulnerabilities and countermeasures using an interactive card game. The development of the game was also reliant on the following aims.

1. The development and designing of Card templates
    a. Spell Cards (VulrabilityCards/ defensives implementations)
    b. Creature Cards (Viruses/ defensives measures / Hacks)
    c. TragetSellCards (defensive measures / Hacks)
2. Working with farther visual elements for the game's layout such as:
    a. Mana Pool, which controls and restricts card playability
    b. Rope Timer: which controls the time Talen by each player
    c. End turn button: a button that ends the turn.
    d. Player/hero player Avatar power button: a function specially made for each avatar and can be used if all criteria are met
    e. Battle scene: The main layout for the game
    f. animations
3. Preparing logical scrips that were used for the following visual elements mentioned above. As well as scrips especially made for the cards in the game for example:
    a. Card organization and showing enlarged displays of cards and creatures
    b. Several scrips that aid with the drag and drop features of the cards

4. Implementation and integration logical scrips that were used for the following visual elements mentioned above, handing, and forming relationships between them. In addition to adding more visual features such as displaying how much damage was taken (Damage effects) by either a creature or an avatar. A messaging system that will display the start and conclusion of each turn for each Avatar. Cards built with targeting features.
5. This fifth aim is mainly focuses on scripting and integrating all the scripts including logic scripts into the project. Establishing scripts made for:
    a. handling and testing the games basic mechanics for drawing and dragging cards from a player's hand and deck, playing, and activating cards on the battlefield and attacking.
    b. Animating and initiating a turn-based management system. As well as testing it.
    c. Creating cards that were made with reference to the OWASP to 10 vulnerabilities.
    d. Implementing an AI script that was found online. This script is aimed at controlling the opponent's behaviour and allows the opponent to play against the computer.

1.3. Technology

Presently, the focus of the interactive card games functionality such as randomized decks and draggable/droppable cards will be implemented with the use of Unity 2D game engine. To add behaviour to Game Objects such as the cards, gauges and timers Scripting in C# is a must, thus requiring the need to use Visual Studios.

The Technologies used to build the game is now more detailed than its previous iteration. A combination of 3 sets of technologies were used to successfully build this project. These are the following:

1.0 Unity Game Engine – This cross-platform game engine was used to develop and design various parts of the game.

1.1. Unity Hub 2.4.2 – this application was used for project management especially manually adding versions of Unity editor such as the one listed below

1.1.1. Unity version 2019.4.20f1 – this was the version that was used

- Unity3D – this version of the editor helped aided in learning and creating various 3-dimensional visual elements seen through the game as well as dealing with animations.

1.2. Visual Studio Code - To add behaviour to Game Objects Structures this source-code editor in combination with Unity Game Engine is required. This is mainly due to the unity scripting API that requires scripts to be written, generated, and tested in C#. Visual Studio Code was also the text editor of choice by reason of how familiar, comfortable, and previous experiences of using the tool. Another advantage to using the tool was the various plugins that assisted with scripting and working with Unity Scripting API.

- Debugger for Unity 3.0.2
- Unity Tools 1.2.12
- Unity Code Snippets

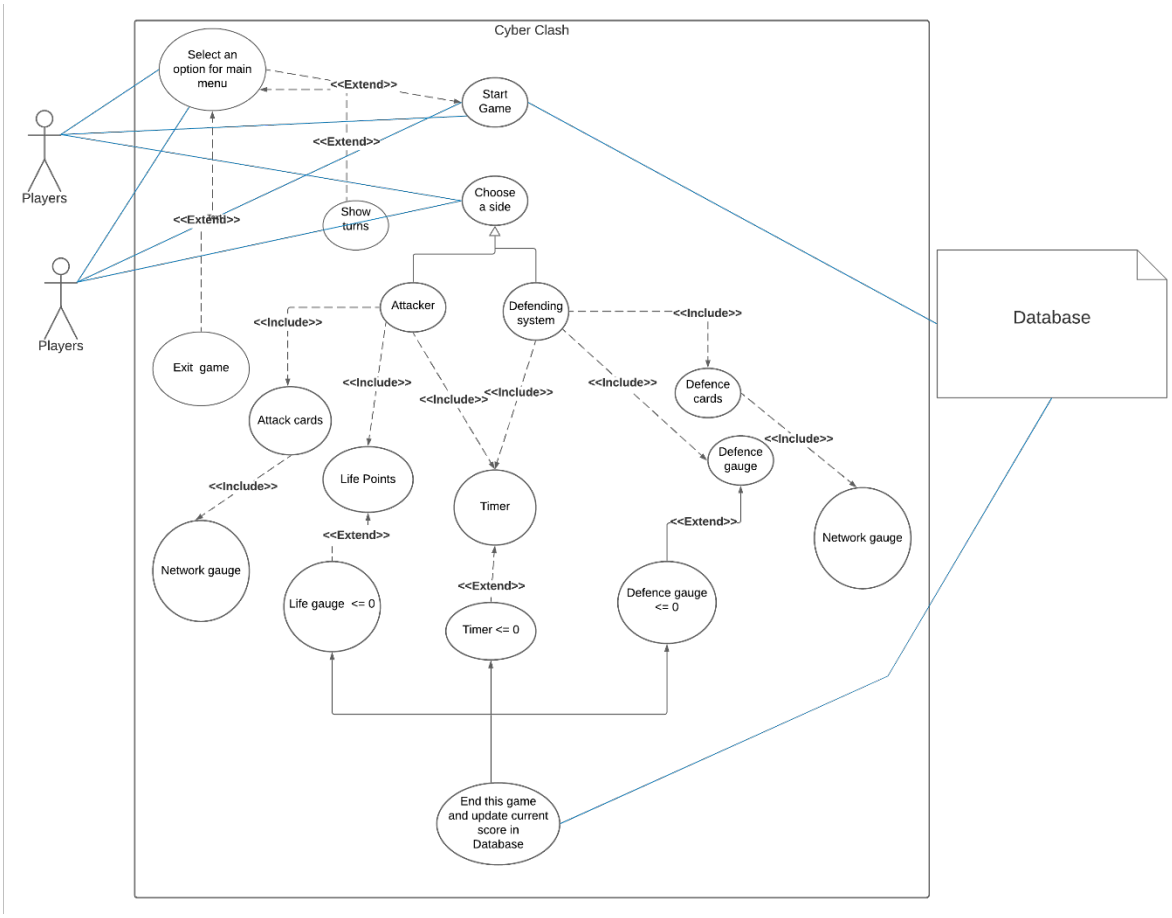
1.3. DOtween (HOTwee V2) – This is a Unity Tweening engine optimised and designed for fast, efficient, fully type-safe object-oriented animation engine for Unity. This engine was

essential when animating the visual effects for the cards in the game. Specifically Dragging, drawing from a deck, and hovering over a card or creature to show enlarged previews

The structure of the document will consist of system visualization and functionality with the use of use case diagrams. The data, user, environmental, and usability requirements and Graphical User Interface (GUI).

2.0 System

- ### Use Case Diagram



- ### Requirement 1.1: Registration
- ### Description & Priority

The user registration takes a priority of (1) because it is first of three pages an actor must encounter before stating the game.

- ### Use Case

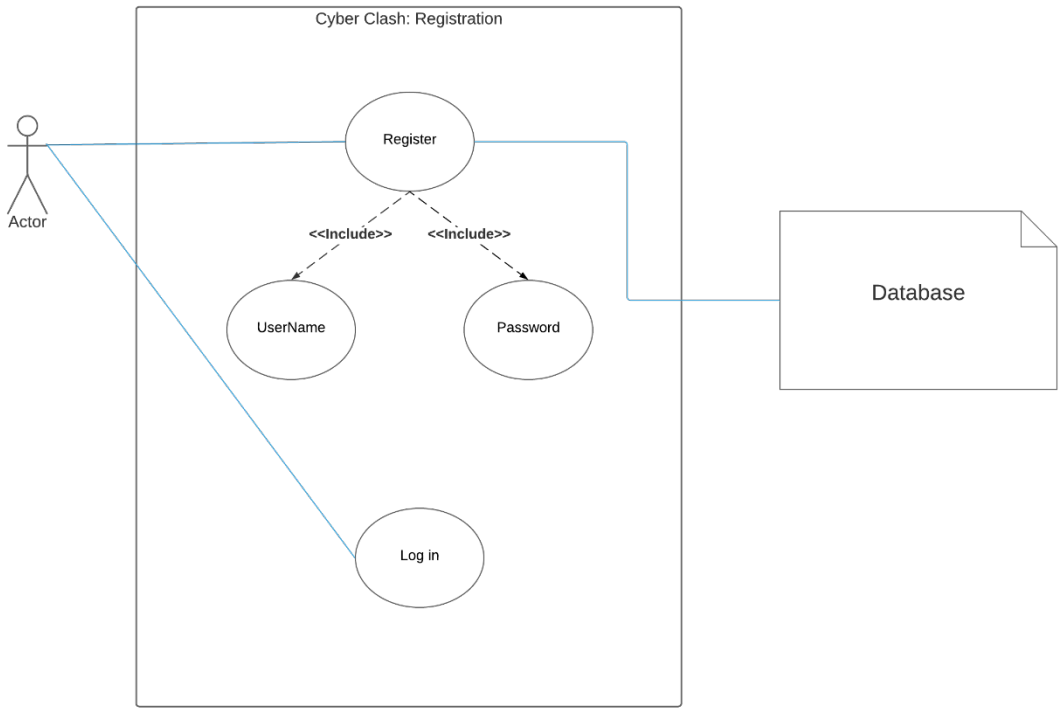
Scope

The scope of this use case is to give a visual understanding of the registration process.

Description

This use case describes the registration process.

Use Case Diagram



Flow Description

Precondition

For this part of the system to take an actor must visit the website.

Activation

This use case starts when an Actor clicked on the registration button.

Main flow

1. The actor clicks on the registration button
2. The Actor enters a username
3. The Actor enters a password
4. The Actor is then taken to the log in page

Termination

When the Actor enters the login page.

Post condition

The system goes into a wait state

- Requirement 1.2: Log In
- Description & Priority

The user Log in take a priority of (2) because it is second of three pages an actor must encounter before stating the game.

