BILKENT UNIVERSITY

CS 319: OBJECT-ORIENTED SOFTWARE ENGINEERING

FINAL REPORT

DRAW IT!

Group 4 Section 1

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1. Introduction - Problem Statement

Few years ago, one of the most popular games was a game called draw the word. It was also part of TABU game and its concept is very basic. A person chooses a word from the card and tries to draw the word within a limited time. The other person tries to guess it within his/her time limit. A web-based and mobile based application of this game is played too much. However, we notice that this game never been a desktop-application game. Therefore, we as Group 4 decided to make one. “Draw It!” is an entertaining application which has lots of common points with famous “Draw Something” game. The “Draw It!” is a multiplayer game and its concept is mainly constructed on drawing the given words and guessing the drawn images in a particular time to gain points.

Problem Statement

To be specific, “Draw It!” game is played with 2 players in multiple rounds. Each player turns changes within each round. But first they need to connect to the game. Host is opens the game and guest is the player who connects the game. Host is the first active player, who is responsible for choosing the word and drawing it. Passive player tries to find the word. They both have limited times for their tasks. Active player can hit finish button if s/he finishes drawing earlier or s/he can hit the x button and give up his turn. Same way, passive player can give up his turn by clicking ? button. When guessing part finishes, round finishes as well and players change the roles. This game circle continues right until one of the player clicks on the exit button.

During this report, general pre-analysis of the project are going to be investigated. In the first part, the main point is to clearly indicate the features of gameplay including rules. During

the next step, list of requirements and their analysis are explained properly. Final part of the report includes scenarios, use case models, UML diagrams and user interface figures.

2.Requirement Analysis

Requirement Analysis part contains an overview, requirements for the application, scenarios, Use Case Models and the Use Case Interface of "Draw It!" application.

2.1. Overview

"Draw It!" is a Java based computer game which requires a connection between computers. By using this connection, when a player is drawing an image, the other player is able to see the drawing at the same time. In this concept, the aim of the game is to reach the maximum points by drawing and guessing accurately the challenges. The game is played with rounds and at the end of every round, the duties of the players are replaced. During the drawing process, users are able to change the colour and size of the drawing stick to make it more understandable for the player who is guessing.

The "Draw It!" game consists of three main steps. In the first step, there is a menu with three buttons which are "Host", "Join", "Credits". One of the users clicks on the "Host" button to create a new game and the only thing that the second player needs to click on the "Join" button to start the challenge. When the game is started, in the first round host player is the one who is going to draw a figure and the guest player is the one who guesses. Before starting to draw, active player, whose duty is to draw, chooses a word among three random words that the game offers. When the drawer player starts to create an image, the passive player, whose duty is to view and guess, is able to see the drawing in real time. The drawing process needs to be done in

45 seconds and after this 45 seconds, the guessing time period is started. The passive player has also 45 seconds to find the name of the object by filling the blank with letters that are located at the bottom of screen. If the passive player finds the word, the time period is over and passive player gets ten points but if they cannot make it, s/he gets zero points. After every round, the active player becomes passive player and the passive player becomes active player. The game continues until one of the players clicks on the finish button and when the game is finished, both of the players see their scores.

2.2. Functional Requirements

- Players must be able to start or join a new game over a network.
- Players must be able to use and control their mouse during the game (while drawing and guessing).
- Players should change roles after each round.
- For each round, active player should be able to select his/her own word from the given words.
- Active user should be able to finish drawing whenever he wishes to.
- Passive user should be able to give up from his turn if s/he thinks s/he won't be able to find it.
- During the game, passive player should receive points according to his correct responses.
- Players must be able to exit from the game anytime they want to. In this case, game will be over for both players and the scores will be shown.
- Active player should be able to change the colour and the size of the brush.
- Players must be able to login or sign up to the game.

- Brush must at least has 3 different size.
- When passive player finds a word correctly, s/he should get 10 points.
- In the guessing box, 10 letters should be appear in order to help passive user to guess the word.
- When a round crashes, system should be able to start a new round.
- Players should have unique usernames.
- Guessing box's color should turn red if the passive player fail to find the word, green otherwise.

2.3. Non-Functional Requirements

- Before starting the game, the connection between two players (host and guest) should not take more than 2 minutes long.
- Color panel at least should have blue, yellow, red and green colors.
- 45 seconds should be given for both drawing and guessing parts of the round.
- Application should not allocate more than 1 GB of space.
- Players should be able to play game without further documentation.
- Players should not encounter with gameplay errors which are related to code structure problems. For example, if after each successful round, the scoreboard does not change according to score rules, this decreases the reliability level of the game.
- Project code structure should be suitable for new extensions about drawing panel such as new brush styles.
- Total cost of the project should be equal to the total price for the server renting.

2.4. Constraints

- The “Draw It!” game will be implemented in Java.
- The application should work in Windows, Linux, IOS and the other operating systems which are able to work with Java.
- The application should work on the local network.

2.5. Scenarios

Participating Actors: Player (John, Valerie)

John and Valerie are both very famous painters and they decide to meet in 18th September 2015 at the John’s studio. After 6 pm, they get bored and want to try something new for them. Suddenly, John finds an application which is called as “Draw It!” in his personal computer and he asks Valerie to play this game together. Then, Valerie accepts the challenge and download the game for her own personal computer. John clicks on the icon of the game on his computer’s desktop as well as Valerie. Both John and Valerie sign up for the game by declaring their username and password. They both login. John clicks on the “Host” button and waits and his username and password saved to the computer and his personal computer’s IP address sent to the server network. Valerie clicks on the “Join“ and she fills the blank space by entering the John’s username to join his game. When the connection is provided, Valerie encounters with a waiting screen because at this moment John needs to choose a word among three randomly chosen words. After choosing a word from the list, John starts to draw the word and the game begins officially. When John is drawing the image, Valerie can see the mouse movements of

John in real time by using the connection. Every time John releases the left mouse click after a drawing movement, the drawing piece for this period is seen by the Valerie at the same time. When John finishes his drawing, he can click on the “Check” option or he can wait until the time countdown hits to zero. If he cannot finish his drawing until end of the time limit (45 seconds), his turn passes. When he finishes his work before the time is up, entire image is seen on the screen of Valerie and the time countdown starts for her. During the guessing period, Valerie can fill the word space by clicking on the given letters in the guess box to find the word that John chose. If Valerie thinks that she cannot find it, she can click on the “?” option to give up and her turn passes. In addition to this, if Valerie cannot find the word until the time is over, his turn passes as well. If she can find it before the time is up for her, she gains 10 points and the first round is over. At the end of the first round, John and Valerie changes their roles. For the second round, John becomes the passive player and Valerie becomes the one who draws. At the end of every round, game system changes the roles of the players. The game continues, until Valerie decides to go home to cook some meal for her children and she clicks on the “Stop Game” option. After finishing the game, they both sees their personal scores and Valerie wins the challenge. Before closing the application, John wonders the names of people who worked for the construction of this game and he goes back to the main menu to click on “Credits” to see the participants of the project.

