CS 319 - Object-Oriented Software Engineering

CS319-2F-DE: Defender

Analysis Report

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Project Analysis Report

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1. Introduction

For Object Oriented Software Engineering (CS 319) course, as Group 2F DE, we have decided to design and implement a modern and more entertaining version of the arcade game Defender. Defender is a space game that have set on an unnamed planet where the player must defeat waves of invading aliens while protecting astronauts. Defender was published in 1981 by Williams Electronics [1]. We have decided to design a more entertaining and fancier looking version of the original game by adding some new features. However, we preserve the core functions and features of the game.

In our initial design, we consider to include and add the following features:

- Single Player Story Mode

- Single Player Endless Mode

- Two Players Endless Mode

- Enable/ Disable Music and Sound Effects

- How to Play

- Ship and Background Store

- Highest Scores Table

- Health Bar

The structure of the game is based on moving a spaceship and shooting some space creatures coming towards you with a keyboard.

We have three game modes, Single Player Story Mode, Single Player Endless Mode and Two Players endless Mode. At the beginning, Two Players and Single Player modes are locked for the sake of player because before you start single player story mode, game provides a basic tutorial that introduce key bindings, different kinds of

enemies and score distribution among the enemies. When you finish the single player story mode successfully, Single Player and Two Players endless modes are unlocked and the game continues with Single Player endless Mode with the score that you finish the classic mode.

In Single Player endless Mode, you will fight against monsters until spaceship explode. Monsters will drop some coins once in a while that could be used for shopping in Ship and Background Store. When you score a new highest score, it will be recorded to highest scores table on the top. In this mode, unlike the Classic Mode, there are not any astronauts that waits to be rescued, it is only you and the space monsters.

In Two Players endless Mode, there will be a split screen at the top and the bottom. It is similar to Single Player endless Mode; when one of the players is dead, the game continues until the other player also die. Then, the scores are compared to determine which player wins the game.

In Ship and Background Store, you can buy a new type of ship or new background.

In the original game, you have three units of health and every attack from the monster that hit you cause losing of one unit of health, unlike this version we have decided to put a health bar and every monster's attack has different impact on the health and when health runs out spaceship explodes.

2. Overview

2.1. Game Background

Basic game background consists of game screen which represents space with shining stars. Bottom part of the screen represents the surface of an inhabited planet which we can take astronauts from. At the upper right of the screen there is a health bar which belongs to player (spaceship). At the upper left score is shown and there is also pause the game button. Background will expand to the left and right directions if the player goes in that direction.

2.2. Main Menu

This is the screen where the player can choose the game mode, can access the game shop, highest scores, how to play and could cancel the background music and game effects with buttons. There is also a button to quit the game.

2.3. Spaceship

The player is represented with the spaceship in the game. The spaceship can move in the up, down, left, right directions. It has a health assigned in the beginning of the game, with each damage health decreases, damage from enemies increases as the game difficulty increase. When the health runs out spaceship explodes and that marks the end of game. Spaceship can heal itself by taking astronauts from the surface of the planet below. Spaceship can shoot lasers to respond back to its enemies' assaults and defend itself. Laser is activated with key 'X' and it shoots in the same straight direction spaceship faces, starting from shapeships current location. Laser uses energy so it's a discrete beam, player needs to press the key again to shoot another beam. As the player gains more scores, which will give them more coins, they can purchase different kinds of spaceships from the game shop. Spaceships in the shops varies in colors and another shooting styles.

2.4. Enemies

The game has enemies which will came into the game screen and start attacking the spaceship. The damage enemies cause varies from their types and difficulty of the game. They also have varying health status. There are two types of enemies:

2.4.1. Active Enemies

The active enemies consists of enemy spaceships and shooting stars. Enemy spaceships can attack the player with lasers going towards the location of the player. They will try to get closer to the player so they can shoot more accurately. At the

easiest mode, their health runs out in one shot from the player. As the game difficulty increases killing them gets harder.

Shooting Stars will appear on the screen and will move in random path, if they collide with the player, the player will lose some of its health. Their health runs out in one shot from the player.

2.4.2. Passive Enemies

The passive enemies are big meteorites which can appear on the screen. They will stay put on their location. If the player runs into them, the spaceship will lose some of its health. Meteorites' health runs out with two shots from the player.

2.5. Astronauts

The astronauts are the helpers in the game. They will be dropped to the surface of the planet below. If the player decides to save them from ground, spaceship's health will increase. They will appear at random times.

2.6. Gameplay

Basic gameplay starts with the spaceshift standing on the screen. Then, different kinds of enemies will appear on the screen and attack the spaceship in their respectful ways and the spaceship will be trying to survive.

2.7. Game Modes

2.7.1. Single Player Story Mode

This is the basic game mode which will consist of finite levels aiming to show the features of the game. As player passes each level, difficulty will increase and new enemy types will appear. Player needs to defeat all enemies that appears to pass through the level. After passing all levels player wins this mode. Single player story mode will include a story with its each level. Those stories will describe saving of a

fellow astronaut companion from enemy ships. This mode is a must to play to be able to open other game modes.

2.7.2. Two Players Endless Mode

There will be a split screen and two spaceships will be controlled by two different players. Each player will fight with the enemies which will appear in their part of the screen. Game will continue until one player gets defeated by the enemies. The survivor will be the winner of the game.

2.7.3. Single Player Endless Mode

This mode's aim is to go on as far as you can while facing the enemies. Enemies will keep appearing as time goes on and the game's difficulty will increase. The game ends when the player is out of health. Player will gain coins based on their scores. The highest scores will be recorded in the game.

2.8. Highest Scores

This will be a page which could be accessed from the main menu. The highest 10 scores will be kept in a table.

2.9. Shop

This feature will be opened when the player starts to gain coin. Players can purchase different styled spaceships with extra attacks from this screen, they can also purchase new backgrounds.

2.10. How to Play

This screen can be accessed from the main menu. It will show which keys perform which actions. It will also describe the game modes and the playing instructions briefly.

3. Functional Requirements

3.1. Game Modes

There will be a total of 3 different game modes. These will be: "Single Player Story Mode", "Single Player Endless Mode", "Two Players Endless Mode". A player will access these modes from the pop-up in the main screen using the "Game Modes" button. If the single player story mode is not completed, the other two modes will be disabled.

3.1.1. Single Player Story Mode

A player will access this mode from "Game Modes" pop-up menu by using "Single Player Story Mode" button. There will be several chapters in this mode, and they will be in ascending difficulty order. In this mode, each chapter will have wave(s) of enemies coming onto "defender". Each chapter will include chapter-specific enemies. The player can finish a chapter by killing the boss after wave(s). The last chapter will restart if the player's health drops to 0% as a result of enemy attacks.

3.1.2. Single Player Endless Mode

A player will access this mode from "Game Modes" pop-up menu by using "Single Player Endless Mode" button. There will not be any restriction on the difficulty level or the type of enemies in this mode. The player will earn scores by killing enemies and saving astronauts. The player will lose, if his/her health drops to 0%.

3.1.3. Two Players Endless Mode

A player will access this mode from "Game Modes" pop-up menu by using "Two Players Endless Mode" button. There will not be any restriction on the difficulty level or the type of enemies in this mode. The players will earn points by killing enemies and saving astronauts. When both players die, the game will be finished and the player with the highest score will win the game.

3.2. How to Play

A player will access this screen from the home screen using the "How To Play" button. This option presents the rules and tips for all 3 modes of the game. Basic information about the following titles is provided by use of different tabs:

- **Gameplay:** Animated and/or text instructions to show specific buttons to play the game.

- **Game Modes:** Definitions of three different game modes, similarities and differences.

- **Rules:** Win conditions of "Single Player Story Mode" and "Two Players Endless Mode", loss conditions of all modes, definitions etc.

3.3. Highest Scores

A player will access this pop-up menu from the home screen using the "Highest Scores" button. This menu will be consisting of a list of highest 10 scores with score value and according to the player's name.

3.4. Shop

A player will access this screen from the home screen using the "Shop" button. This screen will contain list of different spaceships for "defender". Here, the player will be able to buy and/or apply design on his spaceship.

3.5. Settings

There will be two settings related button on the "Main Screen". One of them is used to mute/unmute music, another will mute/unmute effects sound of the game.

3.6. Credits

A player will access this screen from the home screen using "Credits" button. This screen will contain information about the developers of the game, their personal and contact information, as well as the GitHub link of the game.

4. Non-Functional Requirements

4.1. User-Friendly Interface

Quality of User Interface of any game is one of the most important factors which can affect players first impressions about the game. Therefore, we have pointed out the most necessary UI/UX design:

- There will be several different objects such as spaceships, aliens, bullets, astronauts, etc.in the game. These objects should be drawn neatly and smoothly, so that the player will not be distracted by pixel-bad drawings.

- Main menu and navigation flow should be easy to follow to give comfort to the player to understand, what they are doing and what they want to do inside the game.

4.2. Game Performance

"Defender" is an action game which means game performance is the most important requirement. As any other action game, we will mostly focus on letting players to get as high frame per second as they can get. This focus will ensure that, players with different computer system capabilities will be able to play the game without any performance concern. We will also focus on transition between screen in order to ensure players will not waste so much time while waiting game preparation.

4.3. Extendibility

4.3.1. Multiplayer Mode

We are going to present 3 different modes for the first version of our game. All these modes offer only playing on a single computer. Two Players Mode of our game can be extended into Multiplayer mode to give opportunity to play from different computers.

4.3.2. Artificial Intelligence

In all three game modes, every action of aliens will be based on a given pattern. These actions can be extended from a single pattern into a more logical and a variety of patterns by implementation of AI. This would increase the difficulty level of the game and make the game more competitive.

5. Constraints

5.1. Version Control

For version control, we have been assigned to use GitHub as a git tool.

6. System Models

6.1. Use Case Diagram
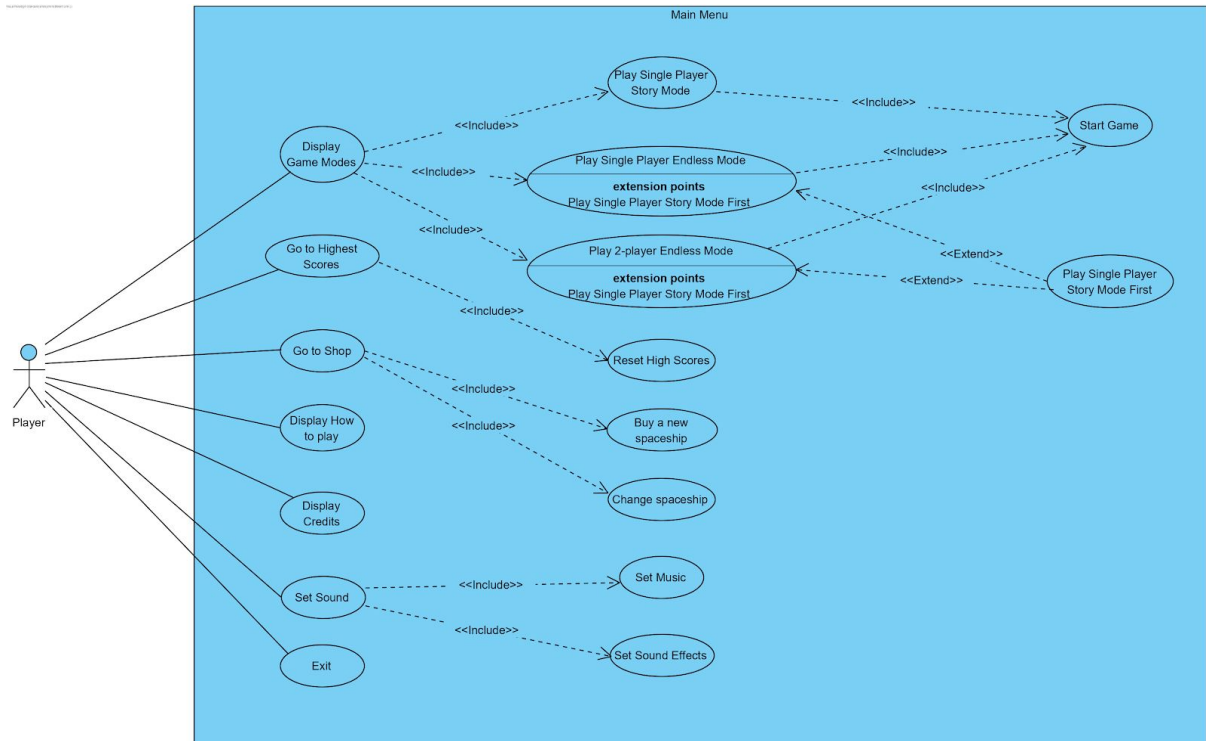
Figure 1. Use case diagram for Main Menu
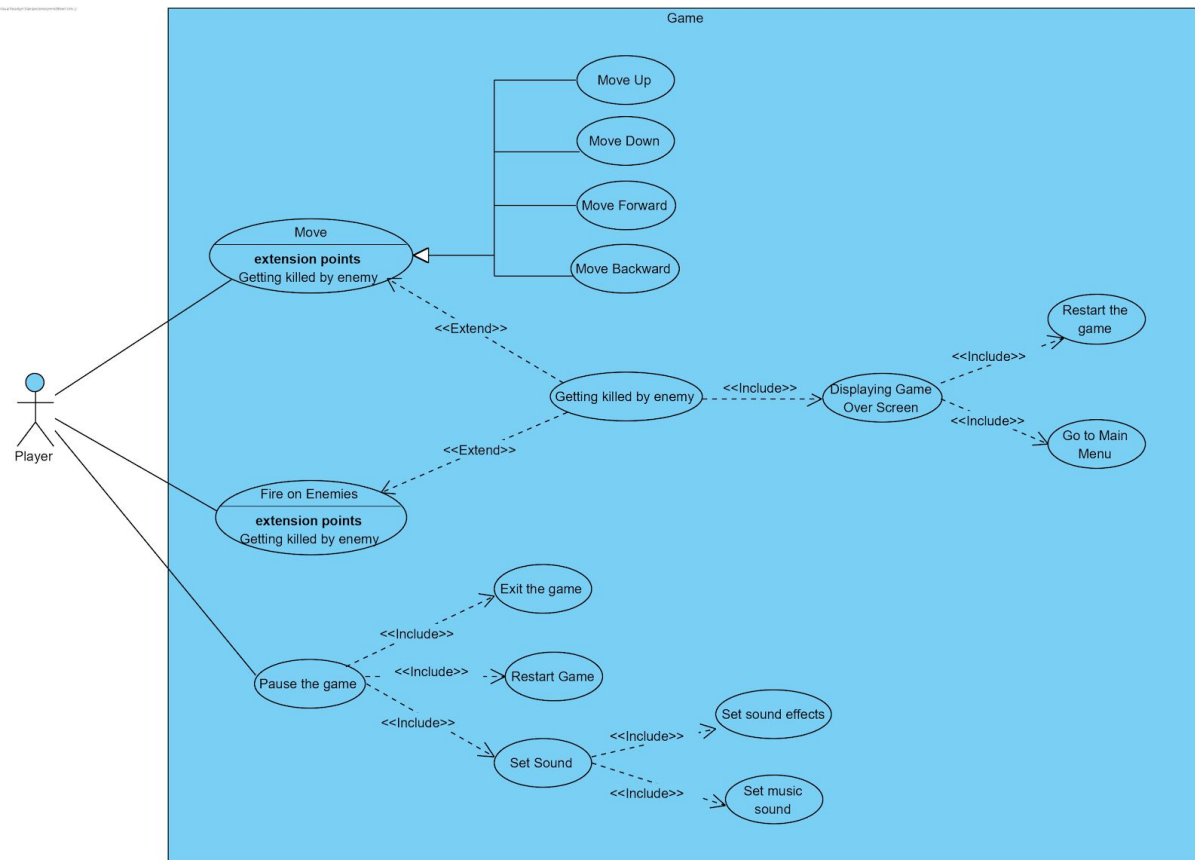
Figure 2. Use case diagram for Game