- Use Case

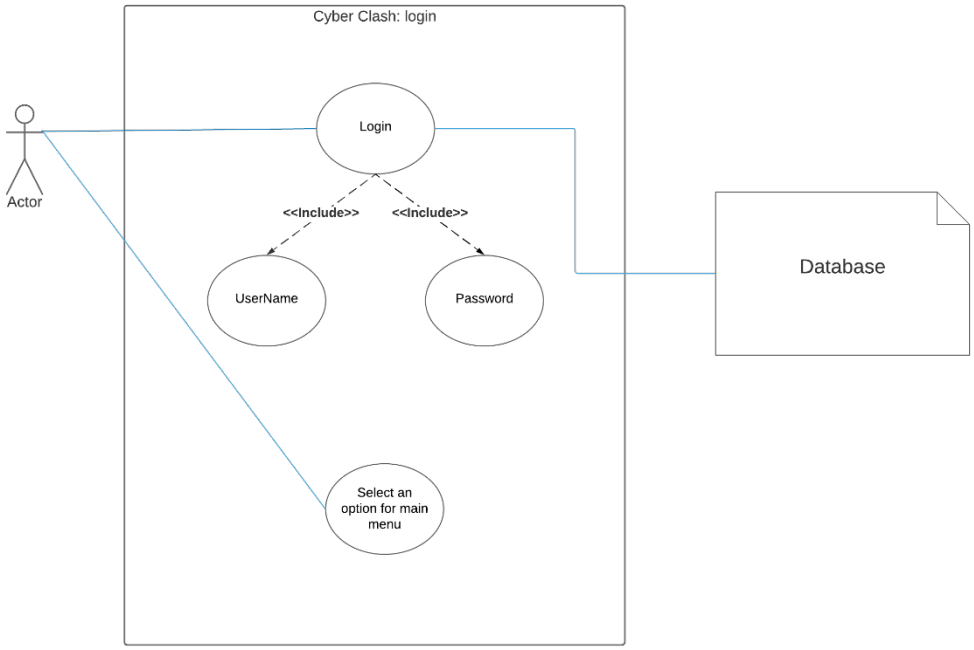
Scope

The scope of this use case is to give a visual understanding of the user login process.

Description

This use case describes the user login process. The user must enter their unique username and password to proceed to the main menu.

Use Case Diagram



Flow Description

Precondition

Use Case 1.1 must take place

Activation

This use case starts when user is taken to the login page after registering or after clicking on the registration button.

Main flow

1. The Actor is taken to the Login page
2. The Actor enters a username
3. The Actor enters a password
4. The Actor is then taken to the main menu ()

Alternate flow

1. The Actor enters the Login page via the login button
2. The Actor enters a username
3. The Actor enters a password
4. The Actor is then taken to the main menu ()

Termination

When the Actor is taken to the Main menu.

Post condition

The Actor is taken to the main menu.

- Requirement 1.3: Log
- Description & Priority

The main menu in take a priority of (3) because it is third of three pages an actor must encounter before stating the game.

- Use Case:

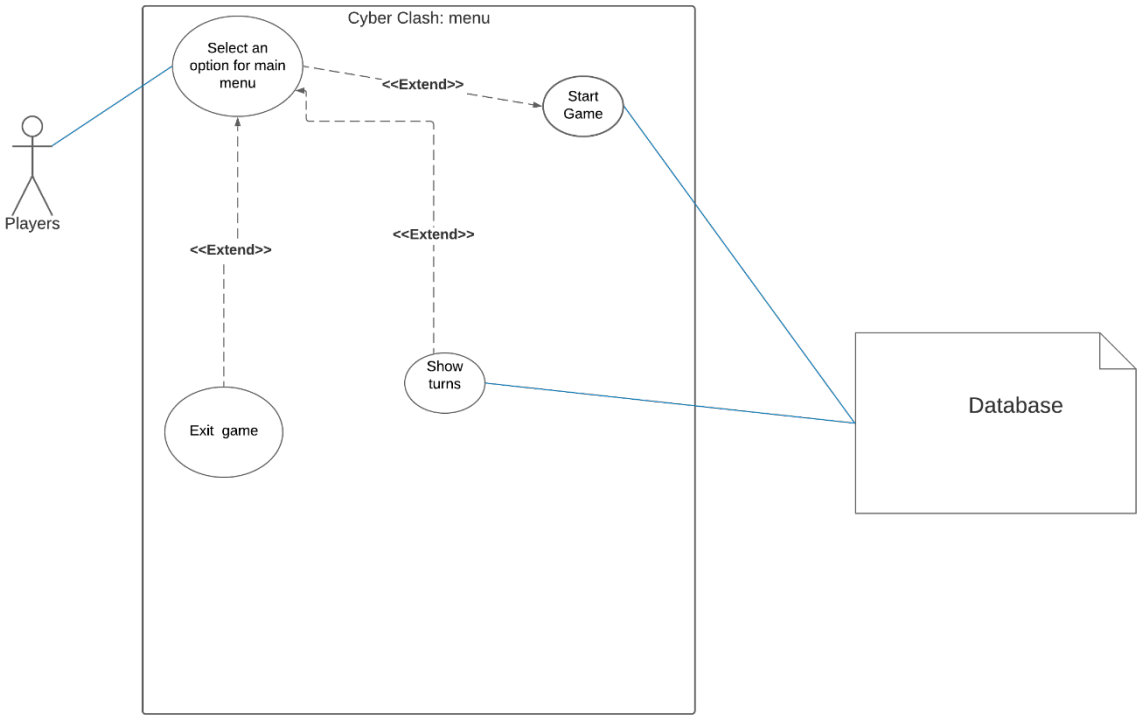
Scope

The scope of this use case is too visual the card game menu and its extended options

Description

This use case describes the main menu where the player will have the option to start game, show previous wins and losses, and the option to exit the game.

Use Case Diagram



Flow Description

Precondition

For this part of the system to take a player must register and login to the system.

Activation

This use case starts when an Actor has logged in to the system with their username and password.

Main flow

5. The system identifies that the player has logged in and introduces them to the menu page.
6. The Actor has selected the option to start the game
7. The system will then process to welcome the Actor to the chose page (Use case number).

Alternate flow

1. The use case continues at position 1 of the main flow
2. The actor chooses the option to show turns.
3. The Actor can view their winning and losing streaks.

Exceptional flow

1. The use case continues at position 1 of the main flow
2. The Actor chooses the option to exit.
3. The Actor is returned to the login page (Use case number)

Termination

When the Actor chooses the option to exit.

Post condition

The system goes into a wait state

- Requirement 2.1: Attacker player
- Description & Priority

This use case diagram gives a visual overview of the games menu and it takes Precedence because it will be one of the first thing the player/actor encounters before starting the game.

- Use Case

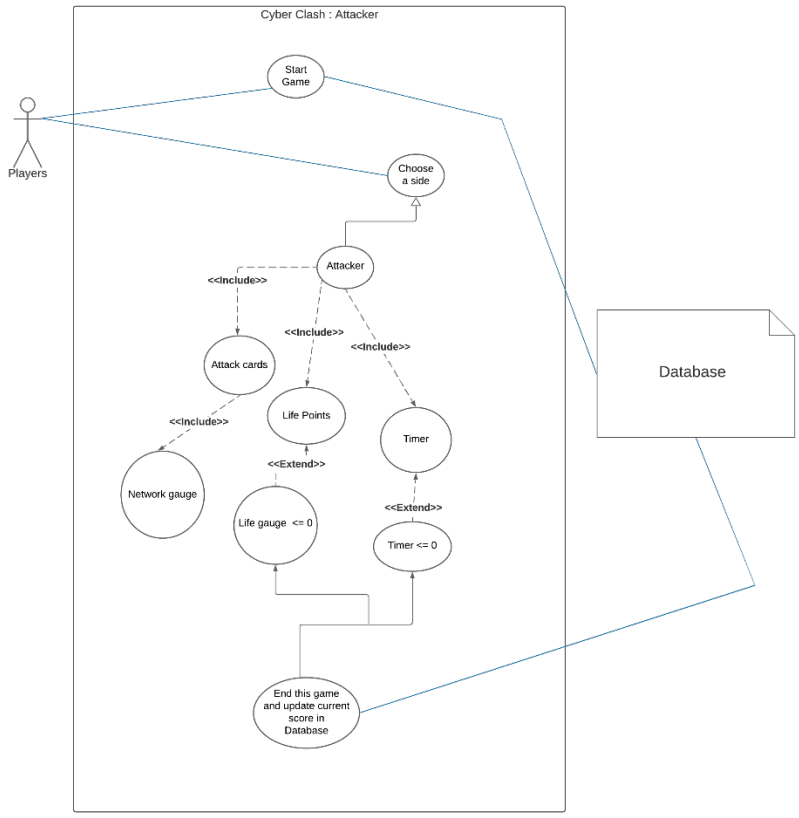
Scope

The scope of this use case is too visual the card game menu and its extended options

Description

This use case describes the main menu where the player will have the option to start game, show previous wins and losses, and the option to exit the game.

Use Case Diagram



Flow Description

Precondition

Use Case # must take place

Activation

This use case starts when the Actor has selected the option to start the game.

Main flow

1. The Actor starts the game
2. The system will then proceed to welcome the Actor to the chose between being an attacker or a Defender.
3. The Actor choses to be an attacker.
4. The attack is then presented with a random selection attack cards which needs a network gauge to play each card.
5. Takes the first turn.
6. The game ends when the attacker's life gauge is at zero
7. The score is then updated to the database

Alternate flow

5. The use case continues at position 5 of the main flow
6. The game ends when the timer runs out
7. The score is then updated to the database

Termination

When the game ends and the score is updated to the database.

Post condition

The Actor is returned to the main menu.

- Requirement 1.3: Defence player
- Description & Priority

This use case diagram gives a visual overview of the games menu and it takes Precedence because it will be one of the first thing the player/actor encounters before starting the game.

- Use Case

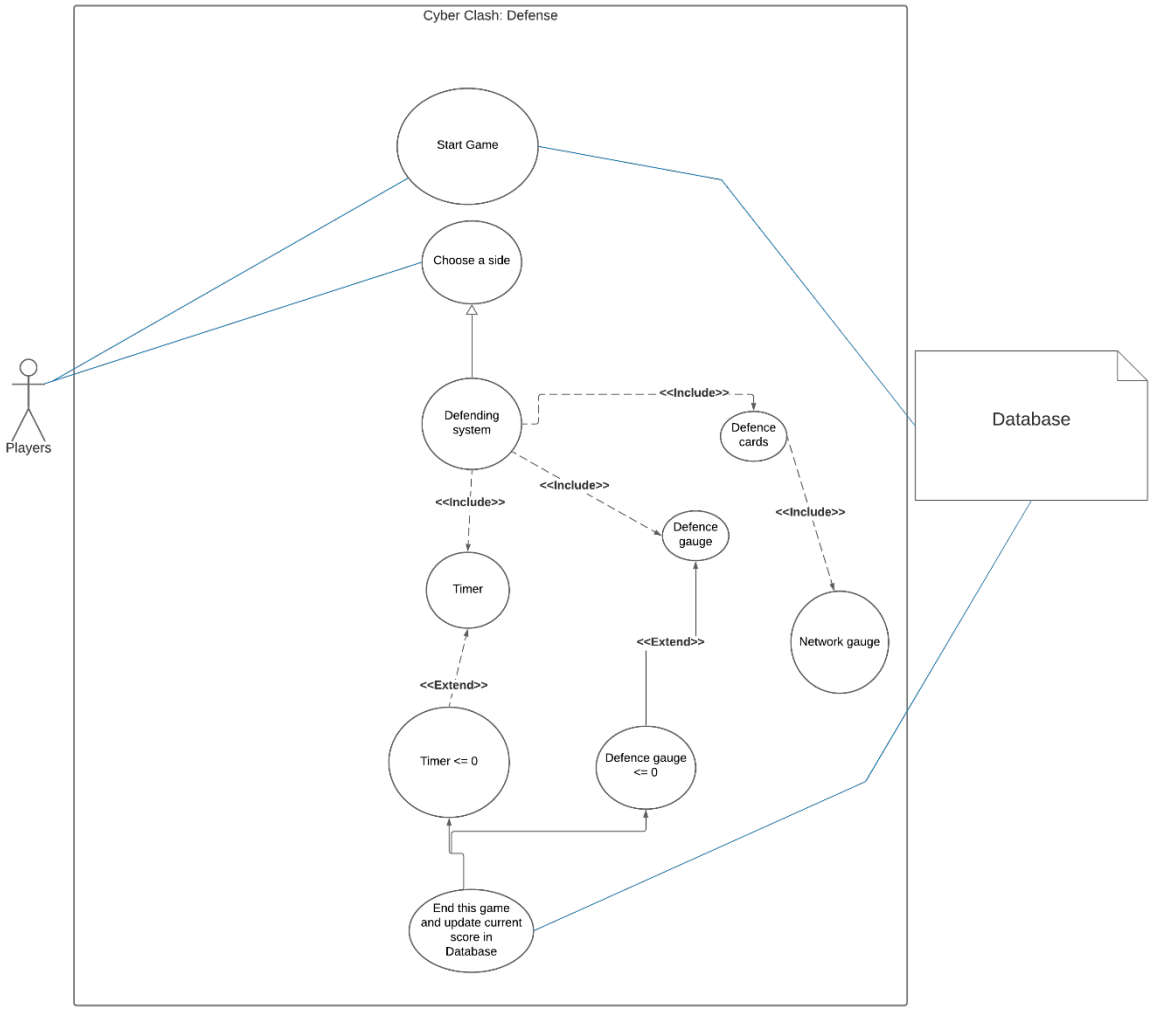
Scope

The scope of this use case is too visual the card game menu and its extended options