2.6. Use Case Model

We intend to make our Use Case Diagram as simple as possible in order to be comprehensible by the client. Below is our Use Case Diagram and Use Cases.

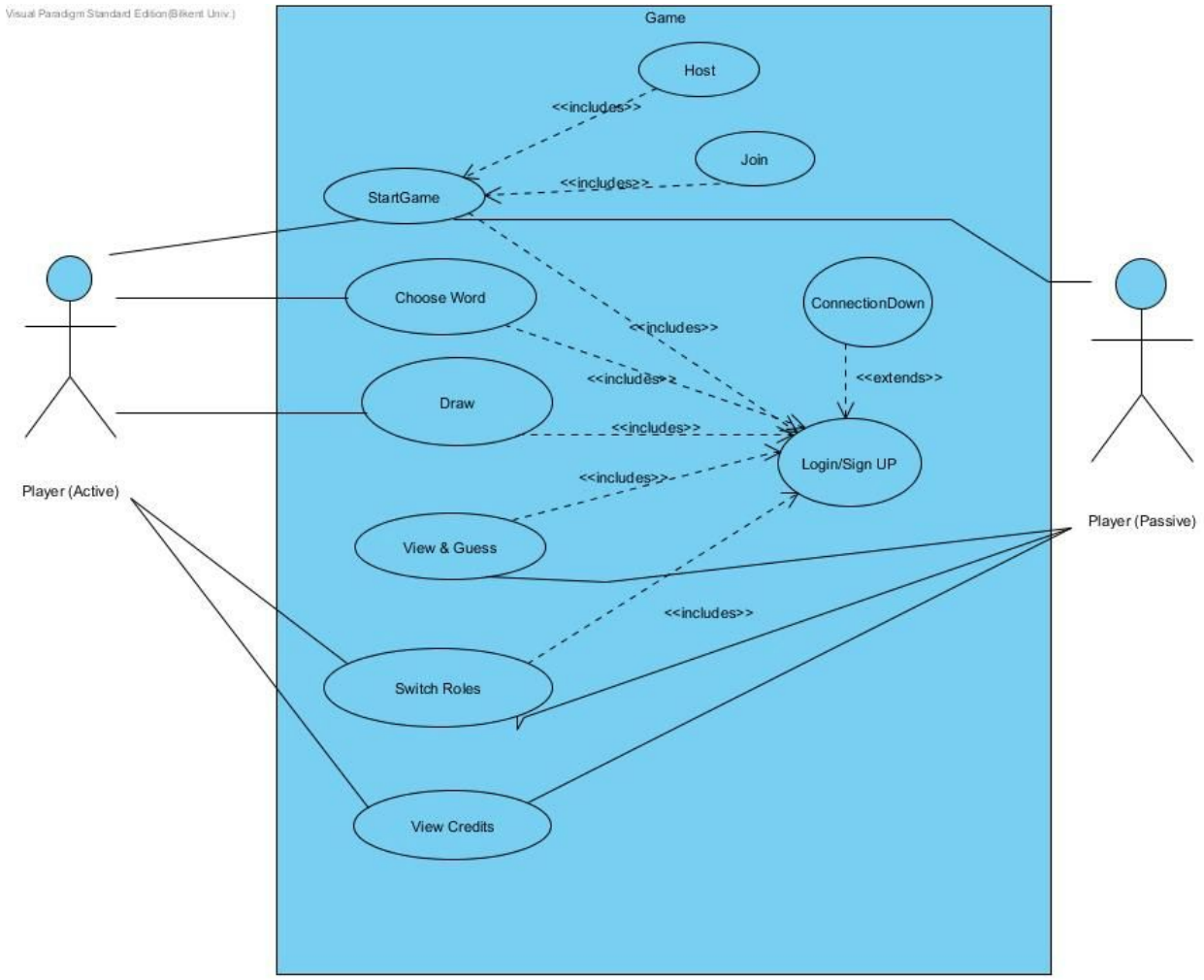


Figure 1. Use Case Diagram

2.6.1. Use Case 1: Login/Sign Up:

Use Case Name: Login/ Sign Up

Participating Actors: Initiated by Player.

Flow of Events:

1. If player enters the game for the first time, he should sign up by entering his unique username and password.

    2. System saves the users IP adress to the network and the username and password is saved onto the computer.

3. If it is not for the first time, when opening game.exe system automatically logs in.

Entry Condition:

- If for the first time, player should sign up the game, else player opens the game .exe.

Exit Condition:

- Player2 enters Player1 IP address.

Quality Requirements:

- Player's username should be unique.

Login/Sign up extends the connection Down use case. This is an exceptional case for the times when the connection fails. If fails, system tries to connect the network until the connection is successfull. Game continues with a new round.

2.6.2. Use Case 2: StartGame

Start game use case both includes Join and Host use cases. As they are very simple use cases, we explain it within the StartGame use case.

Use Case Name: StartGame

Participating Actors: Initiated by Player.

Communicates with another Player.

Flow of Events:

2. Player1 activates the "host" function of the main menu.

    2. Game shows the IP address of the Player1 in a new screen.

3. Player1 starts to wait until Player2 enters his IP address, Player2 enters Player1's IP address.

    4. Game opens choose word step to Player1, when Player2 is waiting for the first round to start.

Entry Condition:

- Player1 clicks on the host button and Player2 clicks on the join button.

Exit Condition:

- Player2 enters Player1 username.

Quality Requirements:

- Player2 must click on the join button and must enter Player1's IP address at most 2 minutes.

2.6.3. Use Case 3: ChooseWord

Use Case Name: ChooseWord

Participating Actors: Initiated by Player.

Flow of Events:

1. Game shows the three words in a new window to Player.
2. Player chooses one of these word to draw.
3. Game starts the round by opening new drawing screen.

Entry Condition:

- Second player joins the game.

Exit Condition:

- Player clicks on the word he chooses.

Quality Requirements:

- -

2.6.4. Use Case 4: *Draw*

Use Case Name: Draw

Participating Actors: Initiated by Player.

Flow of Events:

1.Game starts the countdown of the timer.

2. Active Player (player who draws) starts to draw the word with any color and size he selects.

3. Active Player continues to draw until time is up or he clicks on the finish button.

4. Game finishes active player's part in the round.

Entry Condition:

- Active Player clicks on one the three words.

Exit Condition:

- When time is up.
- When Active Player clicks on the finish button.

Quality Requirements:

- Required time is 45 seconds.

2.6.5. Use Case 5: ViewAndGuess

Use Case Name: ViewAndGuess

Participating Actors: Initiated by Player.

Communicates with another Player.

Flow of Events:

1. Passive Player (player who guesses) sees each drawing movement of the the active player with real-time.

2. After drawing process ends, game initializes Passive Player's guess time and makes visible the guess box.

3. Within the given time, Passive Player tries to find the chosen word. If he clicks on the wrong letter he click on the Trash Bin icon. One clicked icon erases the all chosen letters and passive player should start to select them again.