Use Case #1

1. *Use Case* : Play Single Player Story Mode

2. *Participating actor* : Player

3. *Entry Condition* : Player should be in the main menu.

4. *Exit Condition* : Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* :

    1. Player chooses to display game modes.

    2. Player chooses to play single player story mode.

    3. Player plays chosen mode.

4. Player wins the game.

5. Game displays the congratulations screen.

6. Player chooses to exit game.

7. Player returns to main menu.

6. *Alternative Event Flows* :

1. If player loses the single player story mode.

1.1. Game displays game over screen.

1.2. Player chooses to restart the game.

2. If player wants to return main menu

2.1. Players clicks pause button.

2.2. Game displays pop up menu.

2.3. Player chooses to exit the game.

2.4. Player goes back to main menu.

Use Case #2

1. *Use Case* : Play Single Player Endless Mode

2. *Participating actor* : Player

3. *Entry Condition* : Player should be in the main menu.

4. *Exit Condition* : Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* :

1. Player chooses to display game modes.

2. Player chooses to play single player endless mode.

3. Player plays chosen mode.

4. Player loses the game.

5. Game displays the game over screen.

6. Player chooses to exit game.

7. Player returns to main menu.

6. *Alternative Event Flows* **:**

1. If player wants to restart single player endless mode.

    1.1. Player clicks pause button.

    1.2. Game displays pop-up menu.

    1.3. Player chooses to restart the game.

2. If player wants to return main menu

    2.1. Players clicks pause button.

    2.2. Game displays pop-up menu.

    2.3. Player chooses to exit the game.

    2.4. Player goes back to main menu.

Use Case #3

1. *Use Case* **:** Play Two Players Endless Mode

2. *Participating actor* **:** Player

3. *Entry Condition* **:** Player should be in the main menu.

4. *Exit Condition* **:** Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* **:**

1. Player chooses to display game modes.

2. Player chooses to play two players endless mode.

3. 2 Players plays chosen mode.

4. One player loses the game, the opponent wins the game.

5. Game displays the game over screen for loser and congratulations screen for winner.

6. Player chooses to exit game.

7. Player returns to main menu.

6. *Alternative Event Flows* :

1. If players want to restart two players endless mode.

    1.1. Player clicks pause button.

    1.2. Game displays pop-up menu.

    1.3. Player chooses to restart the game.

2. If player wants to return main menu

    2.1. Players clicks pause button.

    2.2. Game displays pop up menu.

    2.3. Player chooses to exit the game.

    2.4. Player goes back to main menu.

Use Case #4

1. *Use Case* : Go to Highest Scores

2. *Participating actor* : Player

**3. *Entry Condition* :** Player should be in the main menu.

4. *Exit Condition* : Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* :

    1. Player chooses to display highest scores.

    2. Game displays high scores.

    3. Player chooses to go back to main menu.

    4. Player returns to main menu.

6. *Alternative Event Flows* :

    1. If players want to reset high scores.

        1.1. Player chooses to display highest scores.

        1.2. Game displays high scores.

        1.3. Player chooses to reset high scores.

        1.4. Player confirms the selection and high scores reset.

        1.5. Player chooses to go back to main menu.

Use Case #5

1. *Use Case* : Change spaceship

2. *Participating actor* : Player

3. *Entry Condition* : Player should be in the main menu.

4. *Exit Condition* : Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* :

    1. Player chooses to go to shop.

2. Player changes the spaceship.

3. Player chooses to return back to main menu.

4. Player returns to main menu.

6. *Alternative Event Flows* :

    1. If players want to buy a new spaceship.

        1.1. Player chooses to go to shop.

        1.2. Player buys a new spaceship.

        1.3. Player chooses the spaceship.

        1.4. Player confirms the selection and high scores reset.

        1.5. Player chooses to go back to main menu.

Use Case #6

1. *Use Case* : Display how to play

2. *Participating actor* : Player

3. *Entry Condition* : Player should be in the main menu.

4. *Exit Condition* : Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* :

    1. Player chooses to display how to play.

    2. Game displays gameplay buttons.

    3. Player chooses to go back to main menu.

    4. Player returns to main menu.

<u>Use Case #7</u>

1. *Use Case* : Display credits

2. *Participating actor* : Player

3. *Entry Condition* : Player should be in the main menu.

4. *Exit Condition* : Player cancels the selection and goes back to the main menu.

5. *Success Scenario Event Flows* :

       1. Player chooses to display credits.

       2. Game displays credits.

       3. Player sees email address of developers.

       4. Player chooses to go back to main menu.

       5. Player returns to main menu.

<u>Use Case #8</u>

1. *Use Case* : Set sound

2. *Participating actor* : Player

3. *Entry Condition* : Player should be in the main menu.

4. *Exit Condition* : Player is always in the main menu.

5. *Success Scenario Event Flows* :