Description

This use case describes the main menu where the player will have the option to start game, show previous wins and losses, and the option to exit the game.

Use Case Diagram



Flow Description

Precondition

Use Case # must take place

Activation

This use case starts when the Actor has selected the option to start the game.

Main flow

1. The Actor starts the game
2. The system will then proceed to welcome the Actor to the choose between being an attacker or a Defence.
3. The Actor choses to be a Defence.

4. The attack is then presented with a random selection Defence cards which needs a network gauge to play each card.
5. Takes the second turn.
6. The game ends when the Defence's life gauge is at zero
7. The score is then updated to the database

Alternate flow

1. The use case continues at position 5 of the main flow
2. The game ends when the timer runs out
3. The score is then updated to the database

Termination

When the game ends and the score is updated to the database.

2.1.2. User Requirements

Requirement 1: User must have some fundamental knowledge on how to run a program

2.1.3. Usability Requirements

Requirement 1: User must be running Windows OS in order to run this game

Requirement 2: User must have an actively operating pointer device

2.2. Design & Architecture

The games design and architecture are base on those of Hearthstone

- The game is made to randomly select who goes first it does this through the use of the coin cards ability
- After every turn each opponent can draw a card
- Each opponent is granted one additional Wifibar (ManaCrystal), after each turn
- Each opponent Wifibar are replenished with bar every turn.
- Maximum Mana Pool a player can have is 9.
- Each opponent has an ability that costs Wifibars
- The battle ends when an opponent's life is at zero

Cards

The cards are spilt into two categories

- Creatures that can take the form of different types of Viruses, and countermeasure them
- Spells these take the form OWASP to 10 vulnerabilities and countermeasures

2.3. Graphical User Interface (GUI)

Provide screenshots of key screens and explain what can be seen in each one.

Prototype :

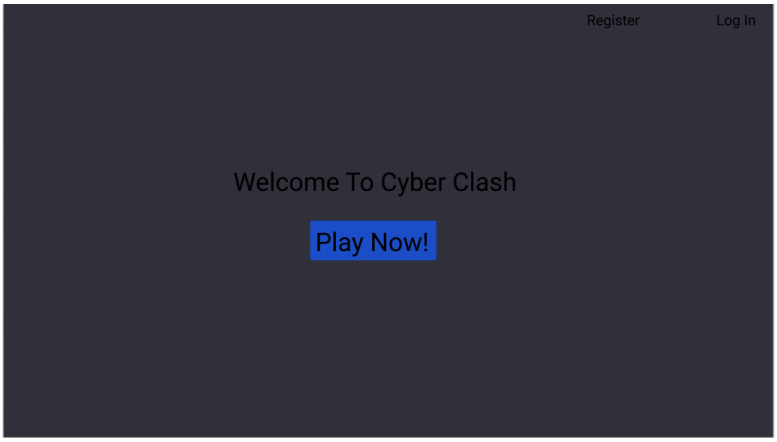


Figure 1: Landing page

Figure 2: Main Menu

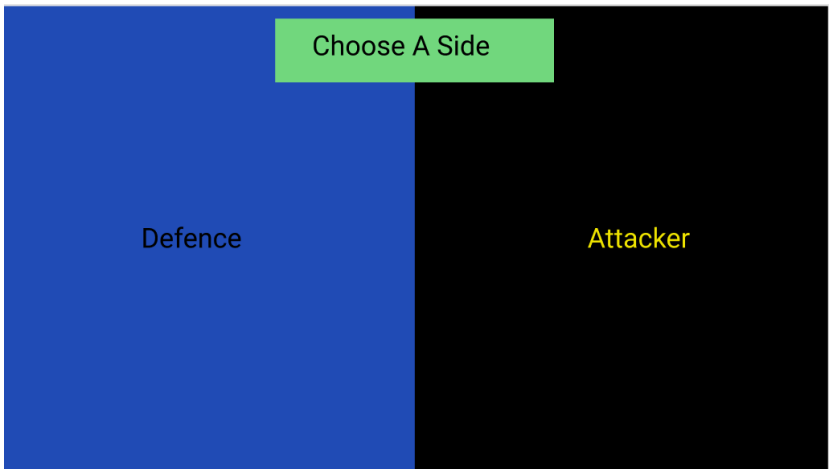


Figure 3: Choose a side

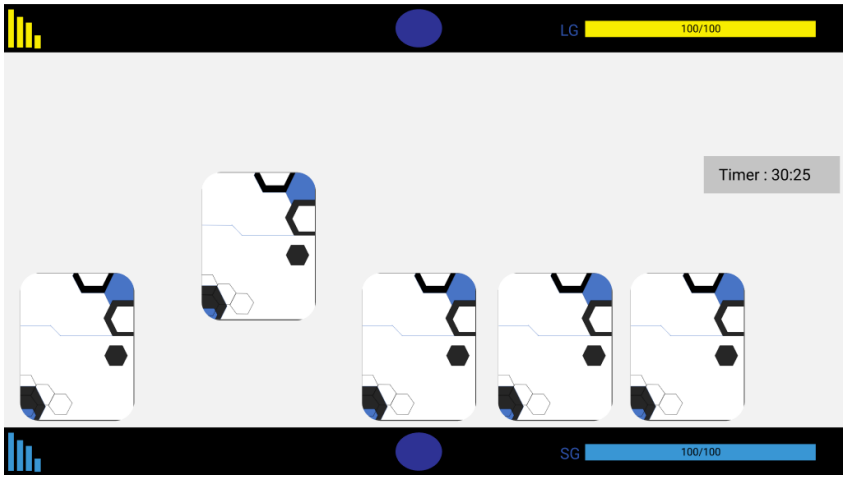


Figure 4: Defence player

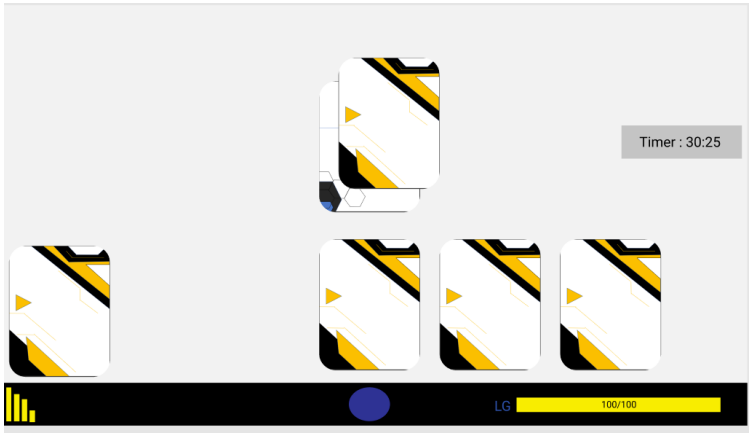


Figure 5: Attacker player

Final Project:

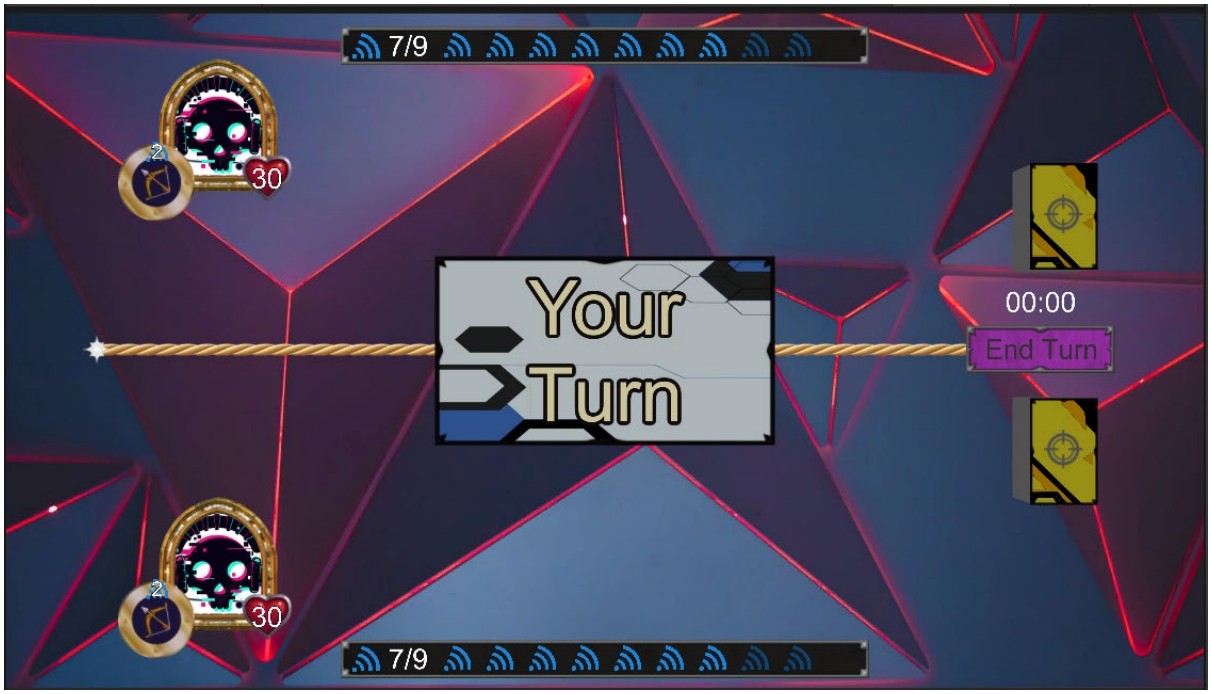


Figure 6 Mana Pool

Deck

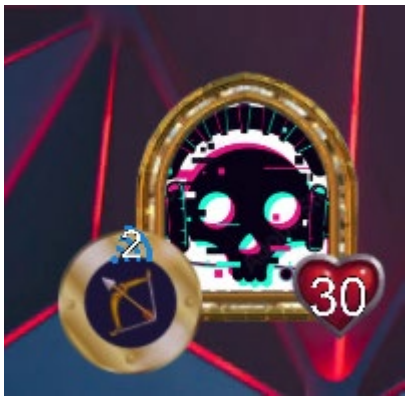


Figure 7 Avatar /Hero portrait - Lifeline - Hero Power

Figure 8 Spell cards

Figure 9 .1 Creature / Virus card

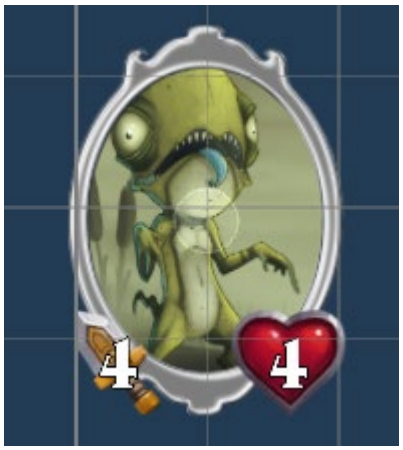


Figure 10 Creature / Virus card once placed on the table

Figure 11 Message card to establish each turn

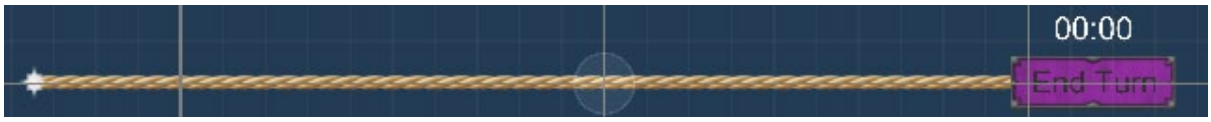


Figure 12 rope Timer

Figure 13 Demonstration of targetable spell cards - green glow showing the activation of avatar / hero power button as well as cards

Figure 14 once the game the user loses the game a pop up message will appear with a start new game button

Figure 15 damage effect on creature/Virus

Figure 16 Damage effect on Hero/Avatar portrait

2.4. Testing

Three testing techniques were found to be the most useful while developing the game these are:

Unit testing

- This form of testing was used to ensure individual parts of the game were functional and operational in the form of visual elements and scriptable assets. Majority of these tests were conducted on the visual elements and scripts

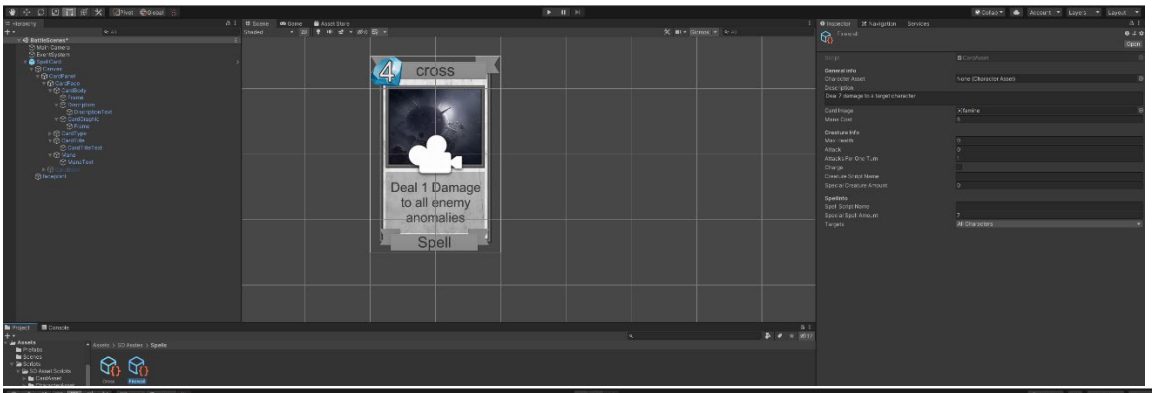
Integration testing

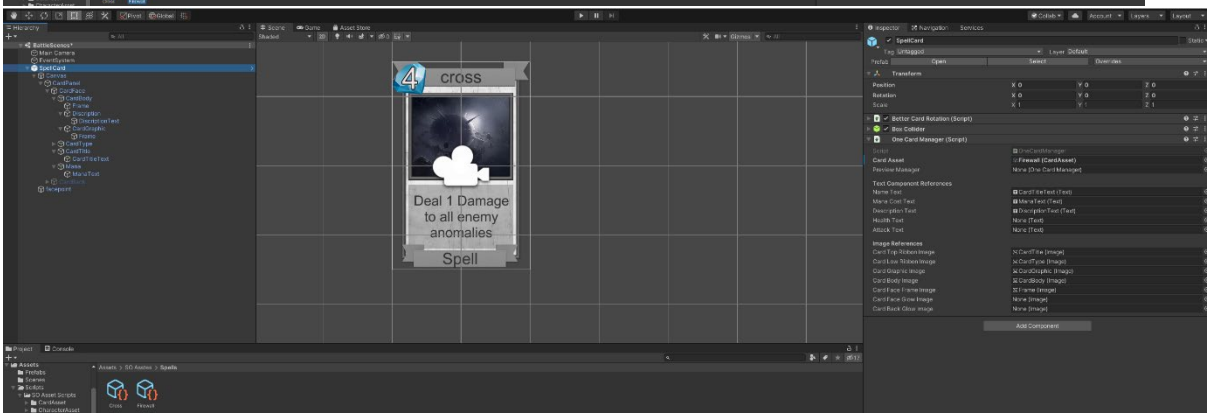
This type of testing was conducted with the goal of combining and fusing units that were tested successfully.

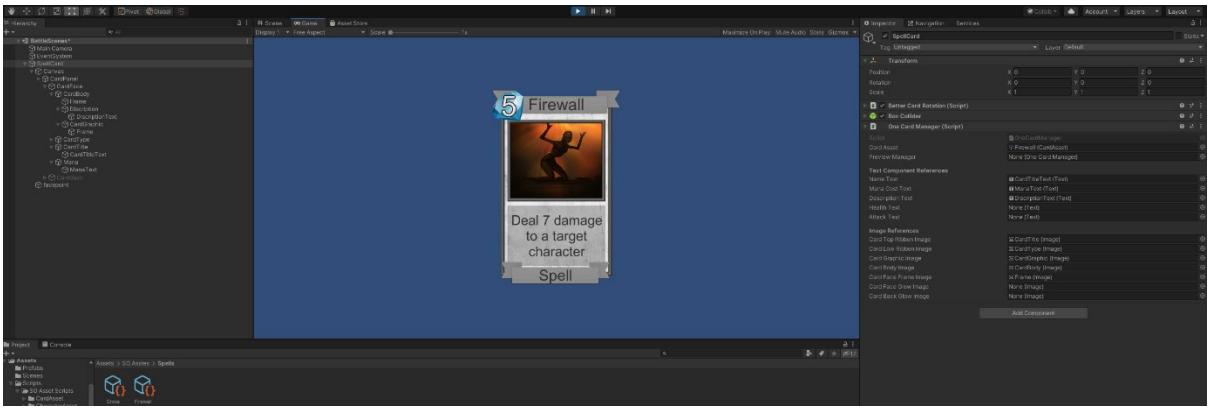
UI testing

- This from of testing was used to test UI controls and configurations. In this case Buttons, messages, timers and animation.
- Testing the relationship between one card manager script and the spell card that was made using unity3D. This test helped find a way to make multiple card

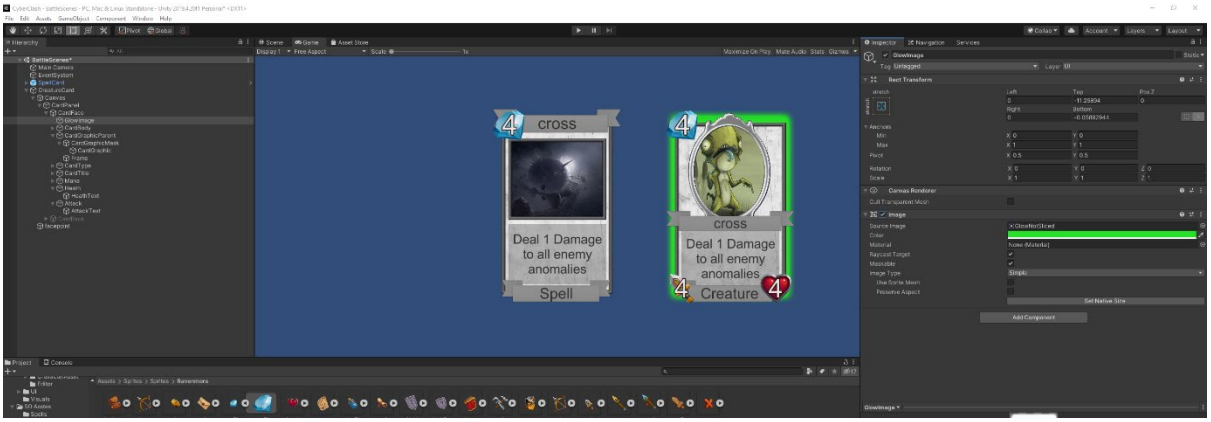
assets without to make more than one card. The script used is oneCardManager which is used to make universal actions for any Card

- 

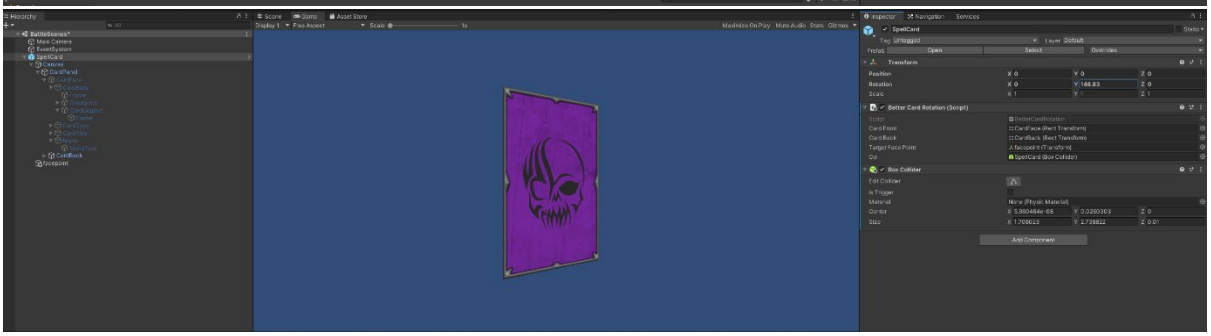
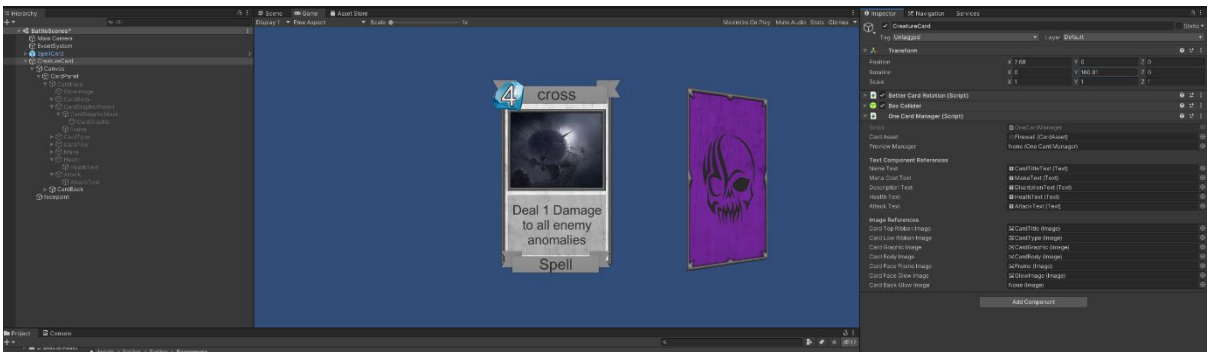
- 