4. If he thinks that he can't find the word, he clicks on the "?" button. If he finds the word or if time is up, his turn passes.

5. If passive player fails to find the word, uses box turns into red. Correct word shown. If word found correctly, guess box turns into green and player receives 10 points.

Entry Condition:

- Active player releases the mouse for the first time whilst he draws.

Exit Condition:

- Time is up.
- Passive player finds the word correctly.
- Passive player gives up and clicks on the "?" button.

Quality Requirements:

- Required time is 45 seconds.

2.6.6. Use Case 6: Switch Roles

Use Case Name: SwitchRole

Participating Actors: Initiated by Game.

Communicates with the other two Players.

Flow of Events:

1. When each round is finished, scores of the players is updated by Game Controller.

2. If player 1 is active player for the finishing round, guessing window is sent to him or vice versa. If player 2 is active player for the finishing round, guessing window is sent to her or vice versa.

Entry Condition:

- Round is finished.

Exit Condition:

- Both active and passive players takes new screen.

Quality Requirements:

- -

2.6.7. Use Case 7: ViewCredits

Use Case Name: View Credits

Participating Actors: Active and passive players

Flow of Events:

1. Players use Credits button on the main menu.

2.Game displays the contributors of the game.

Entry Condition:

- Press on Credits button.

Exit Condition:

- Press “Back” button.

Quality Requirements:

- -

2.7. User Interface

User Interface is one of the crucial thing in designing process. We care our application to be user-friendly. The images below are only rough sketches, for now.