       3. Player mute/unmute sound effects.

       4. Player mute/unmute music.

6.2. Dynamic Models

6.2.1. Activity Diagram
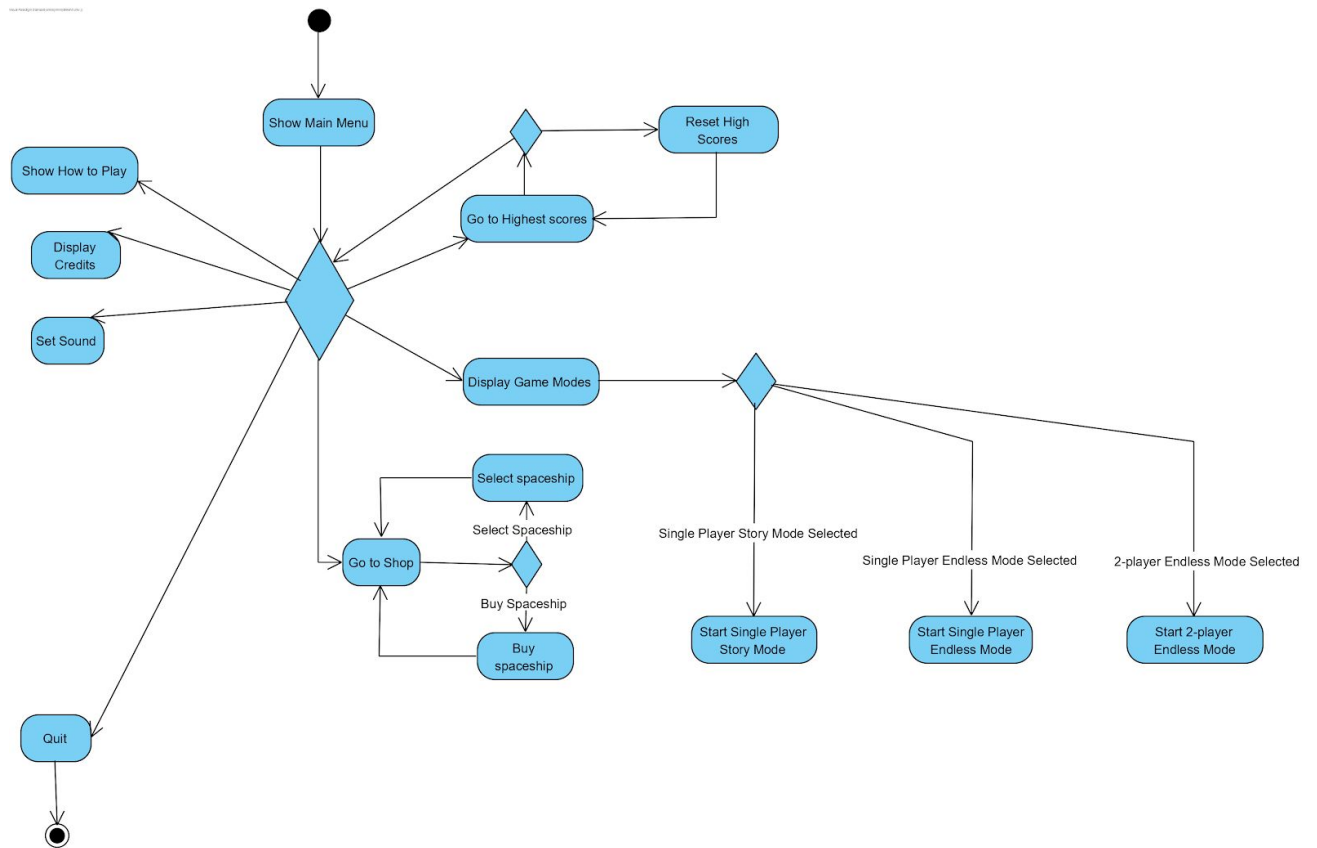
Figure 3. Activity Diagram for the Main Menu

Figure 3 represents activity flow of the main menu. In the main menu there are 6 choices to choose. When user chooses "game modes", pop-up menu will show up and user can make choice of game mode. There are 3 different game modes and their activity diagrams are demonstrated in **Figure 4, Figure 5, Figure 6.**
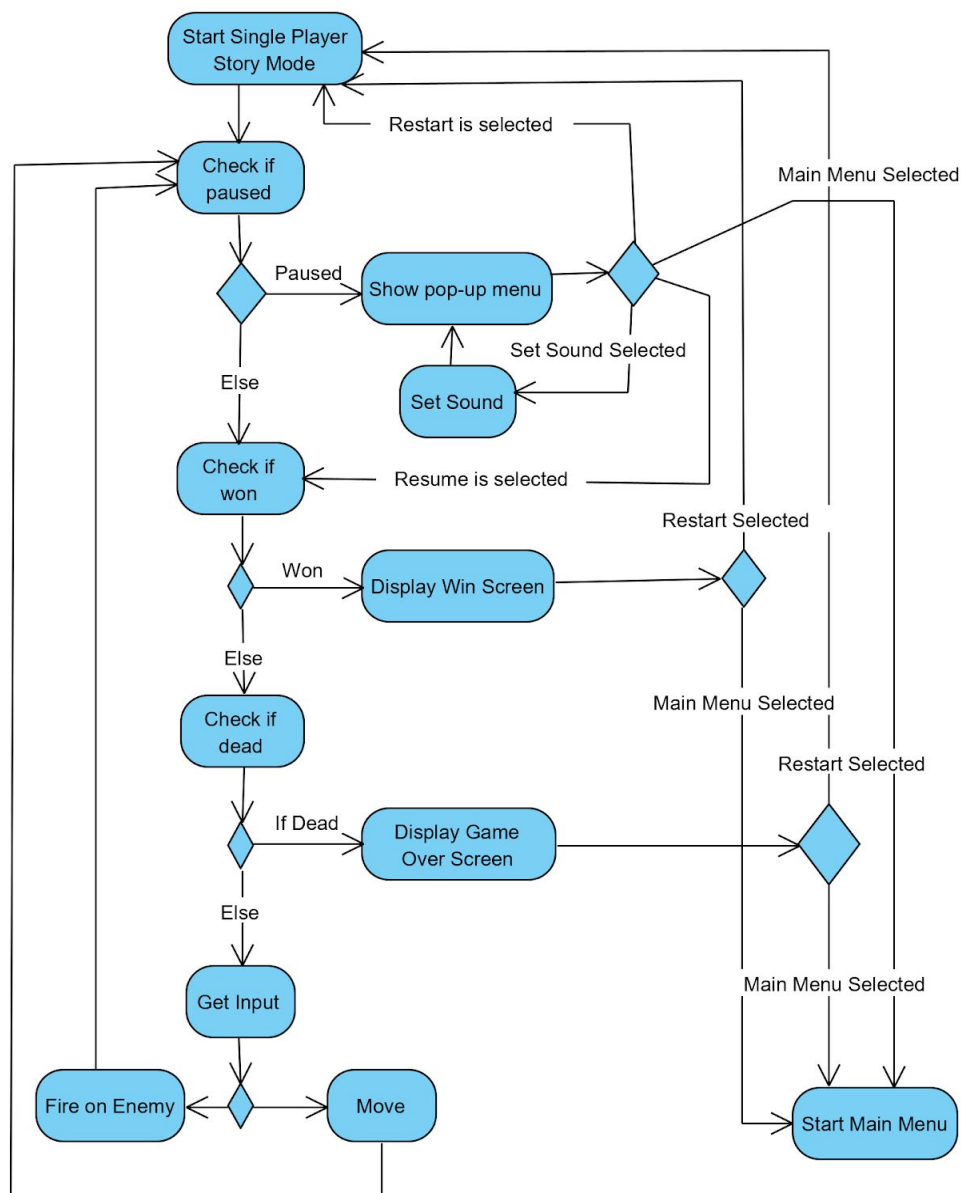
Figure 4. Activity Diagram for the Single Player Story Mode

Figure 4 represents activity flow of Single Player Story Mode. In this mode user plays the game and when he/she wins, loses or pauses the game he/she can go back to the main menu.
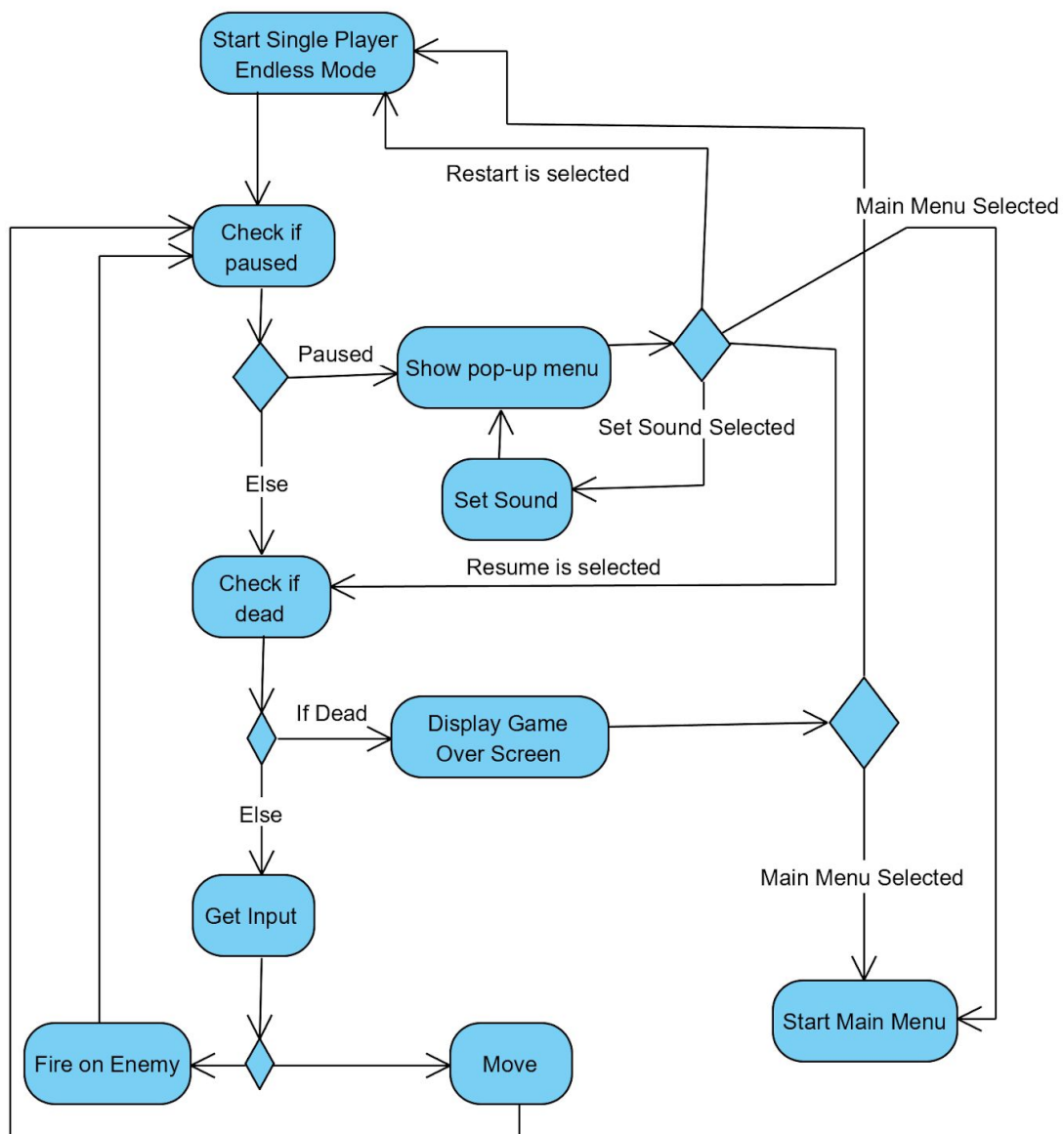
Figure 5. Activity Diagram for the Single Player Endless Mode

Figure 5 represents activity flow of Single Player Endless Mode. In this mode user plays the game and when he/she loses or pauses the game he/she can go back to the main menu.
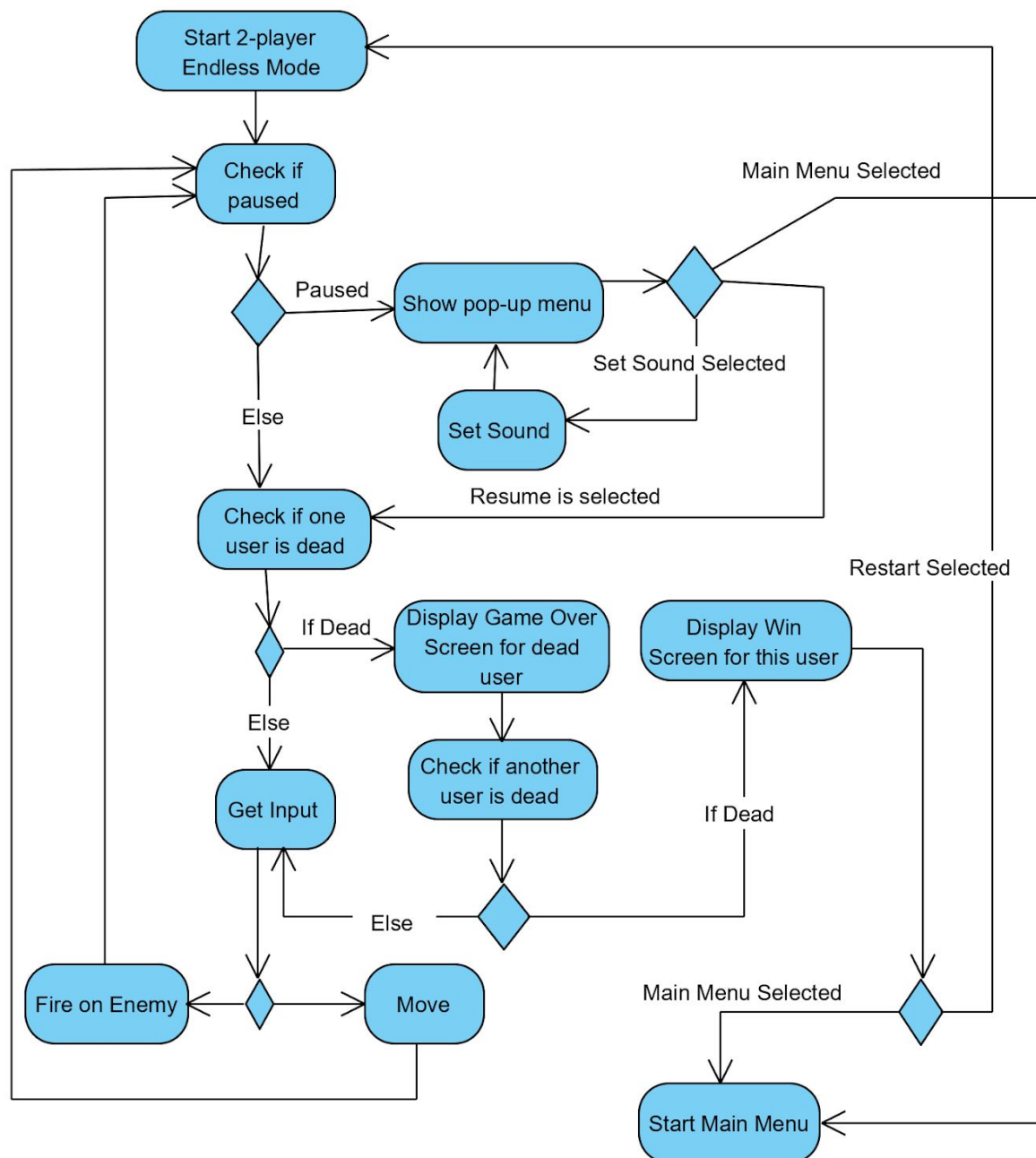
Figure 6. Activity Diagram for the two players Endless Mode

Figure 6 represents activity flow of Single Player Endless Mode. In this mode user plays the game and when he/she loses or pauses the game he/she can go back to the main menu.