- 

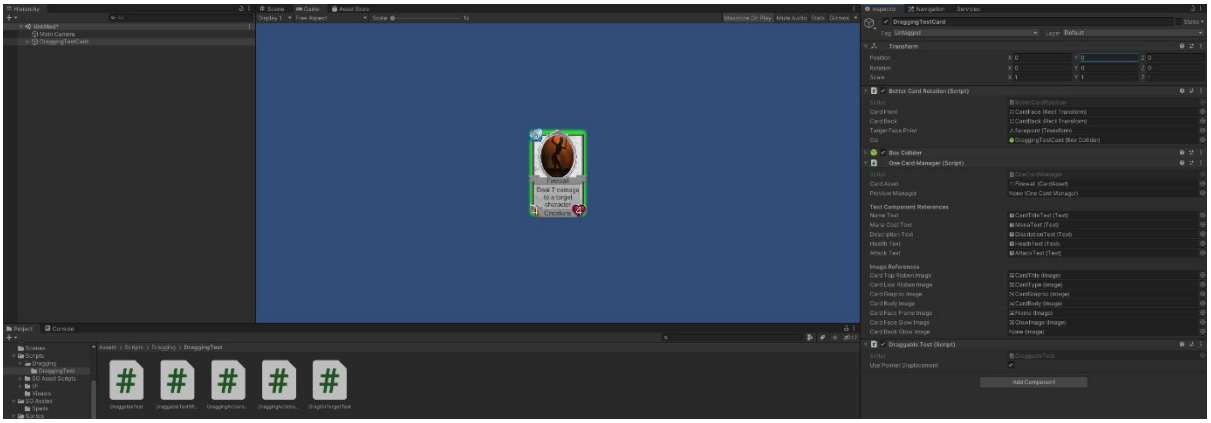
Visual effect test for the card Glow

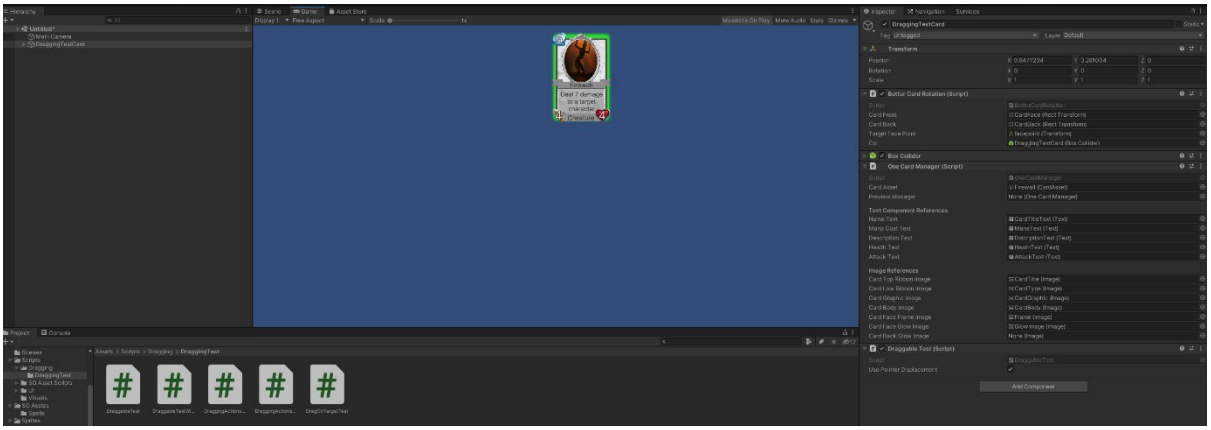
- 

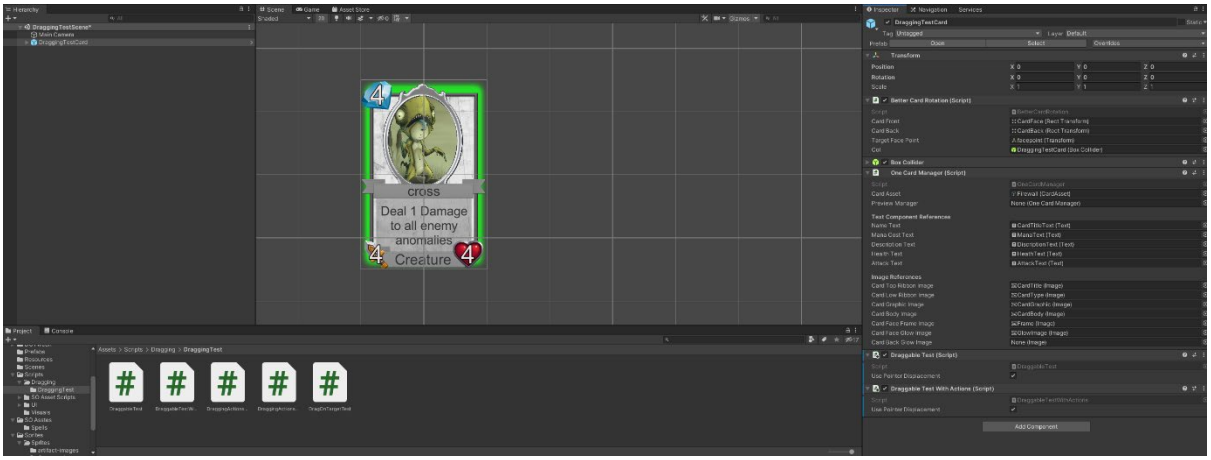
- Testing card as a 3D visual object with a script called better card rotation. This work by combining 2 card designs (card Back and Front). When rotated it shows 2 card designs as one while also utilizing recasting technology
- 

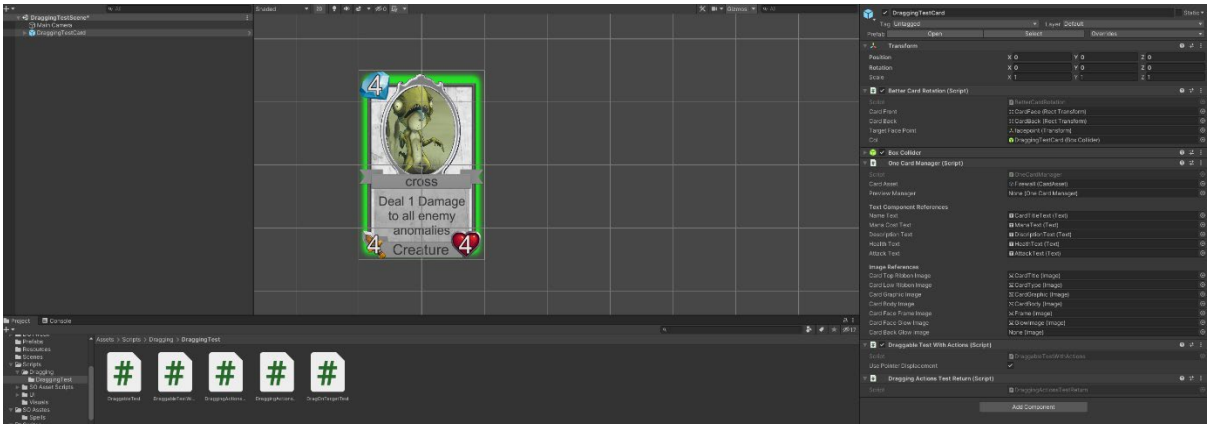
- 
- 

- Testing card dragging animations in combination with DOTween. These scripts can be found in the dragging test file,

- 

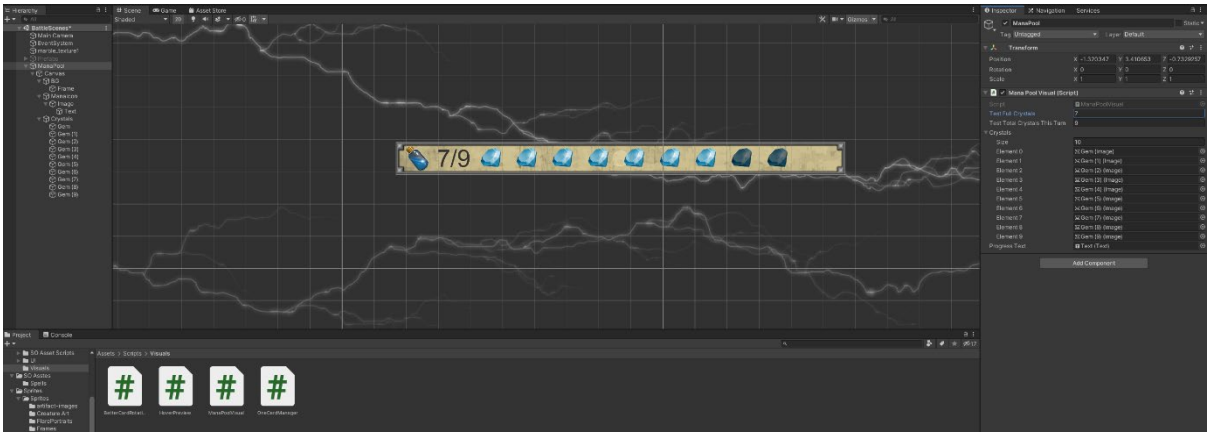



cross
Deal 1 Damage to all enemy anomalies
Creature

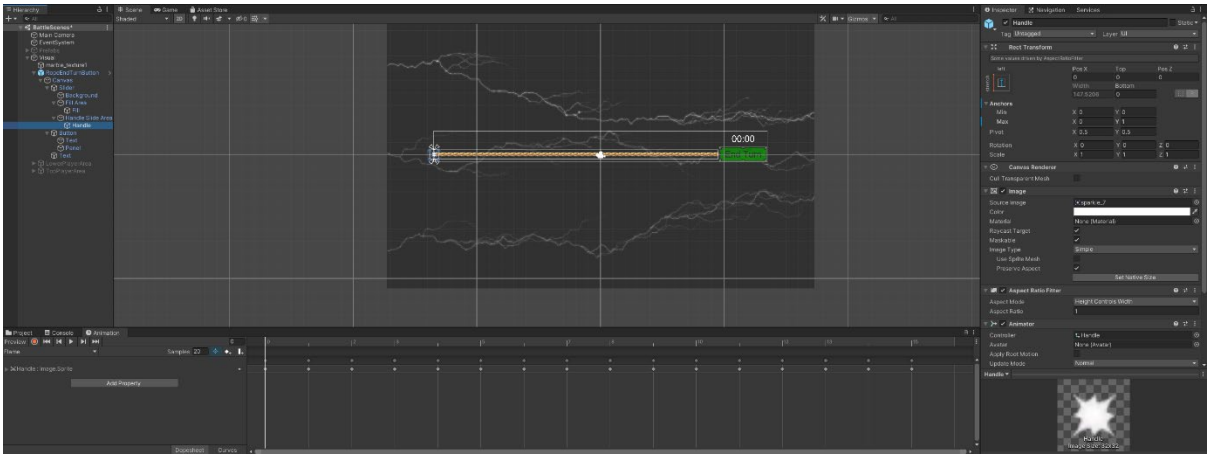

cross
Deal 1 Damage to all enemy anomalies
Creature

Testing card glow in relationship with HoverPreview.cs script. Which enlarges the card once a curser is on the card .