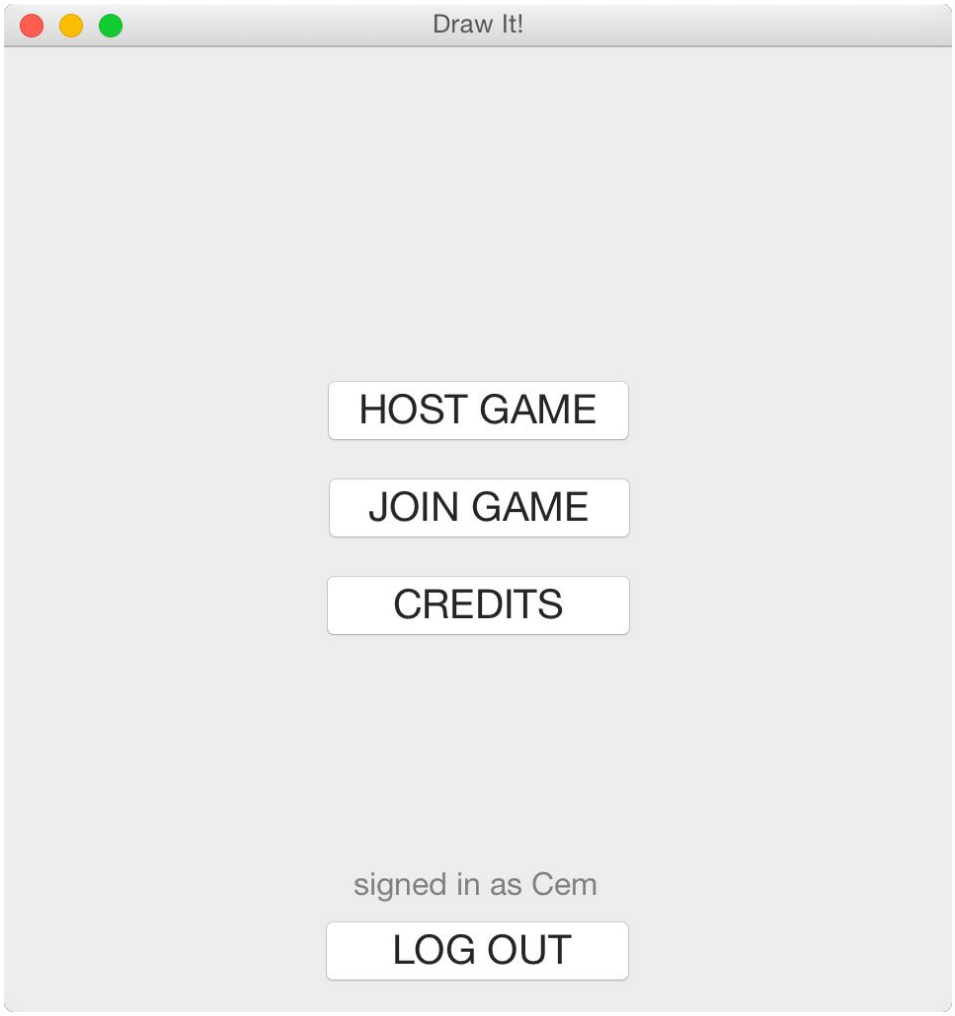


Image 1: Main Menu

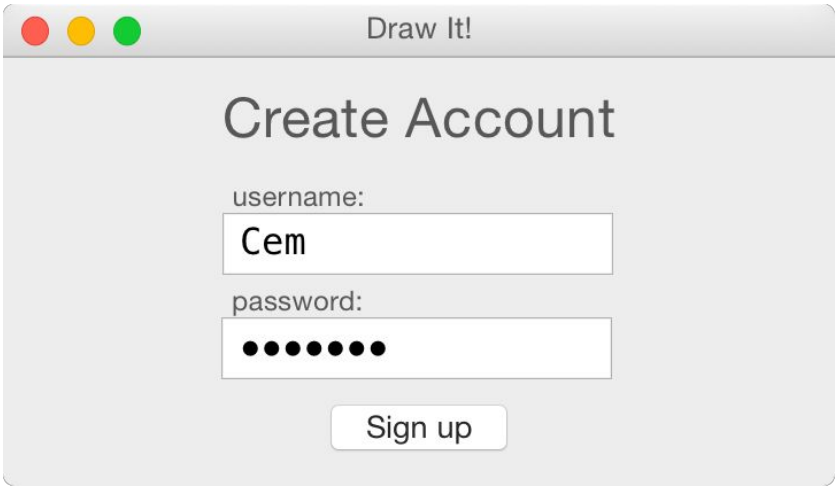


Image 2: Login

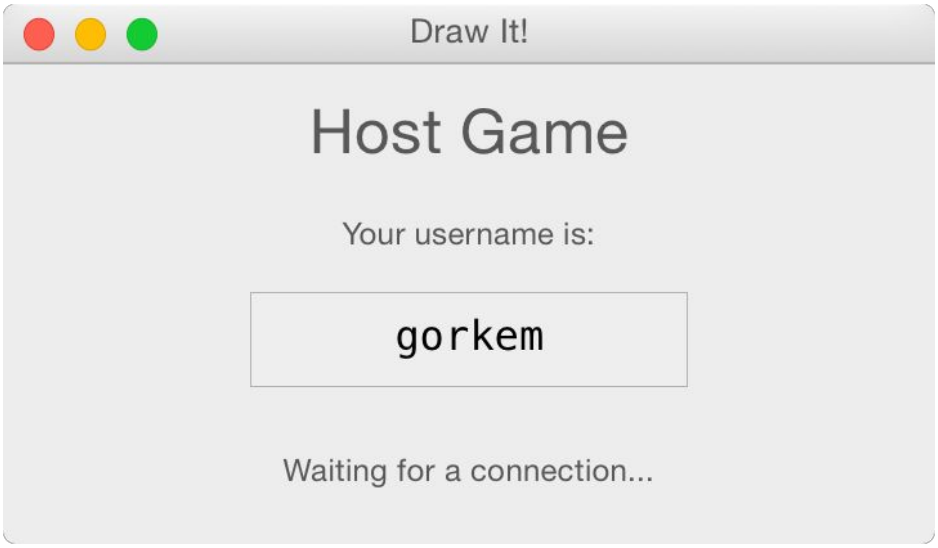


Image 3: Host Game

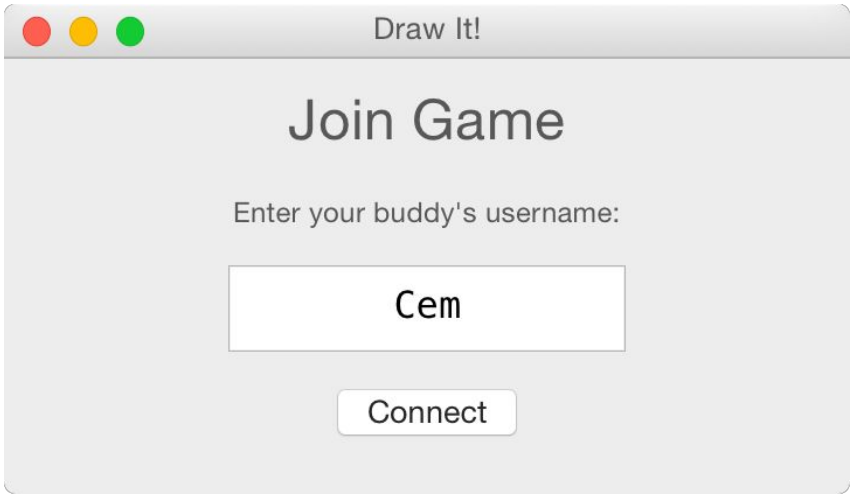


Image 4: Join Game

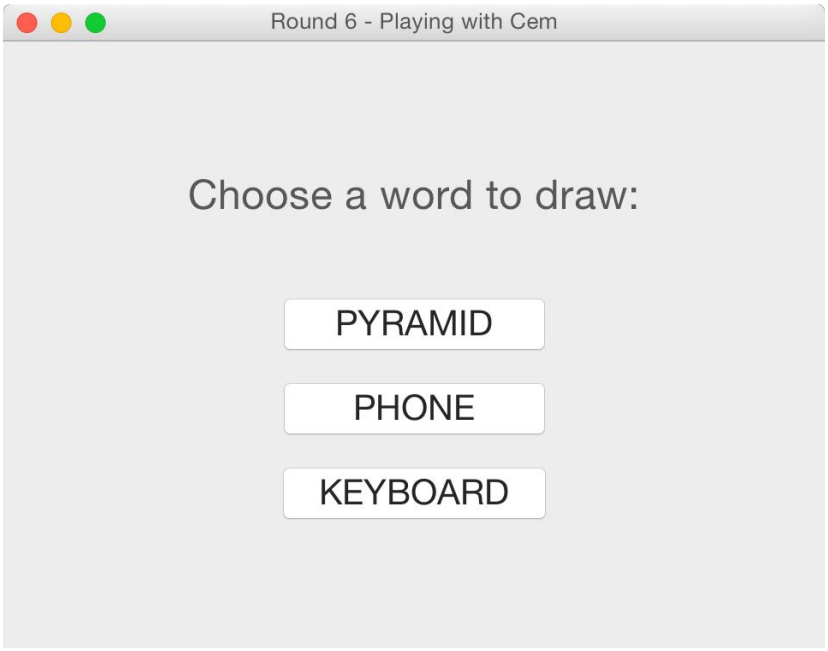


Image 5: Choose Word Screen

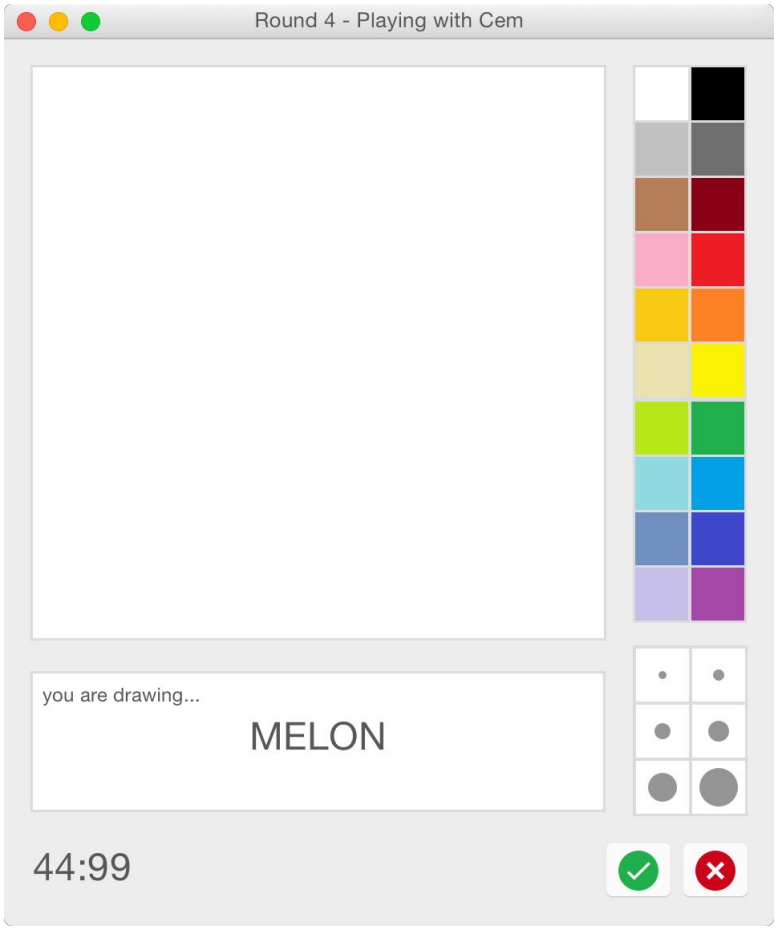


Image 6: Drawing Screen

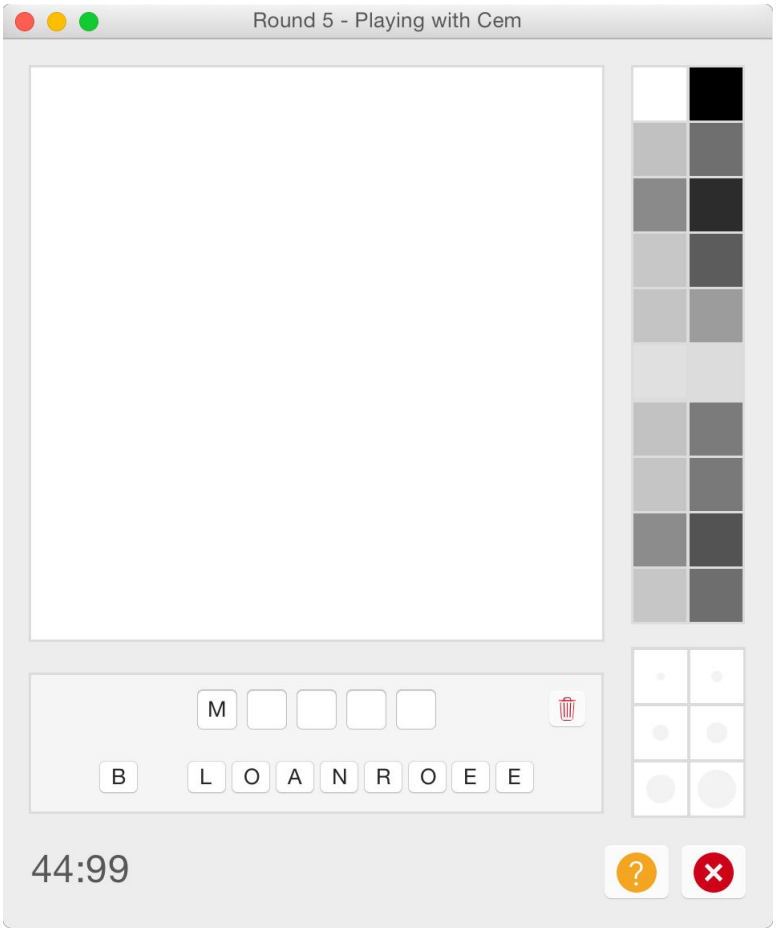


Image 7: Guessing Screen

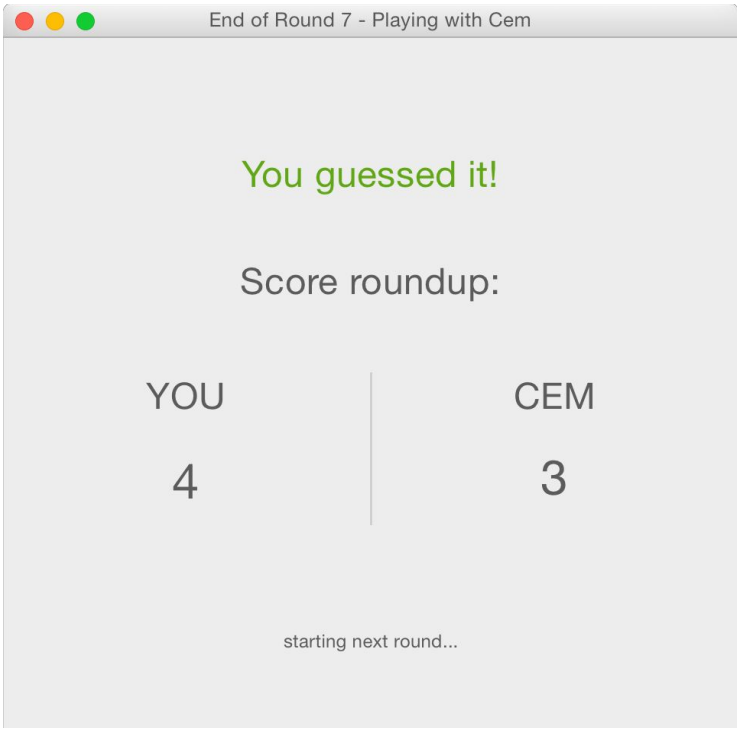


Image 8: End Of Round

Image 9: Credits

3. Analysis

Analysis part contains object model and dynamic models sections for the “Draw It!” application. More detailed explanation about “Draw It!” Game and diagrams are given in this section.

3.1. Object Model

Object Model part includes Domain Lexicon and Class Diagram. Domain Lexicon consists of the “Draw It!” application keywords’ explanation and aims to clarify ambiguous words for the user.

3.1.1. Domain Lexicon

Active Player: The player who draws in that particular round.

Passive Player: The player who guesses the word in that particular round.

Drawing Movement/ Piece: The mouse movement between mouse press and mouse release that Active Player made while drawing.

Guess Box: The box that Passive Player use while making his guess. It contains 10 random letters and n many empty letter boxes where n is the length of the chosen word.

“?” Button: This button is used by Passive Player when s/he thinks, s/he cannot find the word. When player clicks on that button s/he gave up from her turn.

Close Button: This button is used by both players when they want to quit from the game. When players press this button, they can see their total point in the game.

Check Button: This button is used by Active Player. S/he clicks on that when s/he thinks s/he finished the drawing.

Trash Bin: Passive user use this icon to clear the guessing area when he clicks on the wrong letter. Once clicked, all chosen letters are erased.

3.1.2. Class Diagram

In our class diagram, we have Player, Canvas, Piece, NetwrokLayer, TurnTimer and differen control classes such as WordDrawingControl, WatchControl, GuessWordControl and GameController class.