6.2.2. Sequence Diagram
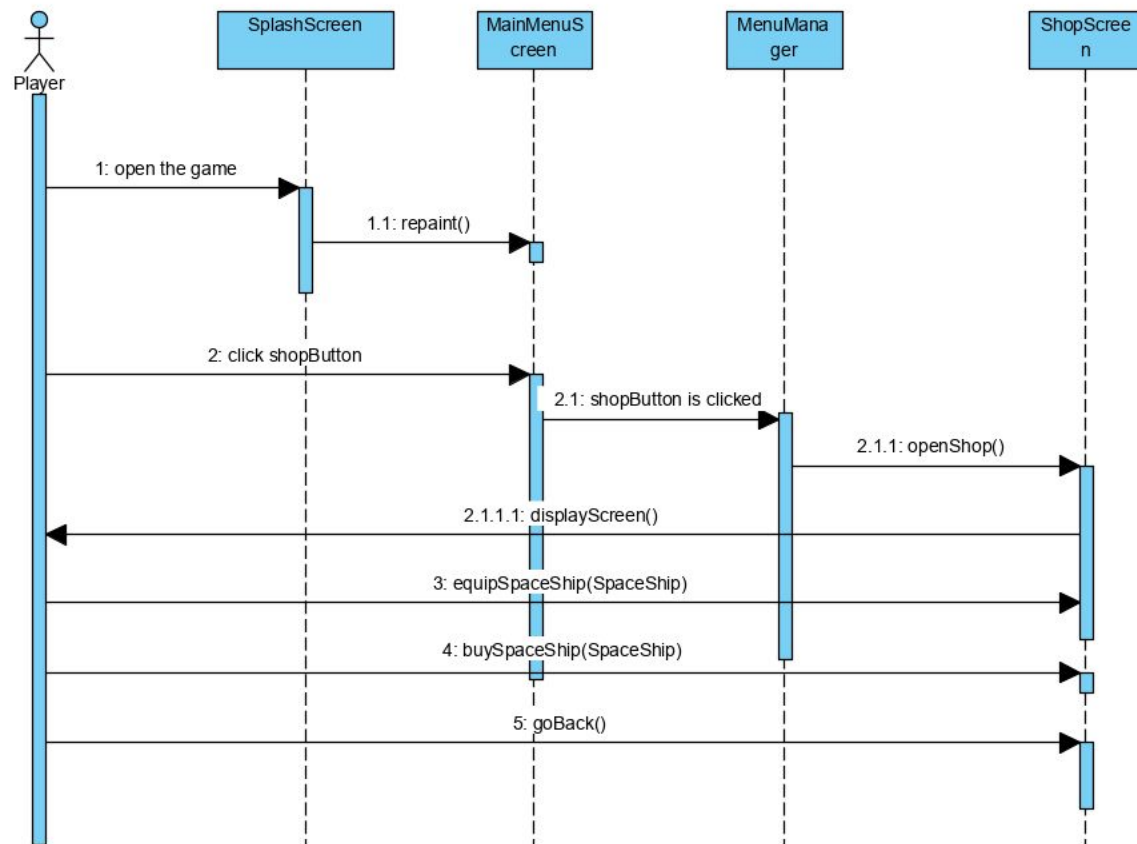
Figure 7

When the player opens the game, the player encounters with splash screen which will disappear after a while. Then, the main screen appears. In **Figure 7**, the player chooses the shop option displayed on the main menu. In this menu, the player can either equip spaceship or buy a new spaceship. The player, then, can go back to the main screen.
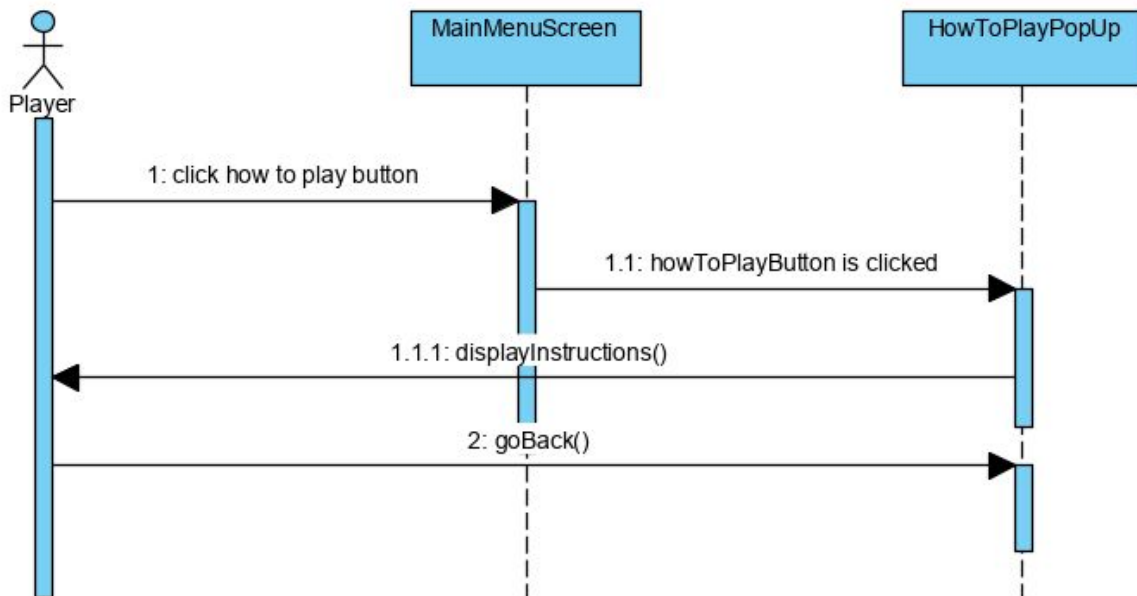
Figure 8

In **Figure 8**, the player clicks the how to play button and the how to play pop-up appears. This pop up displays the instructions and the player can go back to the main menu.
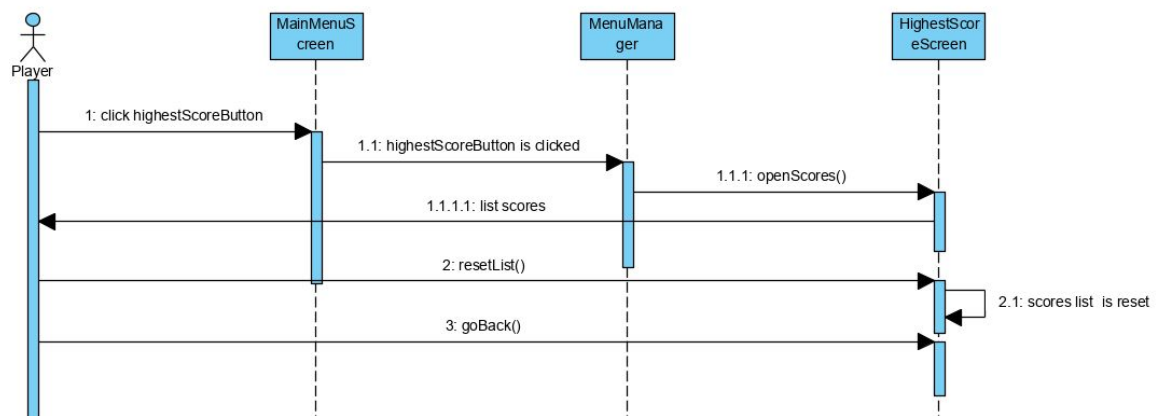
Figure 9

In **Figure 9**, the player chooses the highest score button from the main menu. The screen containing the list of scores appears. The player can reset the list and go back to the main menu.
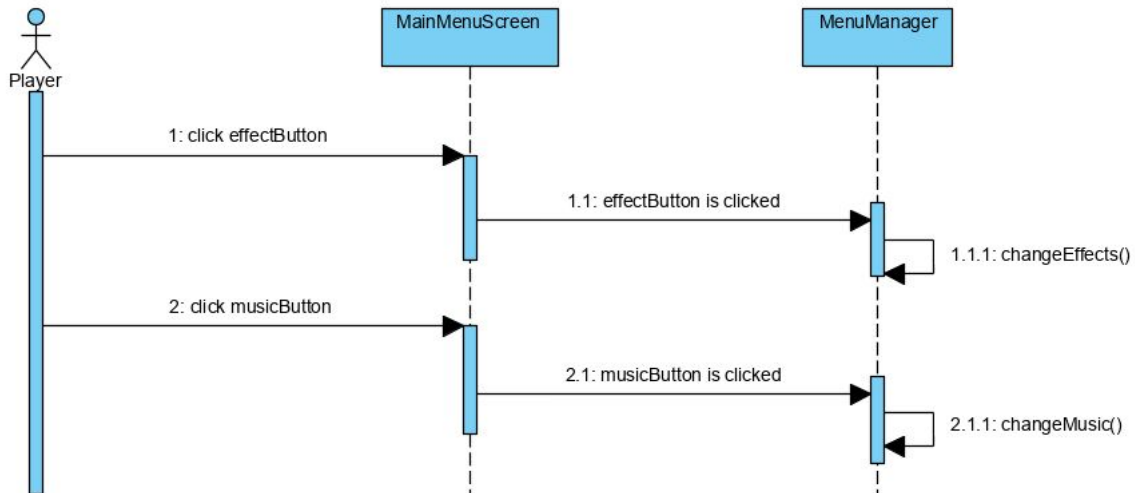
Figure 10

In **Figure 10**, the player clicks the effects and music buttons displayed in the main menu and can mute or unmute effects/music.
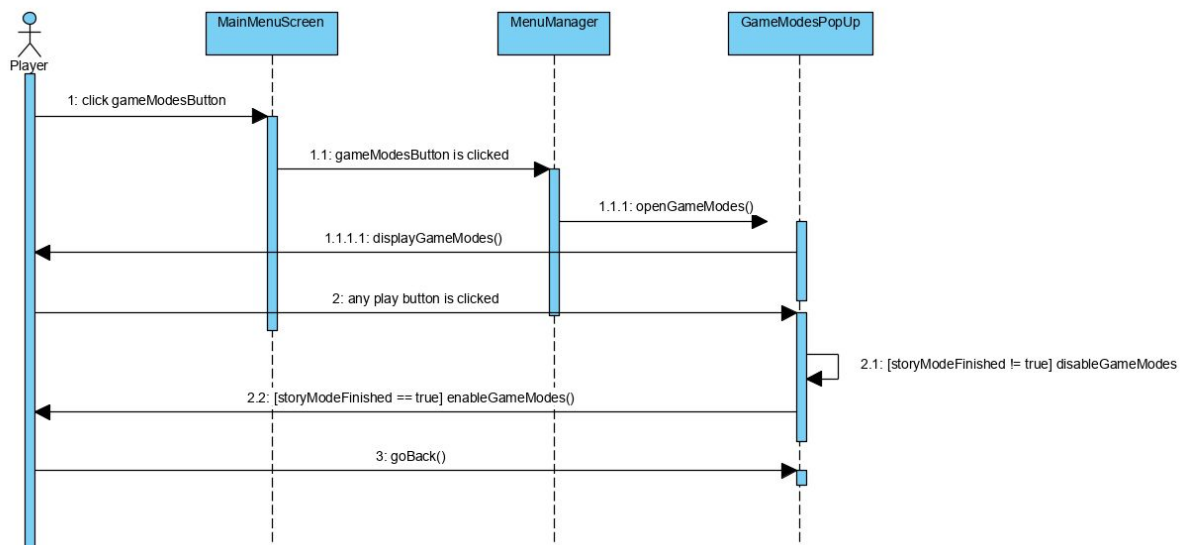
Figure 11

In **Figure 11**, the player clicks game modes displayed in the main menu. The player can display three game modes from the game modes pop-up and choose the mode he/she wants to play with. However, the player cannot choose multiplayer mode or endless mode before finishing the classic mode.

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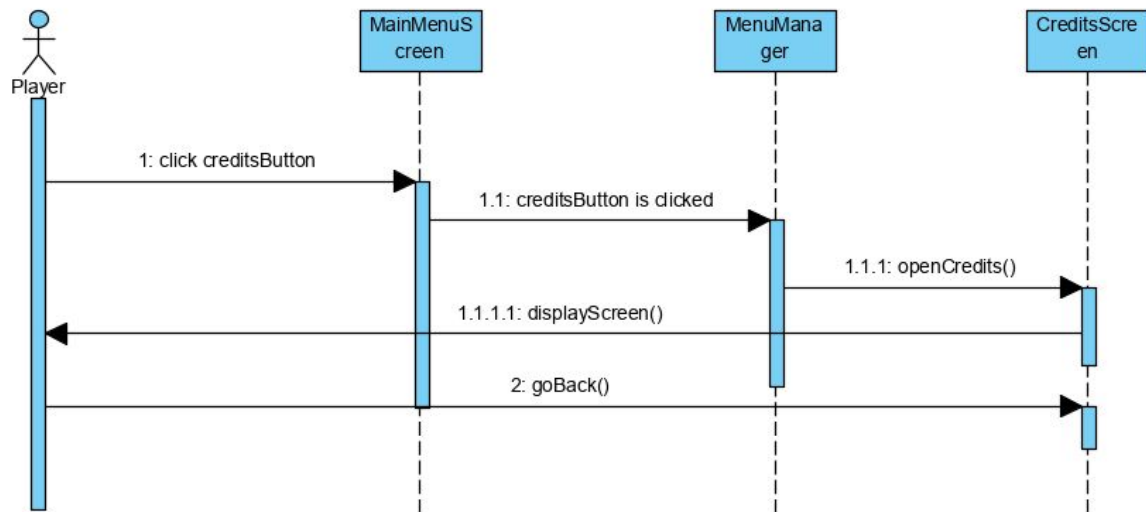
Figure 12

In **Figure 12**, the player views credits screen by clicking the credits from the main menu. He/she can also go back to the main menu.
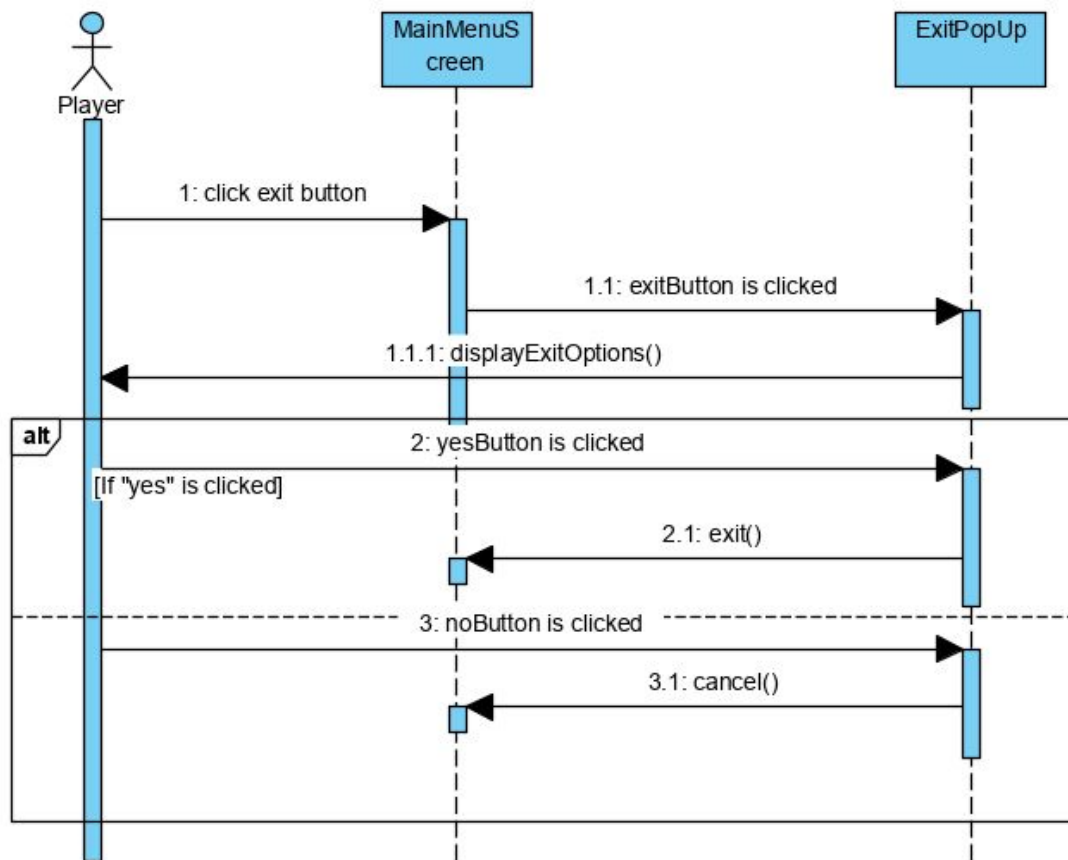
Figure 13

In **Figure 13**, the player clicks the exit button. An exit pop-up appears and gives the player the options to continue playing or exiting.