Testing the mana pool visual element in combination with ManaPoolVisual script. Testing mana population and the subtraction of gems with while visual blacking them out. All before visual changes were made.

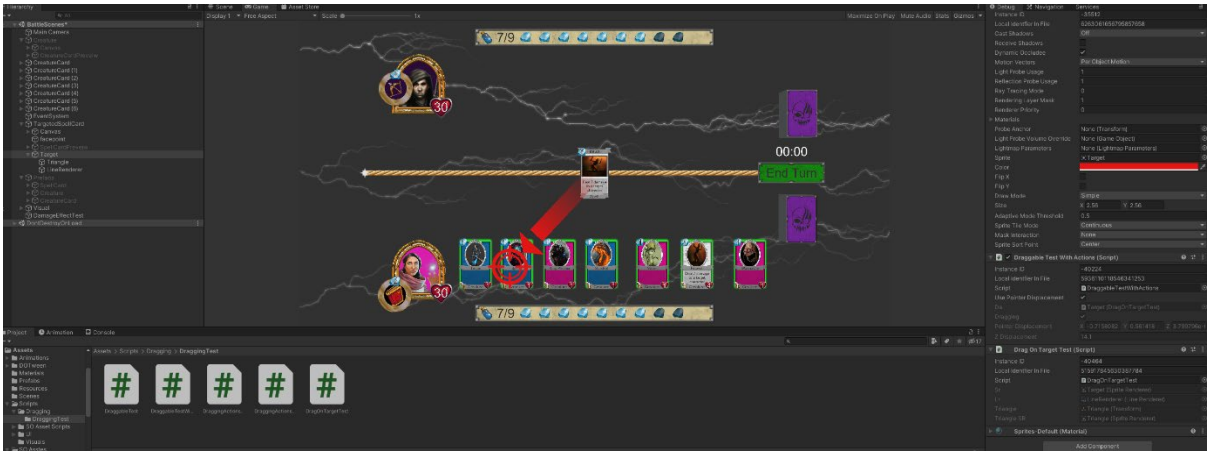


Testing Ropetimer animation



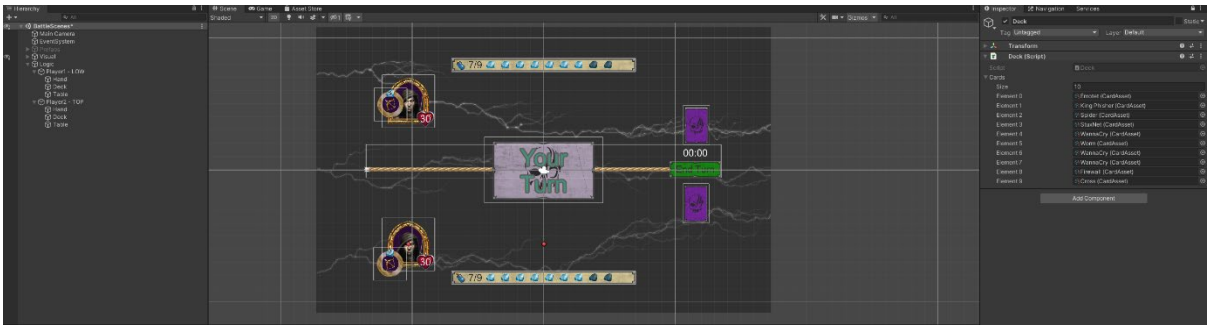
Testing Splash damage. In testing environment (BattleScene)

Testing Spell cards and creature cards with DragOnTarget.cs. The red red drag on target was made using unity editor

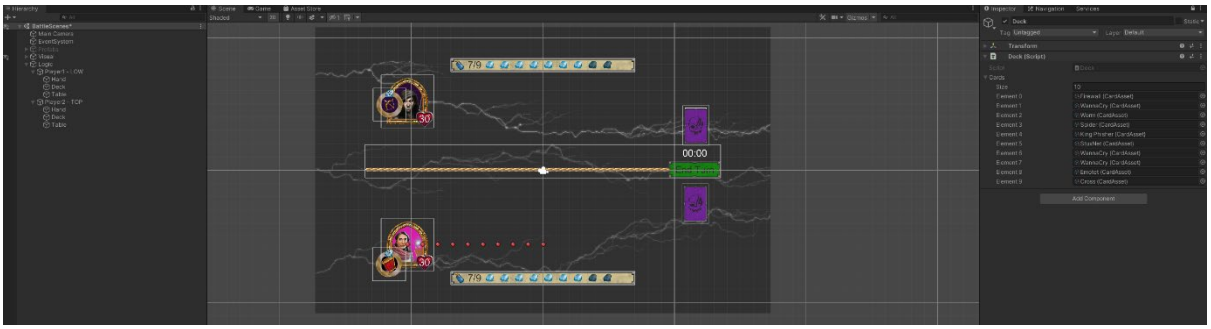


MessageMangerTest

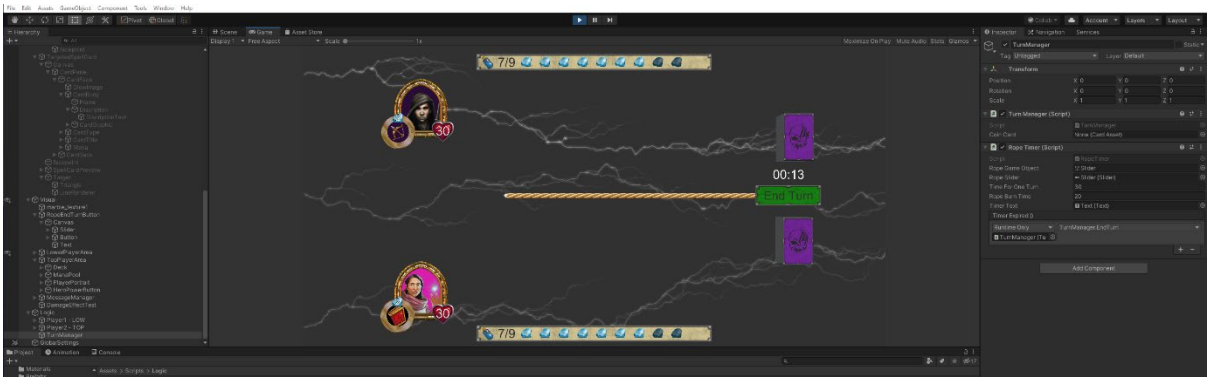
Testing Deck visual relationship with DeckPlayerVisual.cs , Deck.cs. Testing shuffle cards in deck after each game



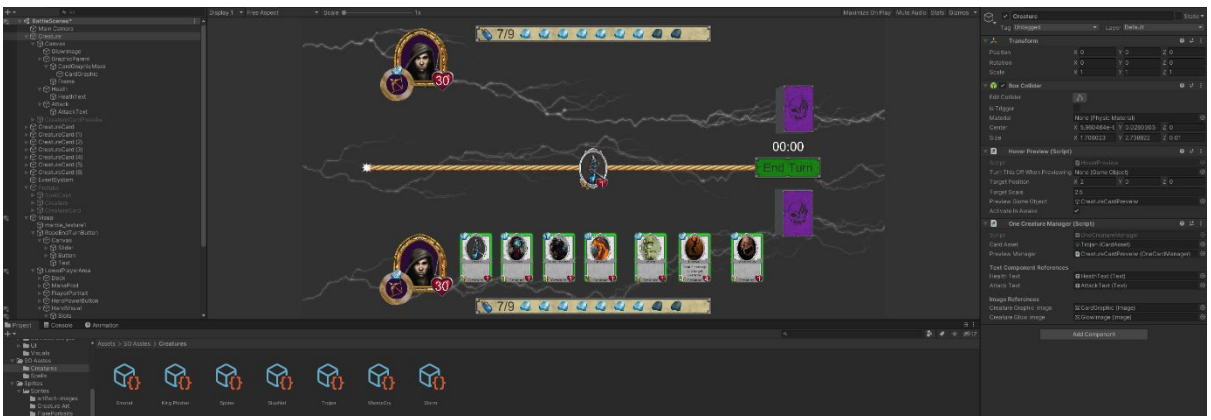
Testing Card Holding Hand visuals and measuring each card placement for every card in hand (red dots)

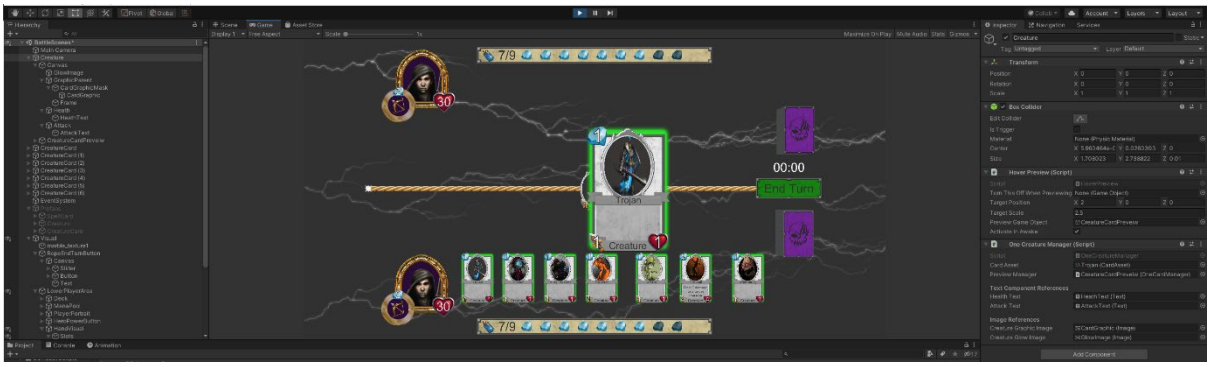


Integration testing Rope timer with other game elements.



Testing Hand, and Table visual elements together with hoverPreview





Testing Card Drawing from deck using keyboard hotkeys

2.5. Evaluation

While testing the final version of the game I came to the realisation that the project in its intertie draws on a lot of memory and for this reason I was unable to upload it to GitHub.