Game Controller class mainly responsible to showing screens and checking whether the users connected or not. It also responsible to starts the rounds and the turns, it updates the player scores as well. Player class holds a reference to basic player information such as IP address and score of the player. It has a variable called active as well, which is the information for whether the player is active or passive in that specific round. NetworkLayer class is the class which we make our connection and use for sending information. This class is for managing the network connection between the two game instances. ConnectToHost(), turnFinished(success), roundStarted(word) and sendPiece() method are parts of the NetworkLayer class.WatchControl controls the drawing watching stage of the round and it contains drawFinished(), onNewPiece(piece) and operation() methods.

TurnTimer class is the class which we keep count of the drawing and guessing process. This class checks whether the time is up. Time starts when the class's constructor is called. WordDrawingControl and GuessWordControl are using the TimerDelegate interface.

TimerDelegate interface has the onTimeout() method which notify that time is up. WordDrawingControl is the part here we control drawing. It has simple feature like selecting color and brush. Other than these, it has also isFinished(), startDrawing() and finishDrawing() method, as well as createPiece, addToPiece(point) and finishPiece() methods. On the other hand, GuessWordControl is where the part we control guessing process. This part has guess and word variables in order to check whether our guess and word matches. finishGuessing(), isFinished(), setLettter(position, letter), wordCompleted(), guessCorrect(), clearWord() and giveUp() methods.

Also, we have Canvas and Piece classes. Our Piece class is representing a piece of drawing which we call drawing movement as well throughout our report. Piece class has point, brush and color variables. Canvas is basicly for providing a surface to draw something or to see the drawn figure. Canvas class has drawPiece(piece), mousePressed(), mouseDraged(), mouseReleased and refresh() functions.