6.3. Object and Class Model
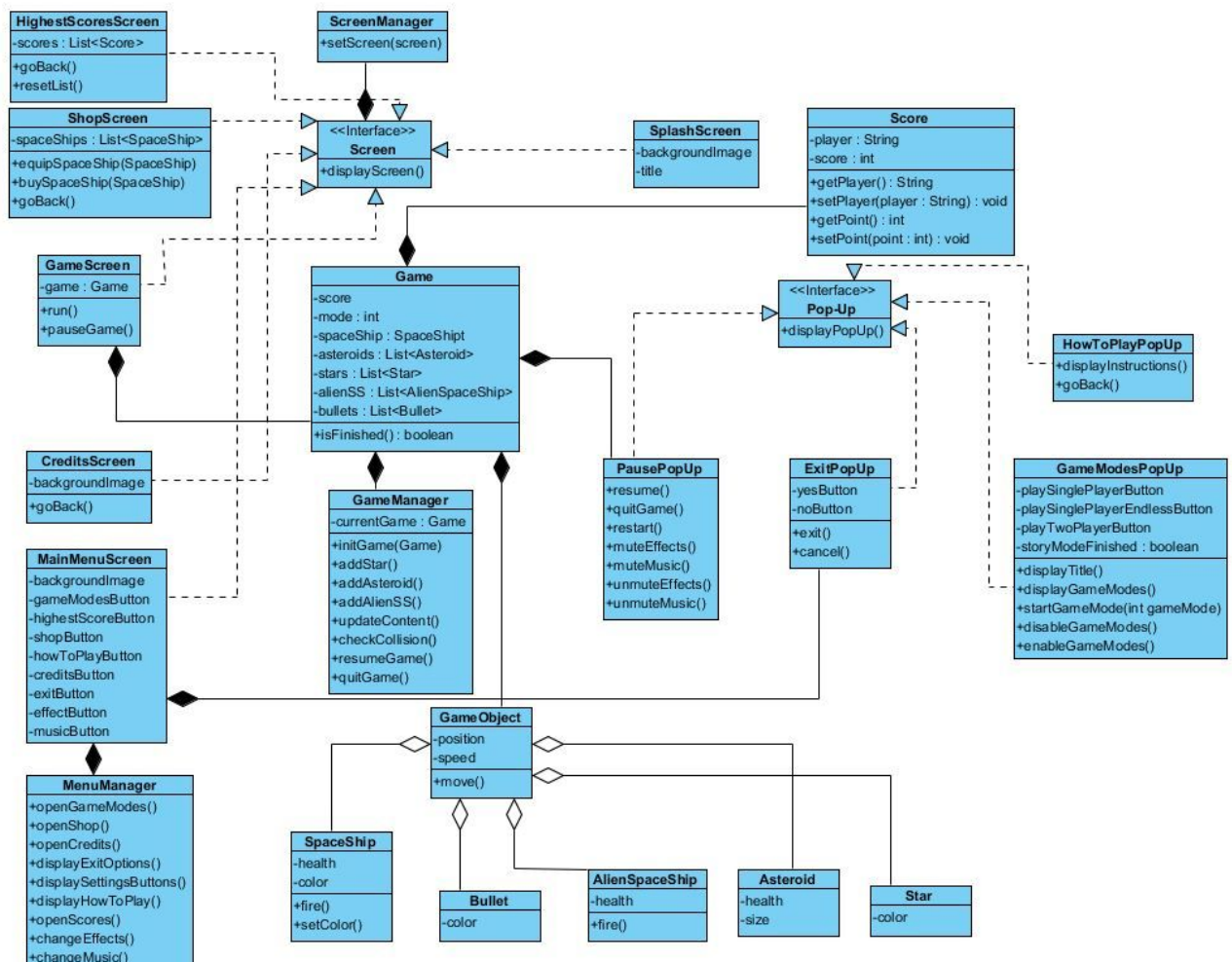
Figure 14

6.4. User Interface

Figure 15. Story screen
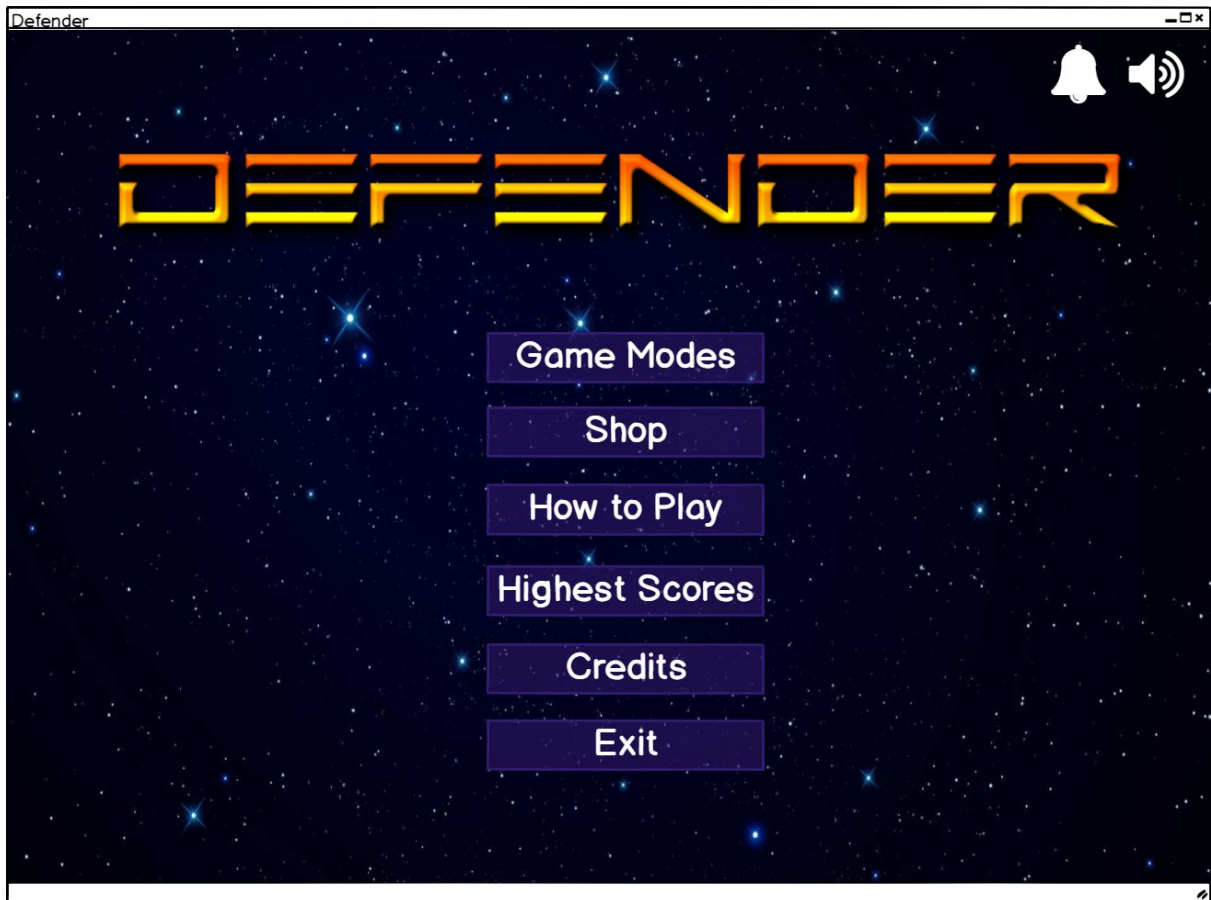
Figure 15.1. Main menu
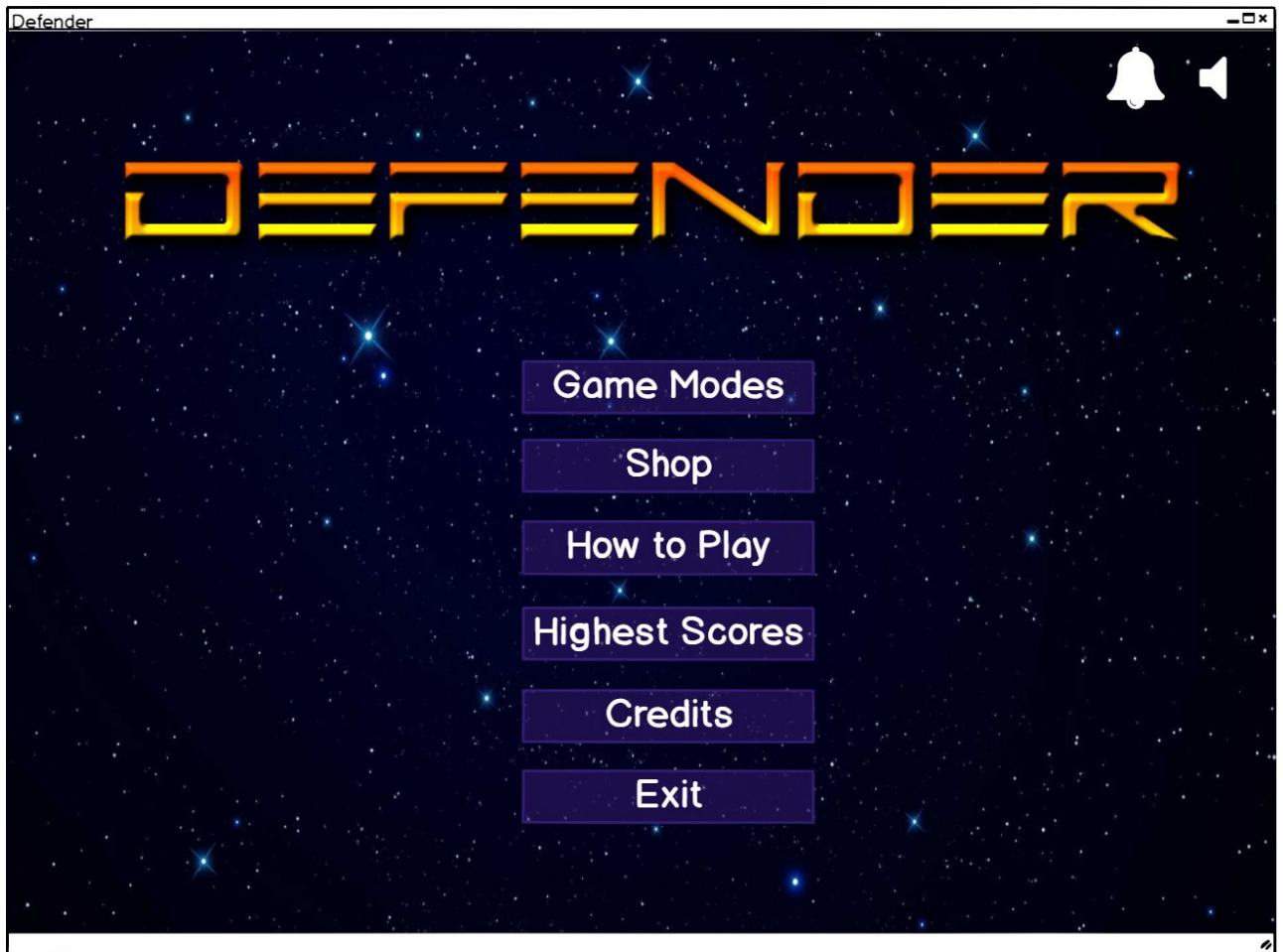
Figure 15.2. Main menu, background music closed
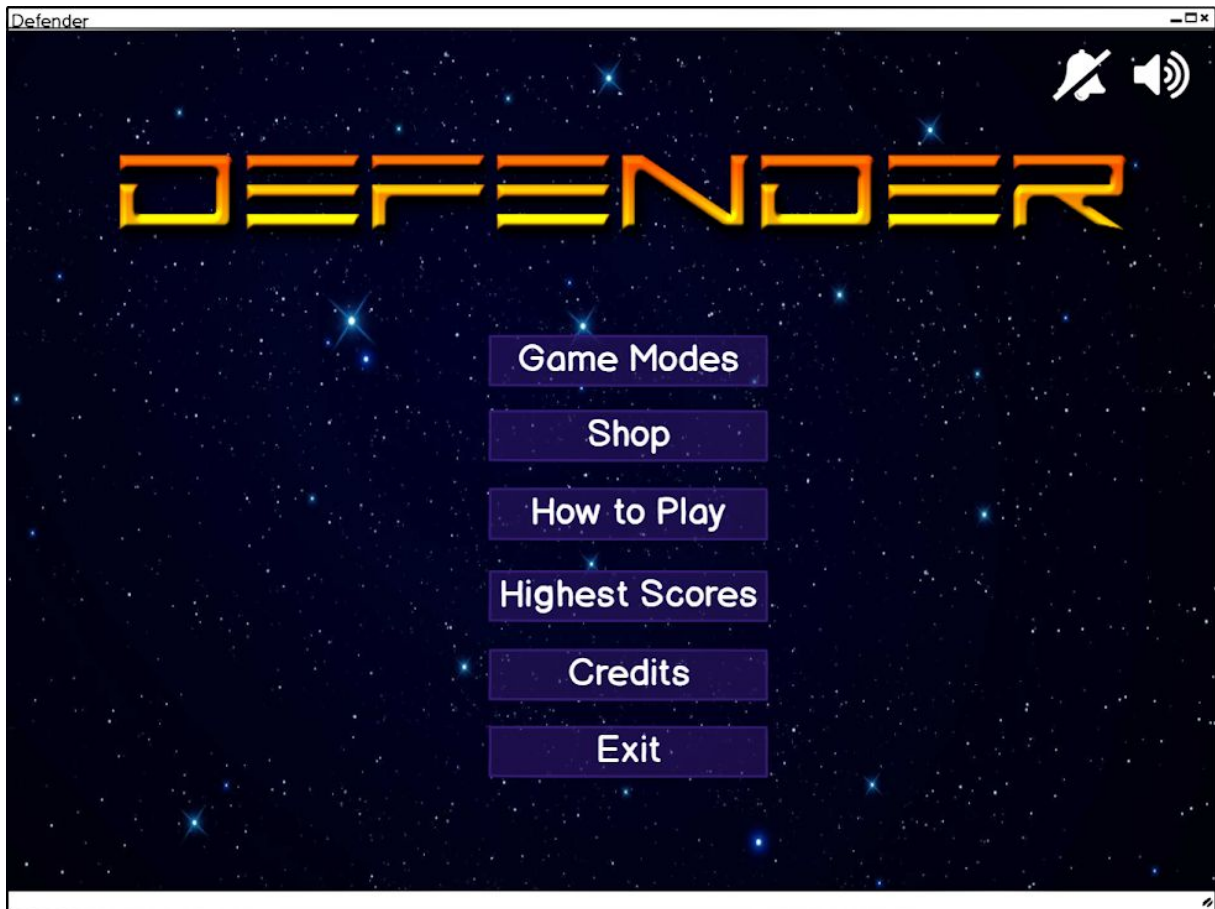
Figure 15.3. Main menu, sound effects closed
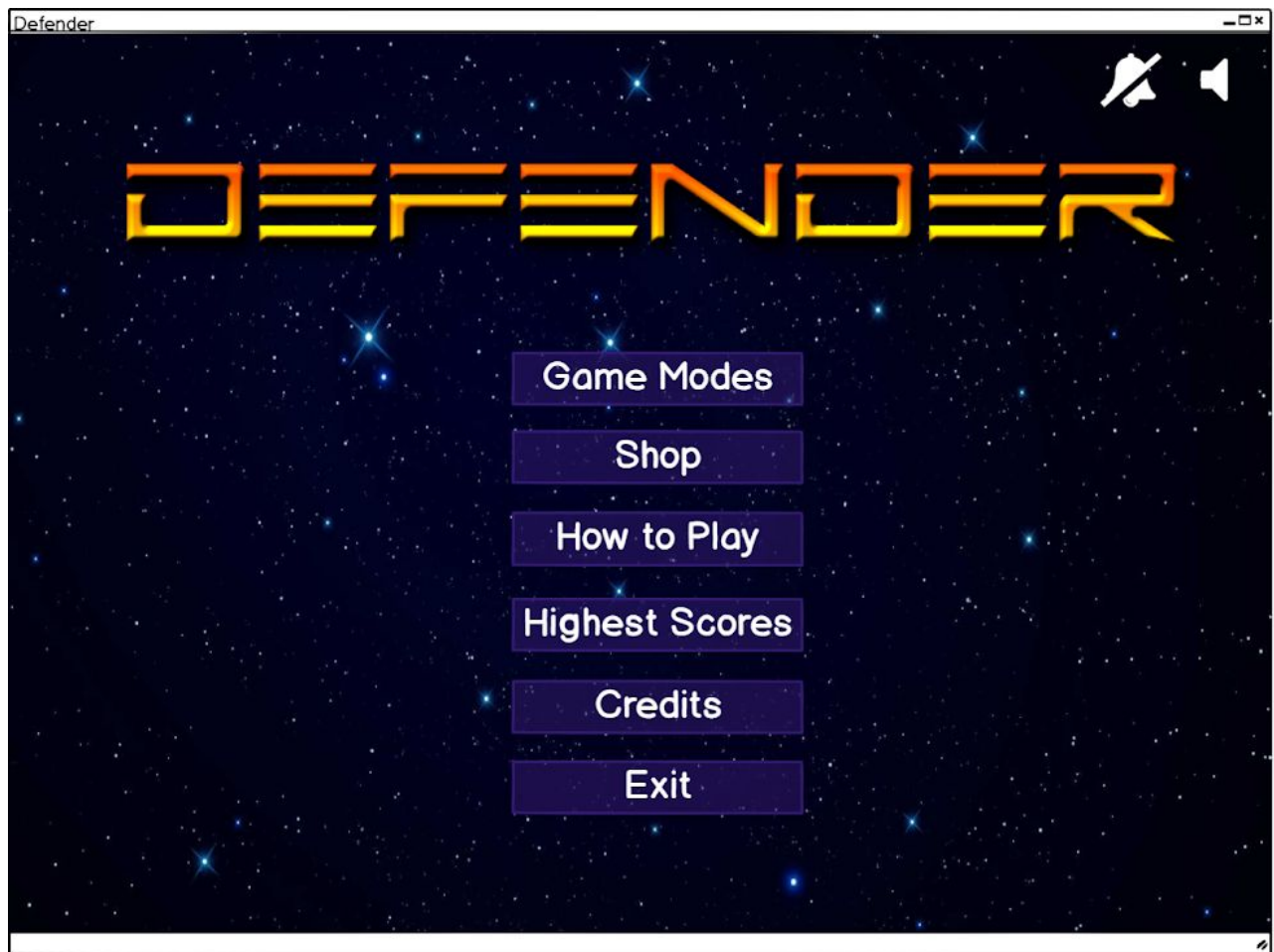
Figure 15.4. Main menu, no sound