3.0 Conclusions

The advantages of developing a project to this scale were as follows:

Advantages

- The advantages were mainly surrounded by the fact that I got the main idea for the card game to work and was able to provide a fully working demonstration of what it could be.
-

Disadvantages

- Due to how overwhelming the project was I was unable to adding the online functionality.
- And colour coding the cards
- Unable to fix bug that allow hacker to only use viruses and vulnerabilities cards and vice versa with user using only Defensive and Countermeasure cards.

4.0 Further Development or Research

With additional time and resources, I would add the resulting point:

- Multiplayer mode
- Design more cards
- Deck customization, Avatar selection

5.0 References

Not applicable

6.0 Appendices

This section should contain information that is supplementary to the main body of the report.

6.1. Project Plan

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Plan**	**4 days?**	**Tue 03/11/20**	**Fri 06/11/20**	
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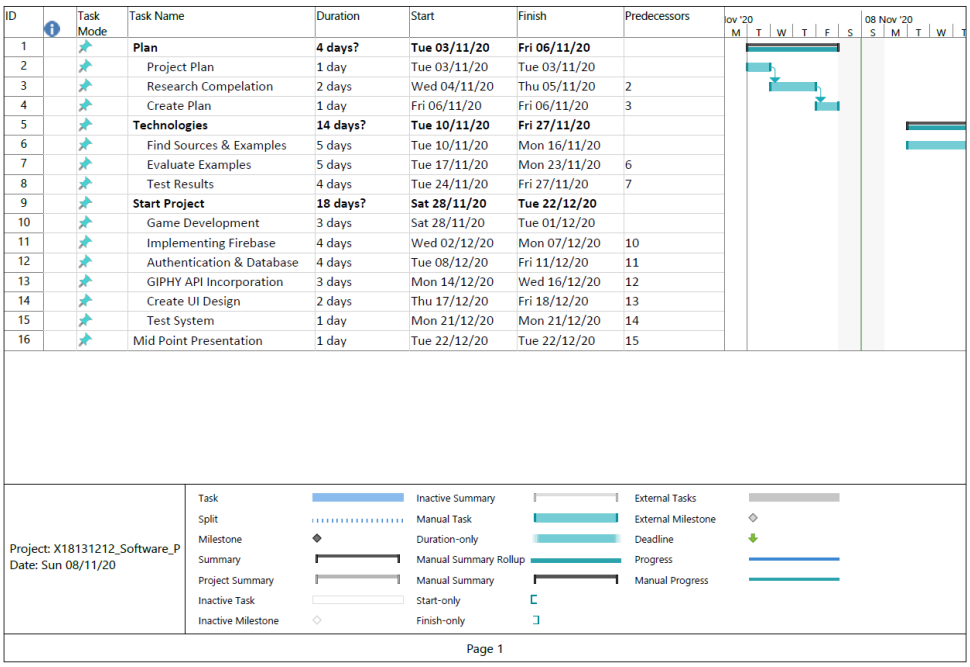
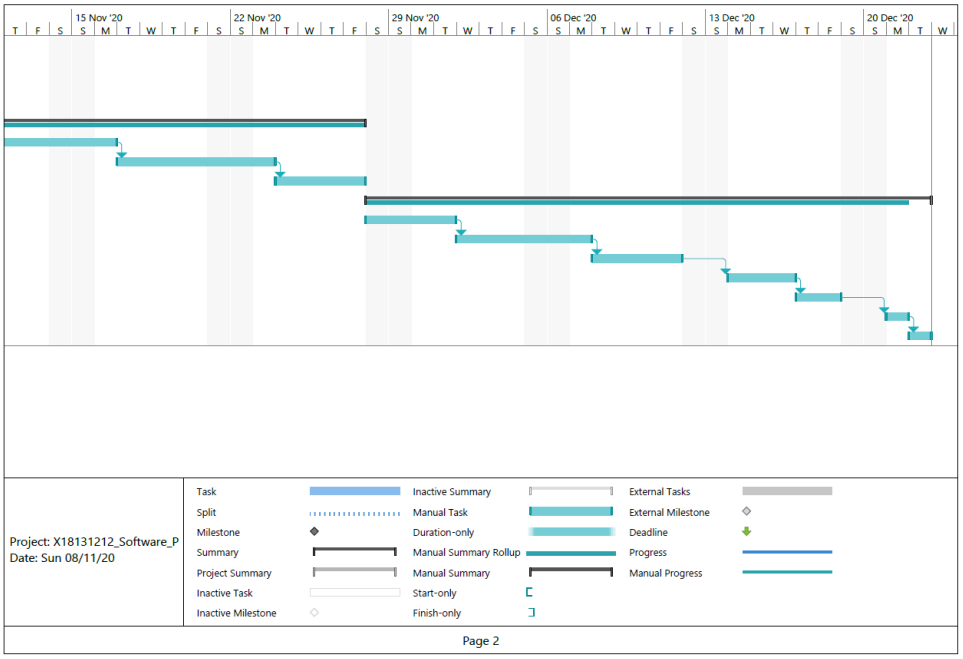
14		Create UI Design	2 days	Thu 17/12/20	Fri 18/12/20	13
15		Test System	1 day	Mon 21/12/20	Mon 21/12/20	14
16		Mid Point Presentation	1 day	Tue 22/12/20	Tue 22/12/20	15





1.1. Ethics Approval Application (only if required)

Not applicable

6.2. Reflective Journals

7.0 REFLECTIVE JOURNAL 1(Oct-Nov)

What have I done?	On the 17th of November, I submitted my project video pitch that outlined the summarized details of my project as well as it's contents.
What am I doing now?	Thus far, I have committed to researching the technologies I will be implementing in the software project. I have also emailed my Supervisor with regards to the progress and results of my Video pitch, and I now await their response.
What Am I going to do next?	My next phase of action would to research, prepare and write my Proposal alongside my Ethical Form. Ones this step is completed it will need to be submitted before the due date on the 8th of November, week 6

8.0

REFLECTIVE JOURNAL 2(NOV-DEC)

What have I done?	I h sc fo

What am I doing now?	Du an co wa an ga
What Am I going to do next?	M wo ch ga pr

REFLECTIVE JOURNAL 4(JAN)

What have I done?	1. Completed Min Point presentation 2. Seen results and gained feedback
What am I doing now?	Presently, the main focus is to apply and learn from the feedback given at the midpoint presentation. Which include the following : 1. Setting the game rules 2. And working on a user-friendly prototype 3.
What Am I going to do next?	Testing the system once It is in its final stages and any documentation that needs to be completed.

REFLECTIVE JOURNAL 5(FEB)

What have I done?	The interactive card games functionality such as randomized decks and draggable/droppable cards will be implemented with the use of Unity 2D game engine. In order to add behaviour to GameObjects such as the cards, gauges and timers Scripting in C# is a most, thus requiring the need to use Visual Studios
What am I doing now?	Presently, the main focus is to apply and learn from the feedback given at the midpoint presentation. Which include the following : 1. Finalizing the game rules 2. Card effects and applications to the game 3. Redesigning user-friendly prototype
What Am I going to do next?	1. Redesigning UI 2. Testing the system once It is in its final stages and any documentation that needs to be completed.

REFLECTIVE JOURNAL 5(Marc)

What have I done?	I planed research, and finalized my please to use Hearts stones gameplay machanices for CyberClach
What am I doing now?	• Using Unity UI to Card templates • Designing the cards hack and defences • Creating a front face side for the cards

	• Making the back of the cards hack and defences with additional designs • Cards point of rotation
What Am I going to do next?	• Implementing Object assets scripts • Utilizing the Card Asset Visual Appearance and applying it to cards • Adding card glow feture • Creating Virus cards

REFLECTIVE JOURNAL 6(Apr)

What have I done?	• Implementing Object assets scripts • Utilizing the Card Asset Visual Appearance and applying it to cards • Adding card glow feture • Creating Virus cards
What am I doing now?	• Visual layout for battle scene, and preparing logical scripts game machanies.
What Am I going to do next?	Testing the system once It is in its final stages and any documentation that needs to be completed.

8.1. Other materials used

National College of Ireland

Project Proposal

Cyber Clash

Due on 8/11/2020

Software Project

Cyber Security

2018/2021

JEGAN FRANCIS MENDY

X18131212

X18131212@student.ncirl.ie

Contents

9.0 Objectives

Cyber clash is a real-time, turn-based, online multiplayer card game that aims to educate people about cyber-attacks and defences in a fun, interactive, and yet familiar setting.

10.0 Background

As mentioned in section 1.0 (**Objectives**), Cyber clash is a real-time, turn-based, online multiplayer card game. The idea and inspiration for this project stem from each of these points:

- **Awareness**
- **Interactive & Fun**

- **Familiarity**

Awareness

This game's primary purpose is to educate and raise people's understanding of the importance of cybersecurity. The most used and essential would have to be our **laptops**, **PC**, and **Smartphones** when it comes to technology. However, even with our understanding of using these devices, do we truly know how to **shield** these computer systems and the user accounts that lay within from **attacks**? By playing this game, the user will learn the Vulnerabilities of these systems and the countermeasures used to combat them.

https://www.pewresearch.org/internet/2017/03/22/what-the-public-knows-about-cybersecurity/

Interactive & Fun to Learn

I chose to use an Interactive game because games are a powerful tool and conditions for learning. A player can **learn new aptitudes, information, bits of knowledge, mentalities, or even practices** in games that challenge them to think, investigate, and react. These factors are what support a player's continued learning experience. Interactive games also compel and promote problem-solving. Learning in a virtual endorses the theory of "Learning by doing."- American philosopher John Dewey. Achieving this in such an environment encourages players to respond to reactions and make decisions based on them.
https://www.researchgate.net/publication/285448990_What_Can_We_Learn_From_Playing_Interactive_Games

Familiarity

The game has elements of Familiarity to aid players in quickly understanding its gameplay and game-play experiences and communication, such as:

- **Cards**
- **Gifs**
- **text messaging interface/environment**

Cards

Playing with cards both in IRL and online are known to be used as a social activity. Social engagement is one of the critical factors for a person's happy life.

Gifs

The cards in Cyber Clash are animated with the use of **Gifs** instead of static images. Gifs were chosen because of the following points:

- Their Popularity
- Increases the players' retention

https://visual.ly/community/Infographics/social-media/infographics-why-you-need-them

- A Fun way to showcase Personality and Creativity
- The human brain processes image 60,000 times faster than it does text.

http://www.t-sciences.com/news/humans-process-visual-data-better

- Gifs speak louder than words

11.0 Technical Approach

The technical approach to building this game would involve an android smartphone user mainly because the game will be strictly developed for android. Firebase will be integrated into the game to aid with account creation, sign in experiences, and authentication. Cyber Clash is an online (1v1) multiplayer match; therefore, a real-time database will be needed to track player and gameplay. Once the actor makes an account, they will have the choice to choose between being an attacker or a defending system.

Defending system

A defending system can be either a laptop, smartphone, or desktop pc.

8-bit sprites will be used as avatar representations. The defending system will have three properties life points and shield points, and a deck of random cards made using gifs to represent each card. Each card represents a security countermeasure, such as a firewall, VPN, antivirus, and so on.