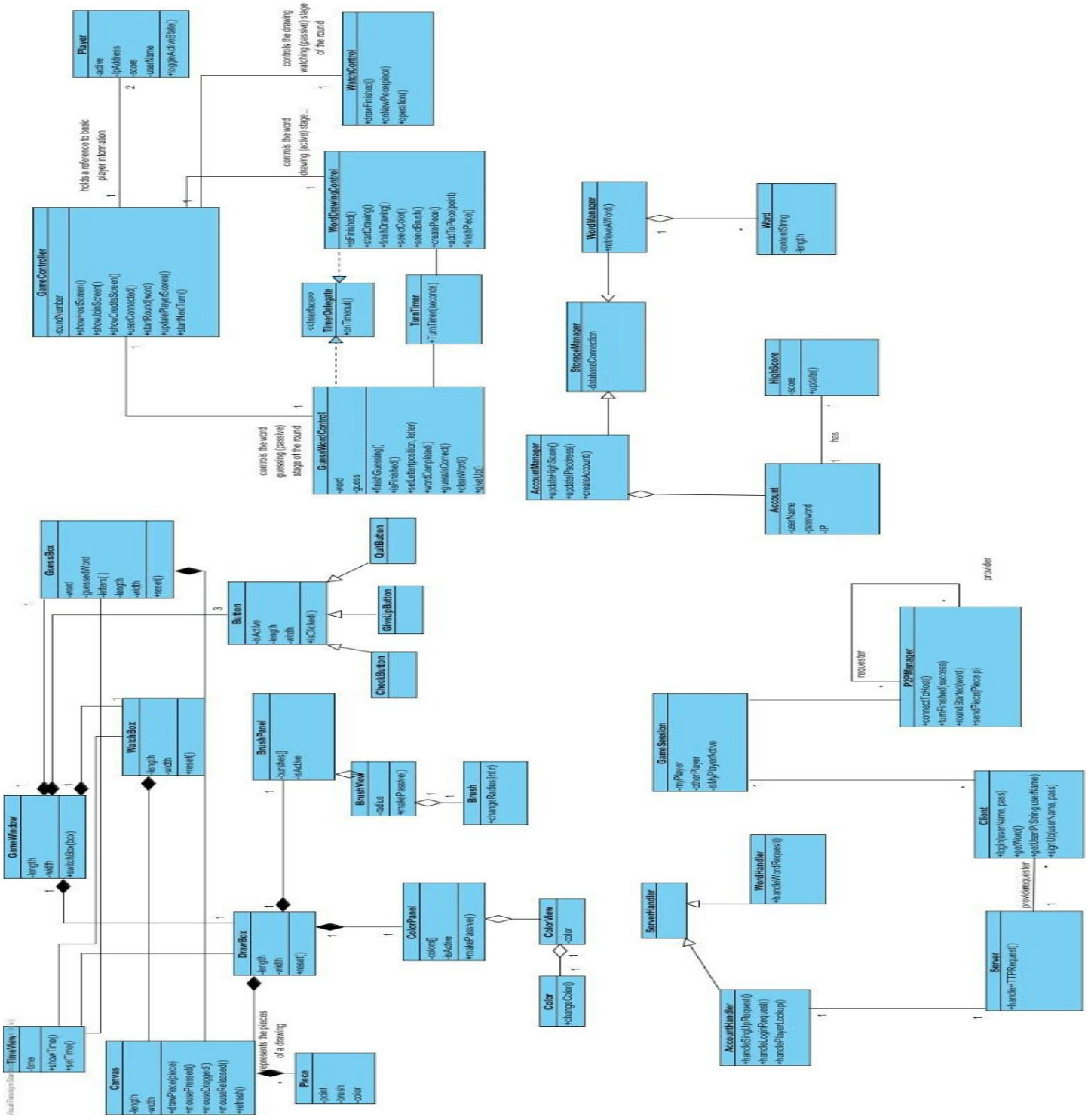


Figure 2. Class Diagram

3.2. Dynamic Models

Dynamic Models part includes the State Chart and Sequence Diagrams along with their explanation and scenarios with the aim of providing better understanding about “Draw It!” Game.

3.2.1. State Chart

We have 2 State Chart Diagrams. They are the states of Active Player’s and Passive Player’s separately. Overall, we introduce the behaviour of a player during the game process. There are two playing options which are hosting and joining. If the player chooses hosting, he needs to choose a word in the first step of the game. After the word choosing condition is finished, the next step is to draw the word. When he finishes the drawing process, he needs to wait for the end of guessing process of the other player. When the round is over, he becomes the player whose duty is to guess the word which is drawn by the other player. In short words, there is a role exchanging process. After this step, his role is turned into being a drawer. If at the beginning of the game, the player chooses the “Join” option, his movement starts from the BecomeGuesser state of the diagram and goes with the same cycle of hosting option and this cycle continues until one of the players wants to exit from the game. Players are able to exit from the game during the ChooseWord, Draw, WaitForGuess, BecomeGuesser, ViewDrawing and Guess states of the state chart steps. Also, following state chart diagrams are the simpler cases for active player and passive player states.