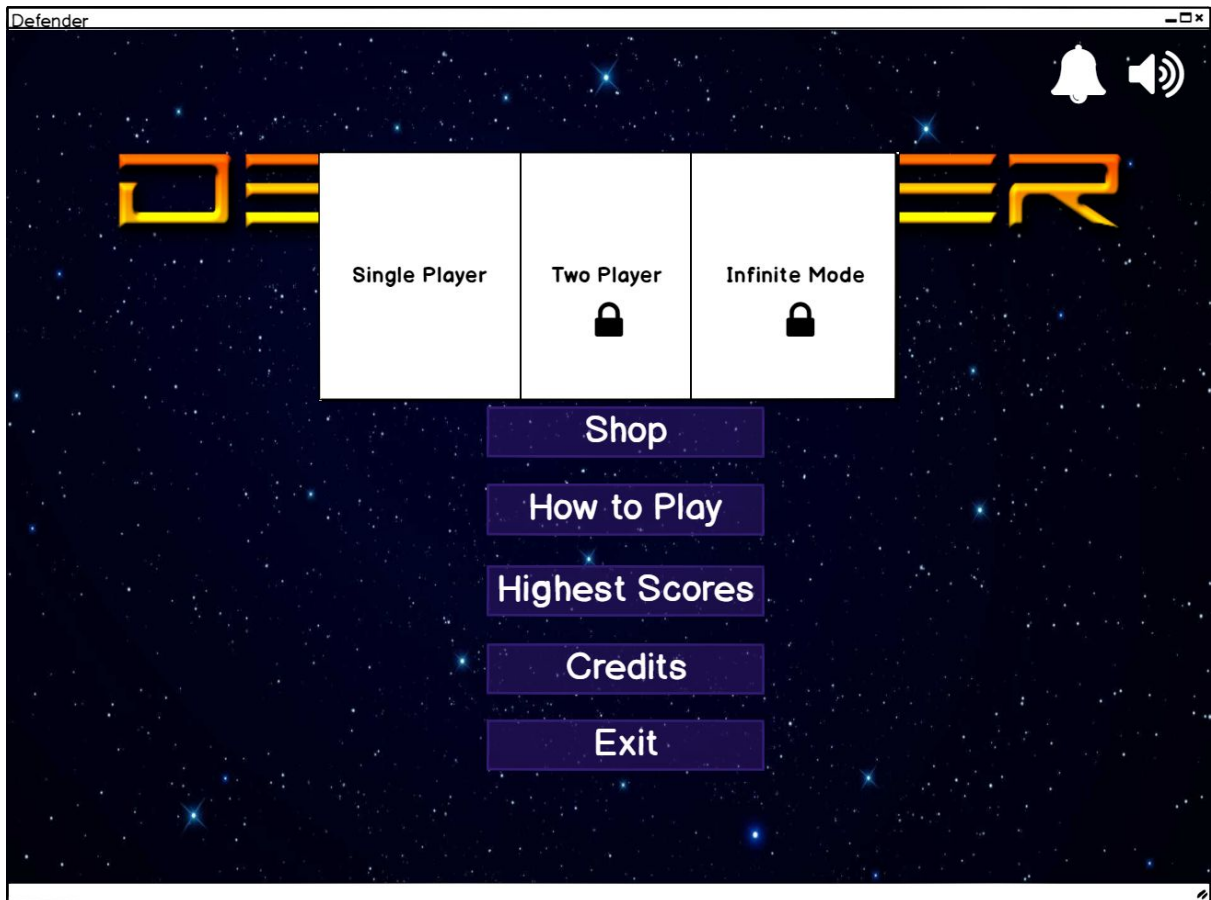
Figure 16.1. Game modes
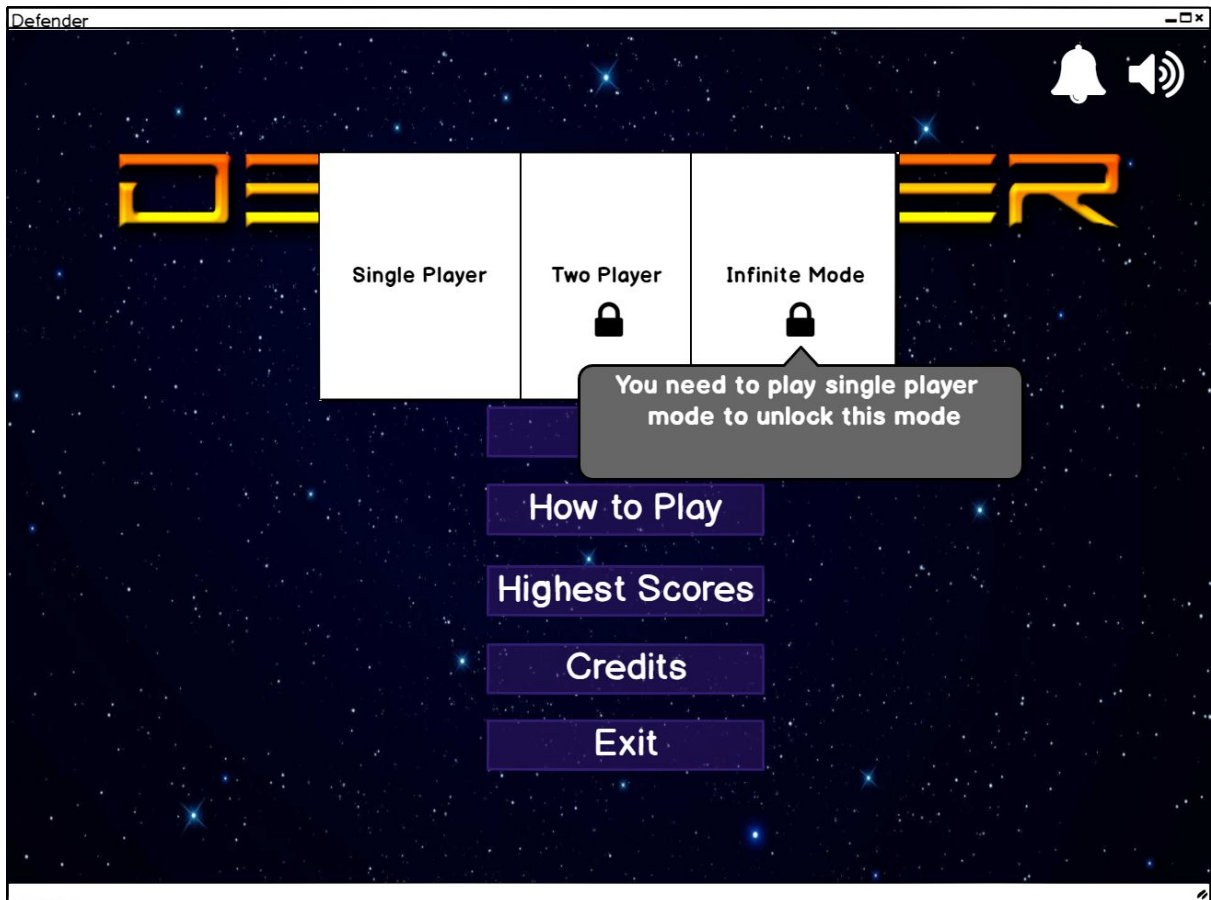
Figure 16.2. Game modes, locked message for endless mode
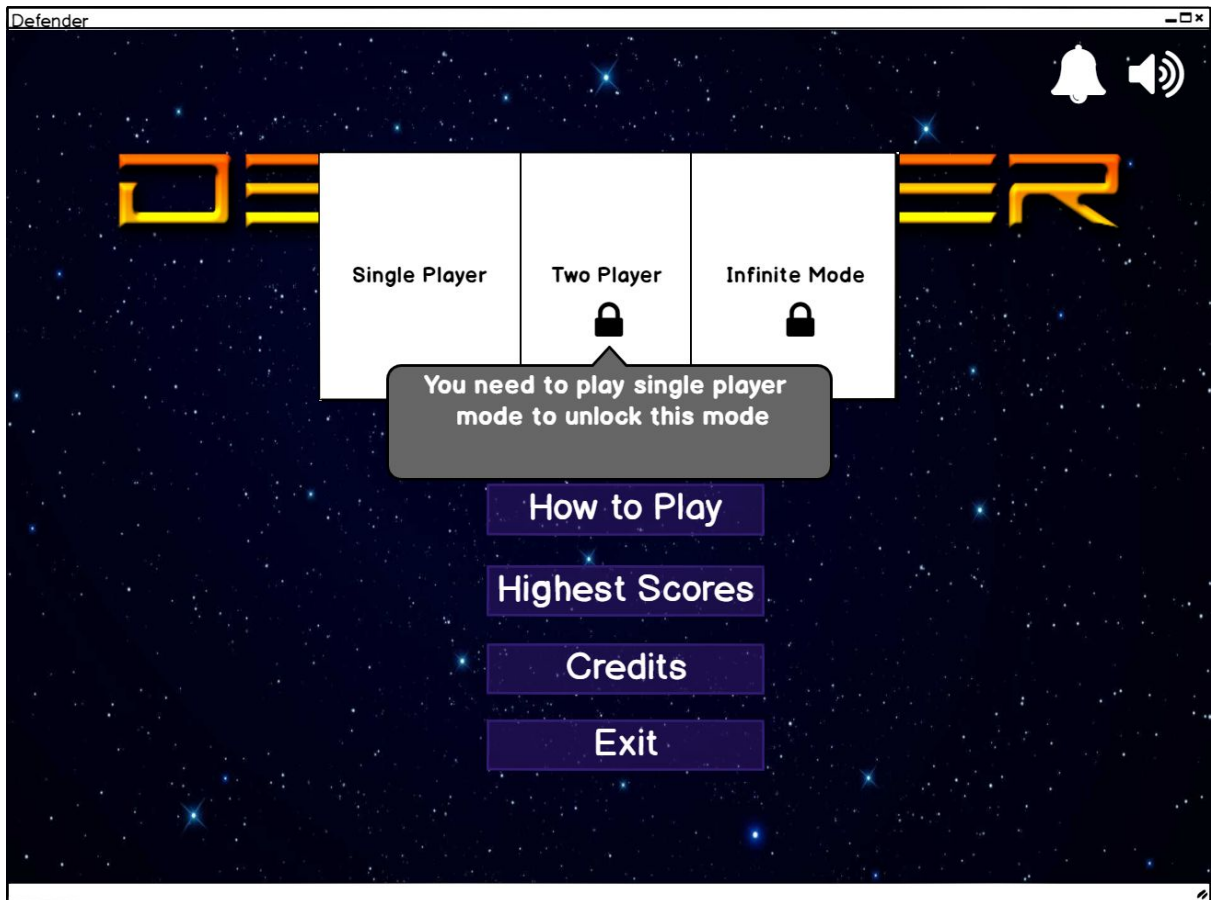
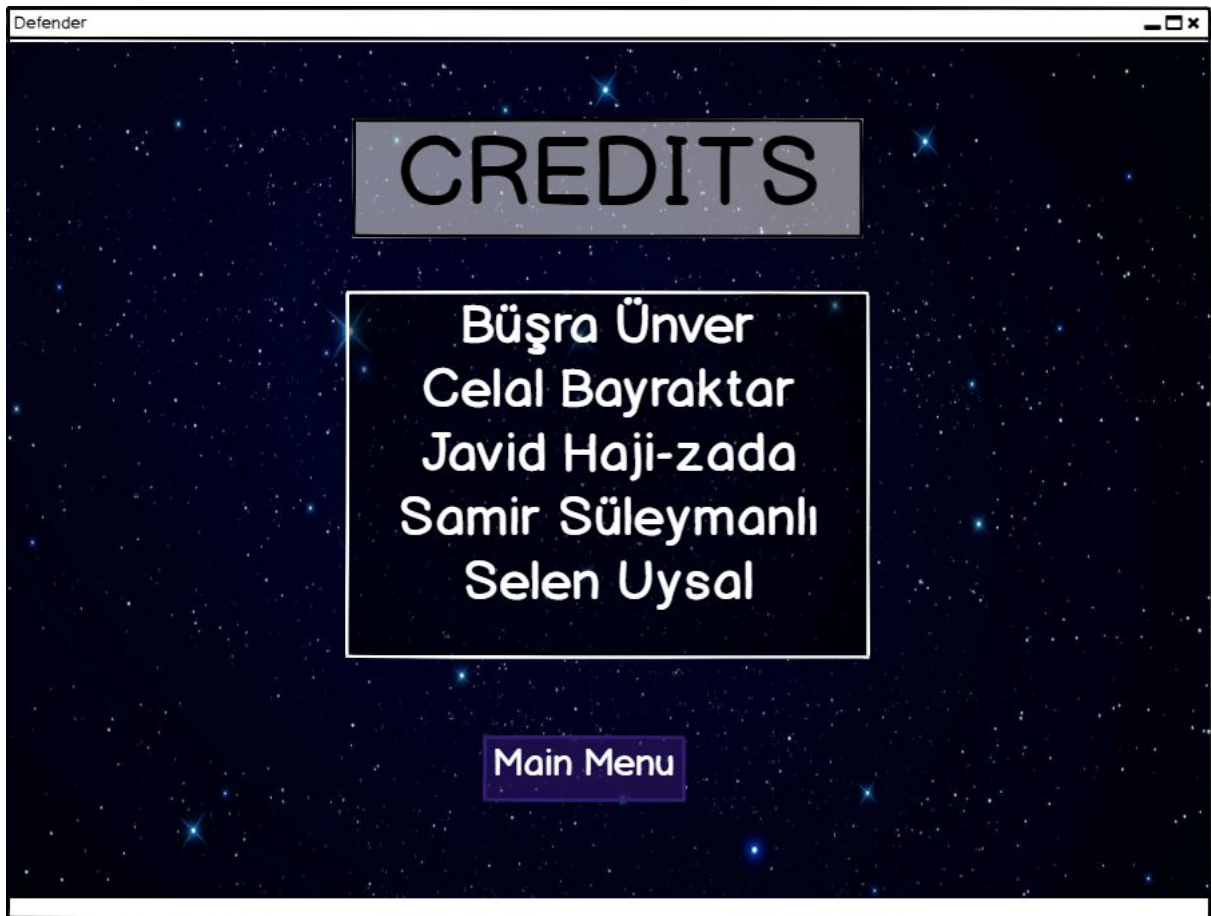**Figure 16.3.** Game modes, locked message for two players
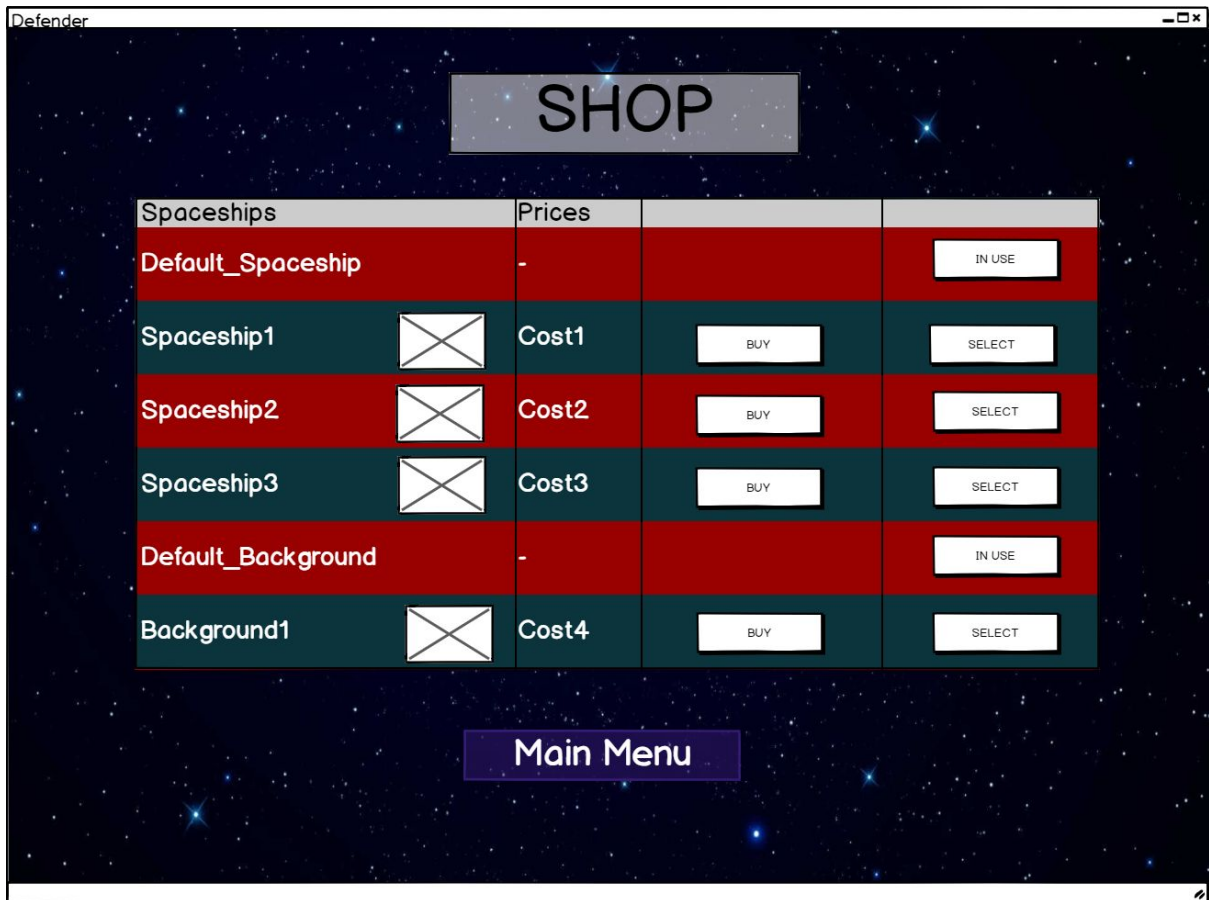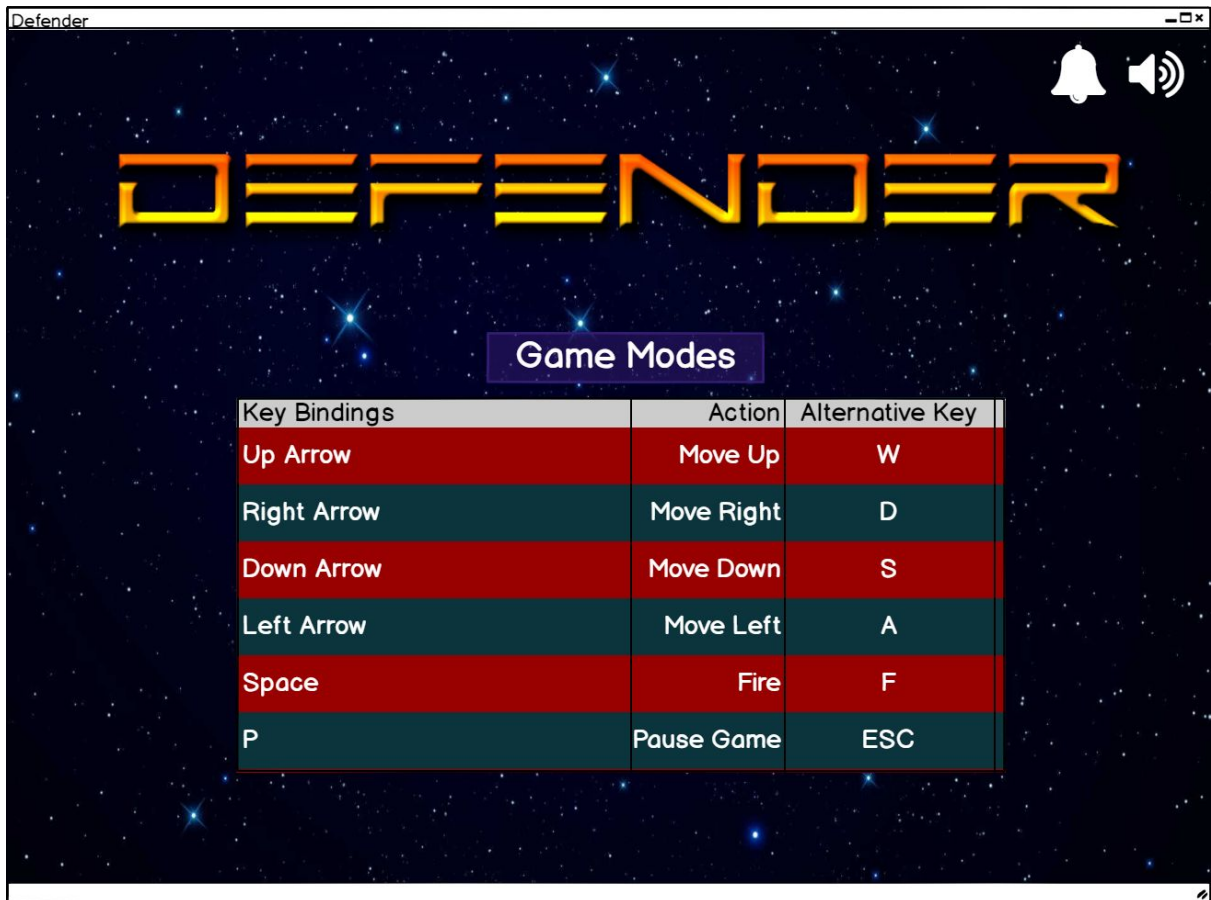
Figure 17. Shop screen