Attacker

This option will allow the player to attack a Defending system. They will have a range of cards that represent computer system and internet security attacks and vulnerabilities.

The rules of the game are as follows:

- The Attacker must take the first turn by playing a card from its randomly generated deck, and it can only play one card at a time and only after the Defending system has played its turn. During the Defending systems turn, it needs to replenish its shields with a card of its own only on its turn.
- The game will have a timer of 5 -10 mins. The Attacker wins when the Defending systems have no shield points left.
- The Defending systems win when it still has shield points remaining within the time limit.

12.0 Special Resources Required

An Android phone will primarily require run and test this game.

13.0 Project Plan

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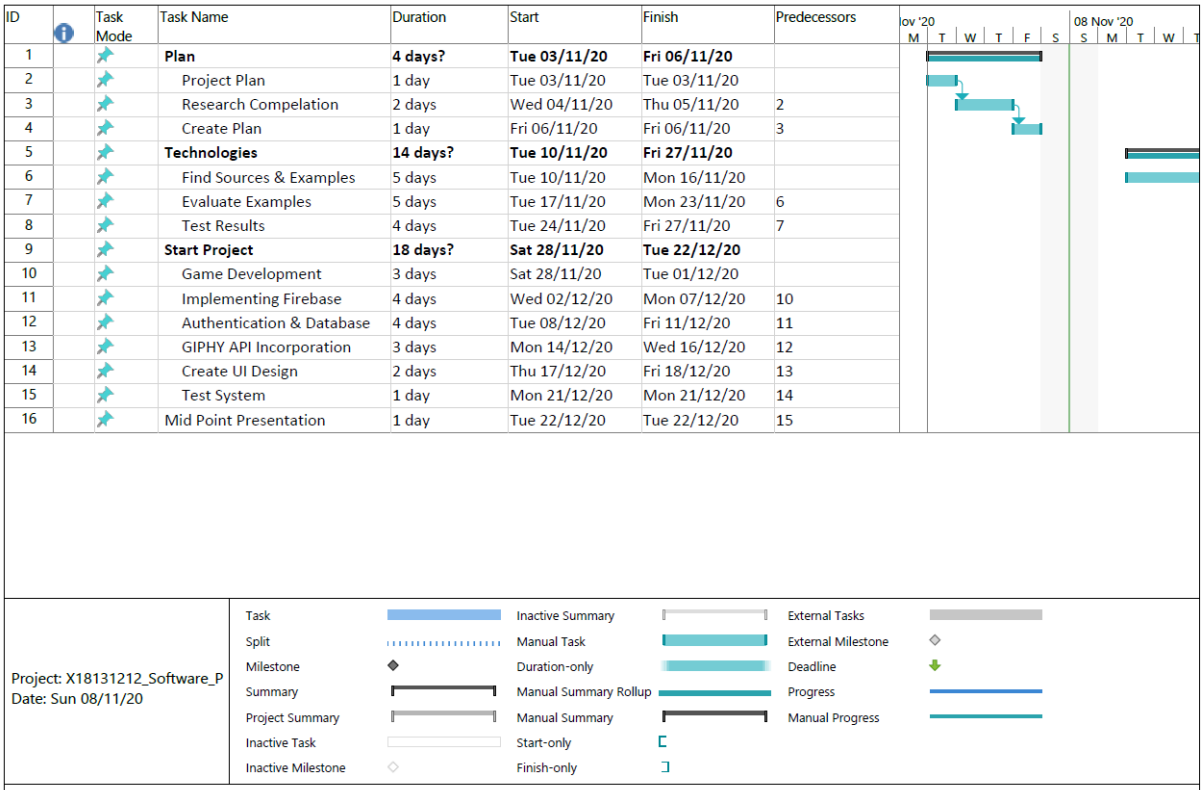

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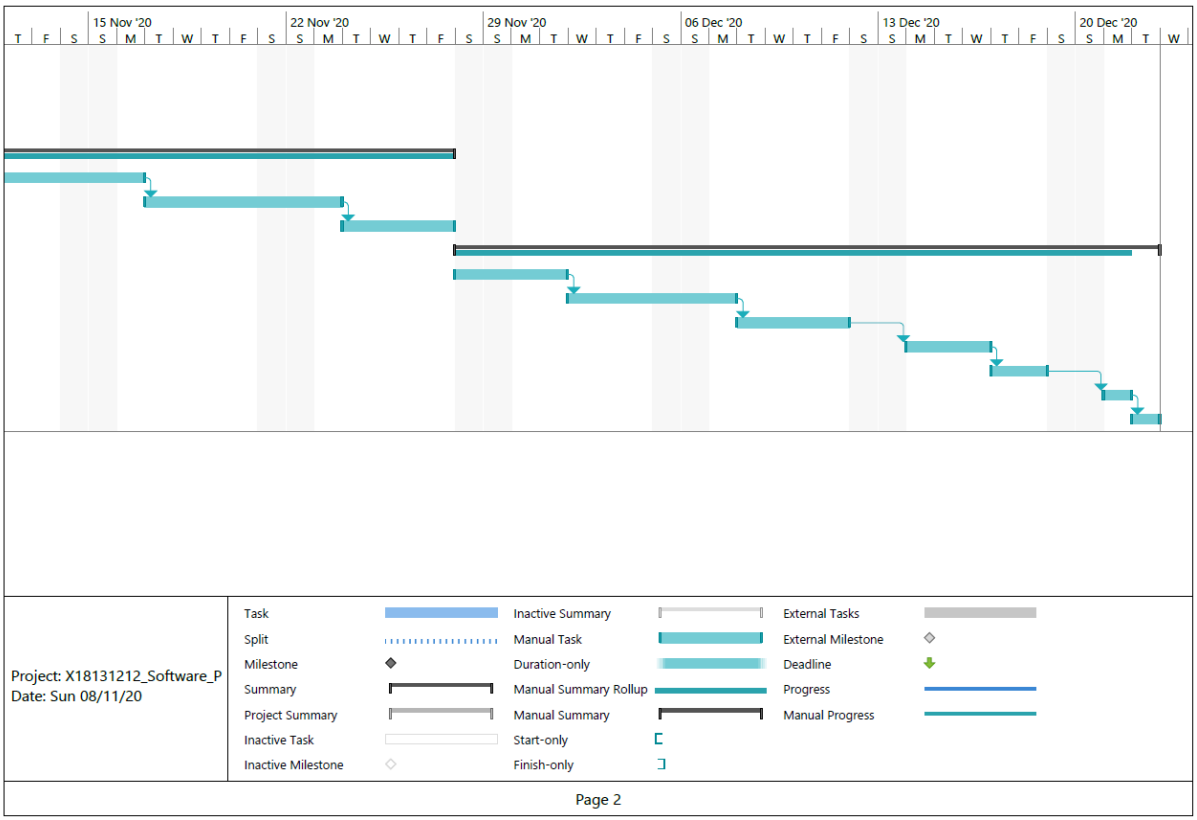

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14.0 Technical Details

- **Unity game engine**

- The game will be developed using this game engine and will be written C# as the **object-oriented** scripting language of chose

- **Visuals studio code**

This IDE (Integrated Development Environment) will be used for identifying issues by debugging, assessing variables and complex expressions

- **Firebase**

Firebase will be used for the following use case:

Authentication: Give players a frictionless sign-in experience that also ensures safe and secure account management.

Realtime Database: Read and write game content using this real-time, scalable database. Realtime Database allows you to keep track of player presence in- or out-of-game.

Cloud Storage: Store and serve player-generated content reliably and securely, such as avatars, game playthroughs, and screenshots.

Cloud Messaging: Inform players about new content or levels or send push notifications to players who have completed your available range.

- **GIPHY API**

This API will be incorporated into the game for its GIF search returns functionality and its category specification. sources

15.0 Evaluation

The projects evaluation will be conducted through various forms of testing such as Unit testing, Integration Testing, System testing and Acceptance testing.

16.0 Invention Disclosure Form

1. Title of Invention

Cyber Clash

2. Inventors

Name	School/Research Institute	Affiliation with Institute (i.e., department, student, staff, visitor)	Address, contact phone no., e-mail	% Contribution to the Invention
Jegan Francis Mendy	National College of Ireland	School of Computing	0894410743, Jeganmendy25@gmail.com, x18131212@student.ncirl.ie	100%

3. Contribution to the Invention

Each contributor/potential inventor should write a paragraph relating to his/her contribution and include a signature and date at the end of the paragraph.

4. Description of Invention

(Please highlight the novelty/patentable aspect. Attach extra sheets if necessary, including diagrams where appropriate). What is novel, the 'inventive step'? For more information on patents, please look at http://www.patentsoffice.ie/en/patents.aspx

Cyber clash is a real-time, turn-based, online multiplayer card game that aims to educate people about cyber-attacks and defenses in a fun, interactive, and yet familiar setting.

5. Why is this invention more advantageous than present technology?

This game's primary purpose is to educate and raise people's understanding of the importance of cybersecurity. Not many games have been made with this in mind.

What is its novel or unusual features? What problems does it solve? What are the problems associated with these technologies, products, or processes? Explain how this invention overcomes these problems (*i.e.*, what are its advantages).

Awareness

This game's primary purpose is to educate and raise people's understanding of the importance of cybersecurity. The most used and essential would have to be our laptops, PC, and Smartphones when it comes to technology.

Interactive & Fun to Learn

I chose to use an Interactive game because games are a powerful tool and conditions for learning. A player can learn new aptitudes, information, bits of knowledge, mentalities, or even practices in games that challenge them to think, investigate, and react.

Familiarity

The game has elements of Familiarity to aid players in quickly understanding its gameplay and game-play experiences and communication, such as:

Cards

Gifs

text messaging interface/environment

6. What is the current stage of development / testing of the invention?

The games development is currently in its planning and analysis stage.

7. List the names of companies which you think would be interested in using, developing, or marketing this invention

N/A

8. Funding Partner(s)

Government Agency & Department	N/A
% Support	N/A
Contract/Grant No.	N/A
Contact Name	N/A
Phone No.	N/A
Address	N/A

Industry or another Sponsor	N/A

% Support	N/A
Contract/Grant No.	N/A
Contact Name	N/A
Phone No.	N/A
Address	N/A

9. Where was the research carried out?

National College of Ireland

10. What is the potential commercial application of this invention?

N/A

11. Was there transfer of any materials/information to or from other institutions regarding this invention?

If so, please give details and provide signed agreements where relevant.

N/A

12. Have any third parties any rights to this invention?

If yes, give names and addresses and a brief explanation of involvement.

N/A

13. Are there any existing or planned disclosures regarding this invention?

Please give details.

N/A

14. Has any patent application been made? No

If yes, give date: _____ Application No.: _____

Name of patent agent: _____

Please supply copy of specification.

15. Is a model or prototype available? Has the invention been demonstrated practically?

N/A

I/we acknowledge that I/we have read, understood, and agree with this form and the Institute's *Intellectual Property and Procedures* and that all the information provided in this disclosure is complete and correct.

I/we shall take all reasonable precautions to protect the integrity and confidentiality of the IP in question.

Inventor: __JEGAN FRANCIS MENDY_____08/11/2020

Signature Date

Jegan Francis Mendy

_____

Signature