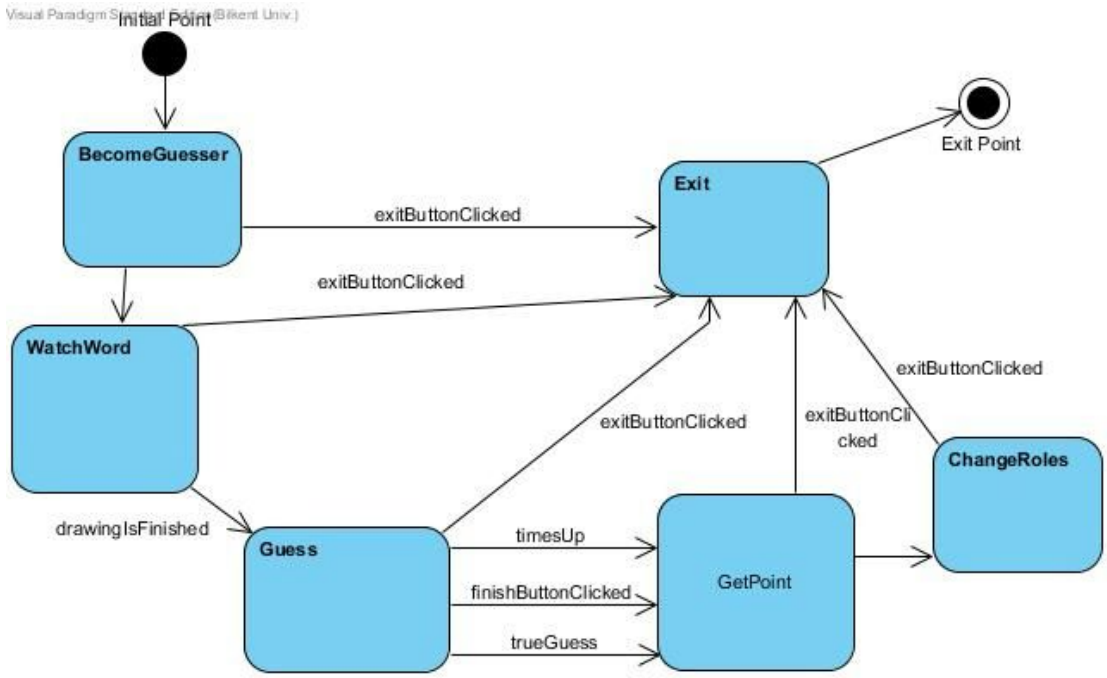


Figure 3. State Chart Diagram 1: Passive Player State

In this state chart diagram, we explain the behaviour of a passive player (the one who views and guesses the drawing). At the first step, he needs to view the drawing. When the drawing is done, in the guessing process, he needs to be successful to find the word or time needs to be up or the player needs to click on "?" option to go to the next step which is called as point check to see the current point situation. After points are shown, the lifetime of the passive player ends.

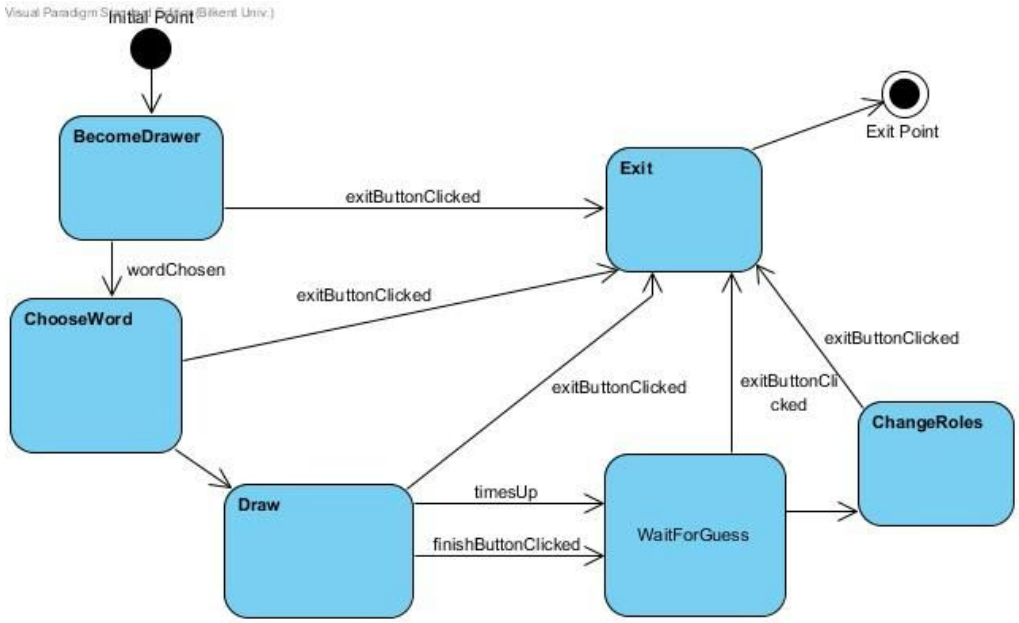


Figure 4. State Chart Diagram 2: Active Player State

In Active Player State chart diagram, we explain the behaviour of an active player (the one who is drawing). At first, the active player chooses a word to draw. After choosing a word he needs to draw it in 45 seconds or needs to click on the "Check" option to go the next step which is called as WaitForGuess. After the guess result comes, lifetime of the active player ends.

3.2.2. Sequence Diagram

This part contains scenarios and their sequential diagrams.

3.2.2.1. Scenario 1: "menu" Scenario

Scenario Name: menu

Participating actor instances: john:Player , valerie:Player

Flow of events:

1. John and Valerie both click on the icon (exe) of the "Draw It!" application and they start the execution of the program.

2. John and Valerie both encounter with the main menu which has "Host", "Join" and "Credits" options.

3. If they want to play the game, John clicks on the "Host" option and Valerie clicks on the "Join" option. This case could be in reverse roles.

4. If John or Valerie want to see the participants of the game project, only thing they need to do is clicking on "Credits" option.

5. If John or Valerie clicks on the "Host" option, s/he starts to wait for the other player to play the game and during this waiting process, he sees his device's IP address. This IP address is for the other player because the one who wants to join

the game needs to use it. When the other player joins the game, John finishes his work with this step and goes to the part that he chooses the word.

6. If Valerie or John clicks on the "Join" button, Valerie needs to fill the IP address space by using the IP address that is shown in the host player's screen. After filling this space, the connection is provided and the game begins.