Figure 18. Credits screen
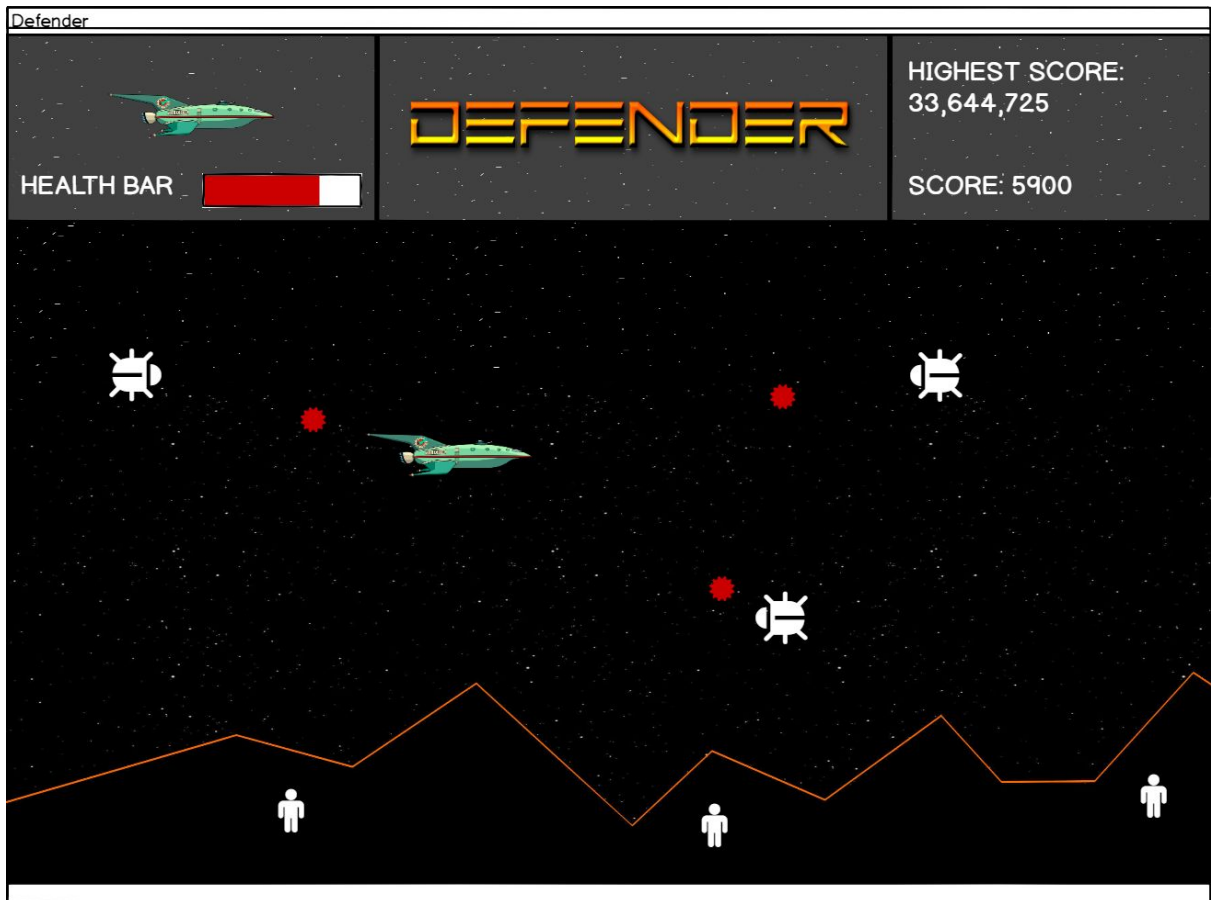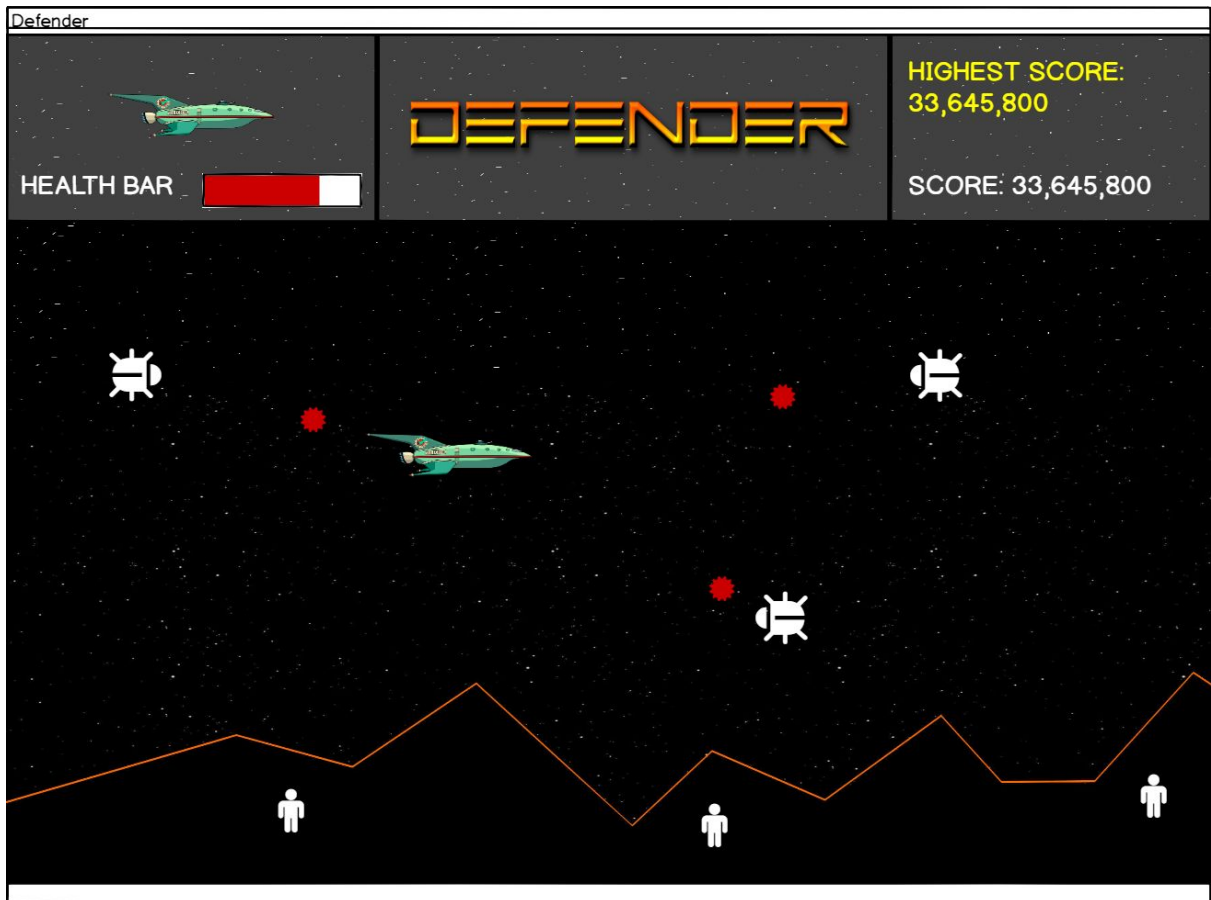
Figure 19. How to play screen

Figure 20. High scores screen

Figure 21.1. Single player

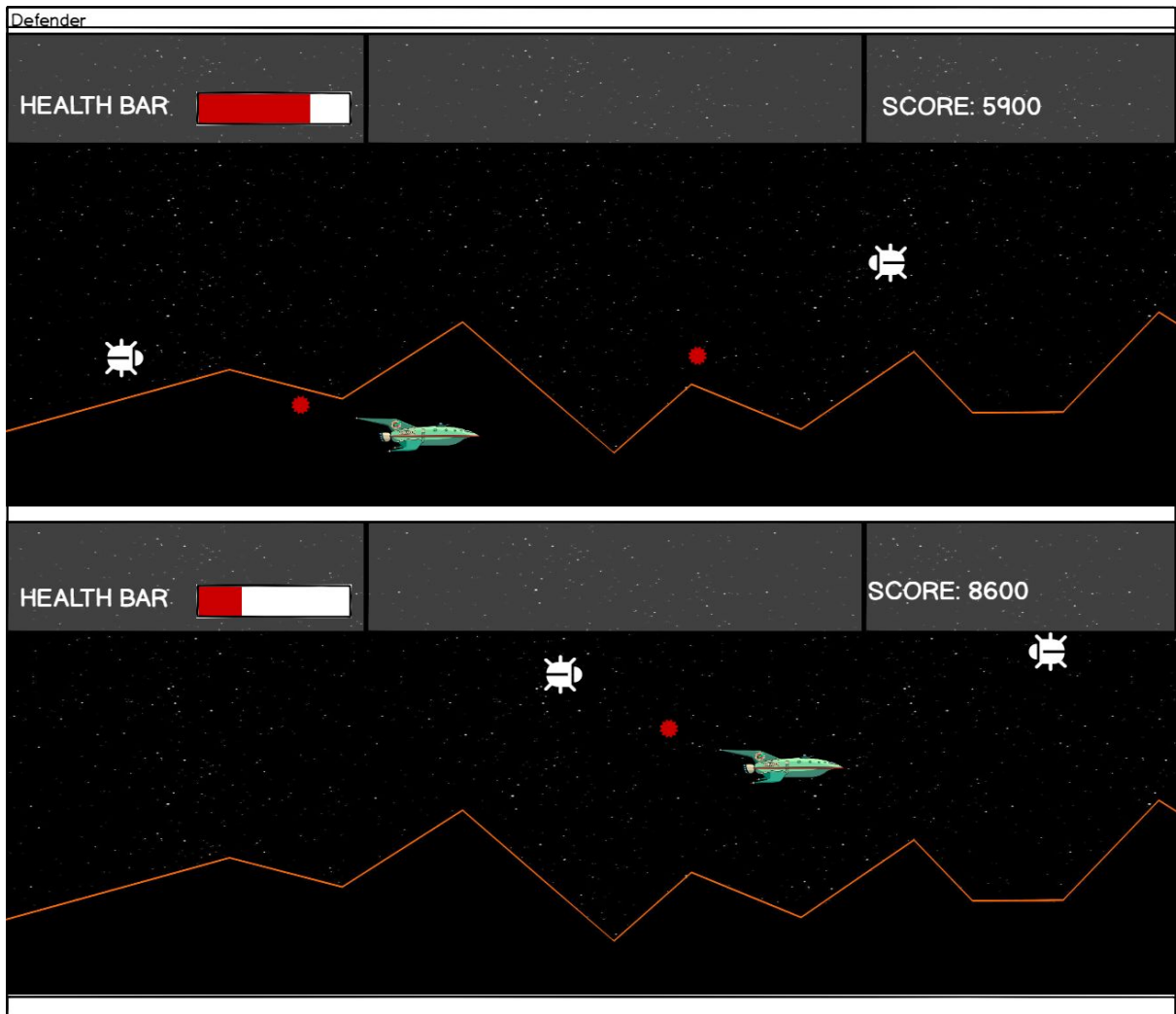**Figure 21.2.** Single player, new high score

Figure 21.3. Game over

Figure 22.1. Two players

HEALTH BAR

TOMMY

SCORE: 7800

HEALTH BAR

JERRY

SCORE: 9200

Waiting For TOMMY...

Figure 22.2. Two players, one died

Figure 22.3. Two players, conclusion

7. References

[1] "Defender (1981 Video Game)." Wikipedia, Wikimedia Foundation, 19 Oct. 2019, https://en.wikipedia.org/wiki/Defender_(1981_video_game).