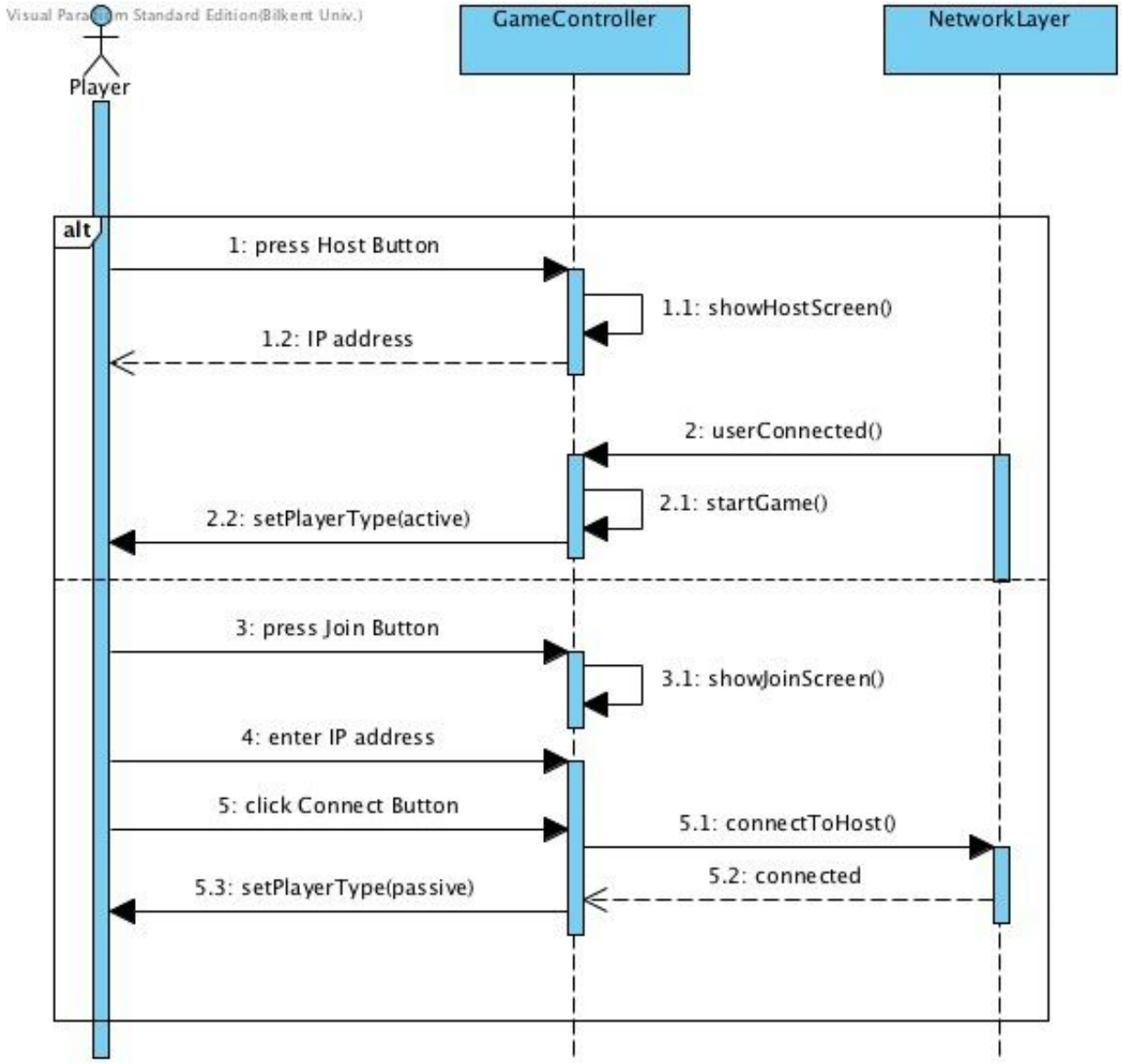


Figure 5. Sequence Diagram 1: "menu" Diagram

3.2.2.2. Scenario 2: "showCredits" Scenario

Scenario name: **showCredits**

Participating actor instances: **john:Player**

Flow of events:

1. One of the players clicks on the Credits button on the main menu.

2. The network sends new canvas which shows the names of contributors and contact information of this game to the player.

3. After choosing the "Credits" option, John finishes his work with the main menu.

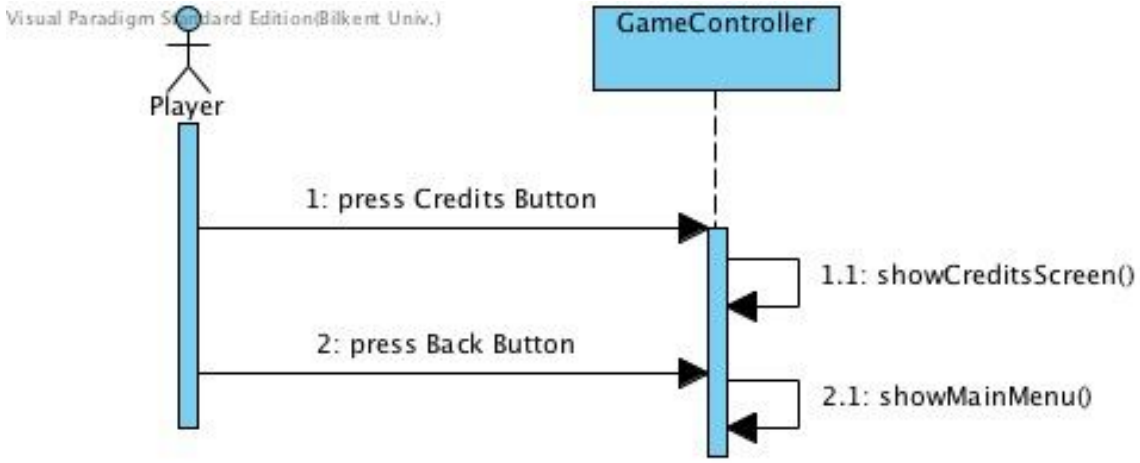


Figure 6. Sequence Diagram 2: "showCredits" Diagram

3.2.2.3. Scenario 3: “wordChoosing” Scenario

Scenario Name: wordChoosing

Participating actor instances: john:Player

Flow of events:

1. John encounters with three different words which are listed randomly.
2. John chooses one of them which he can draw.
3. After choosing one of them, John finishes his work with the word choosing step.

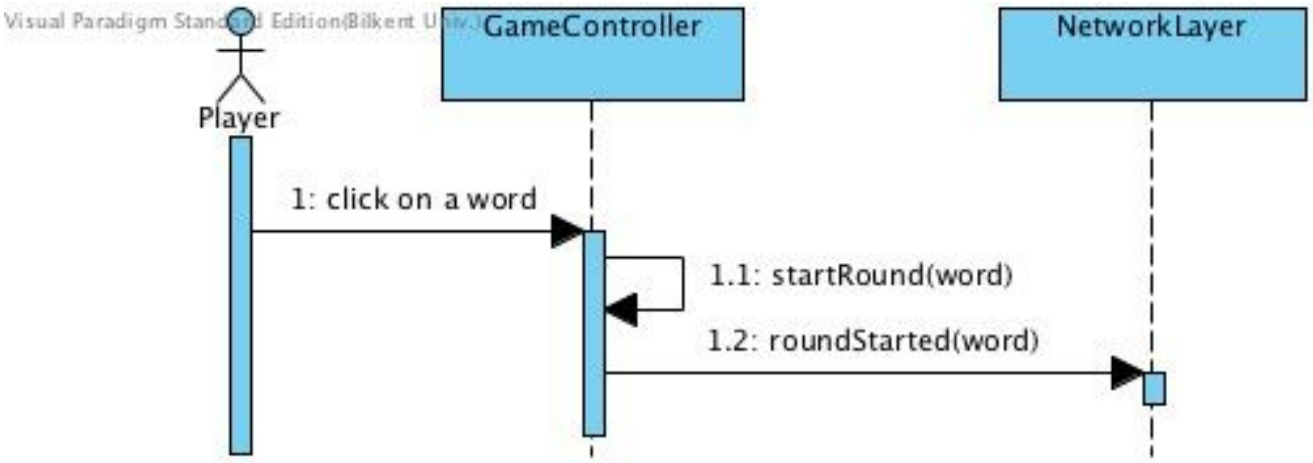


Figure 7. Sequence Diagram 3: “wordChoosing” Diagram

3.2.2.4. Scenario 4: “wordDrawing” Scenario

Scenario Name: wordDrawing

Participating actor instances: john:Player , network:NetworkLayer

Flow of Events:

1. John may select a color from color panel.
2. He presses the mouse when mouse cursor points a specific point (point where he wants to start drawing) in the canvas.
3. He draws the figure partially or completely.
4. He releases his mouse.
5. System send the point coordinations of his drawing to the network.
6. If he didn’t finish drawing, he repeats the first 5 steps.
7. If required time (45 seconds) is up or John clicks the finish (check) button, drawing word process ends.
8. The active player’s (John’s) part of the round finishes.

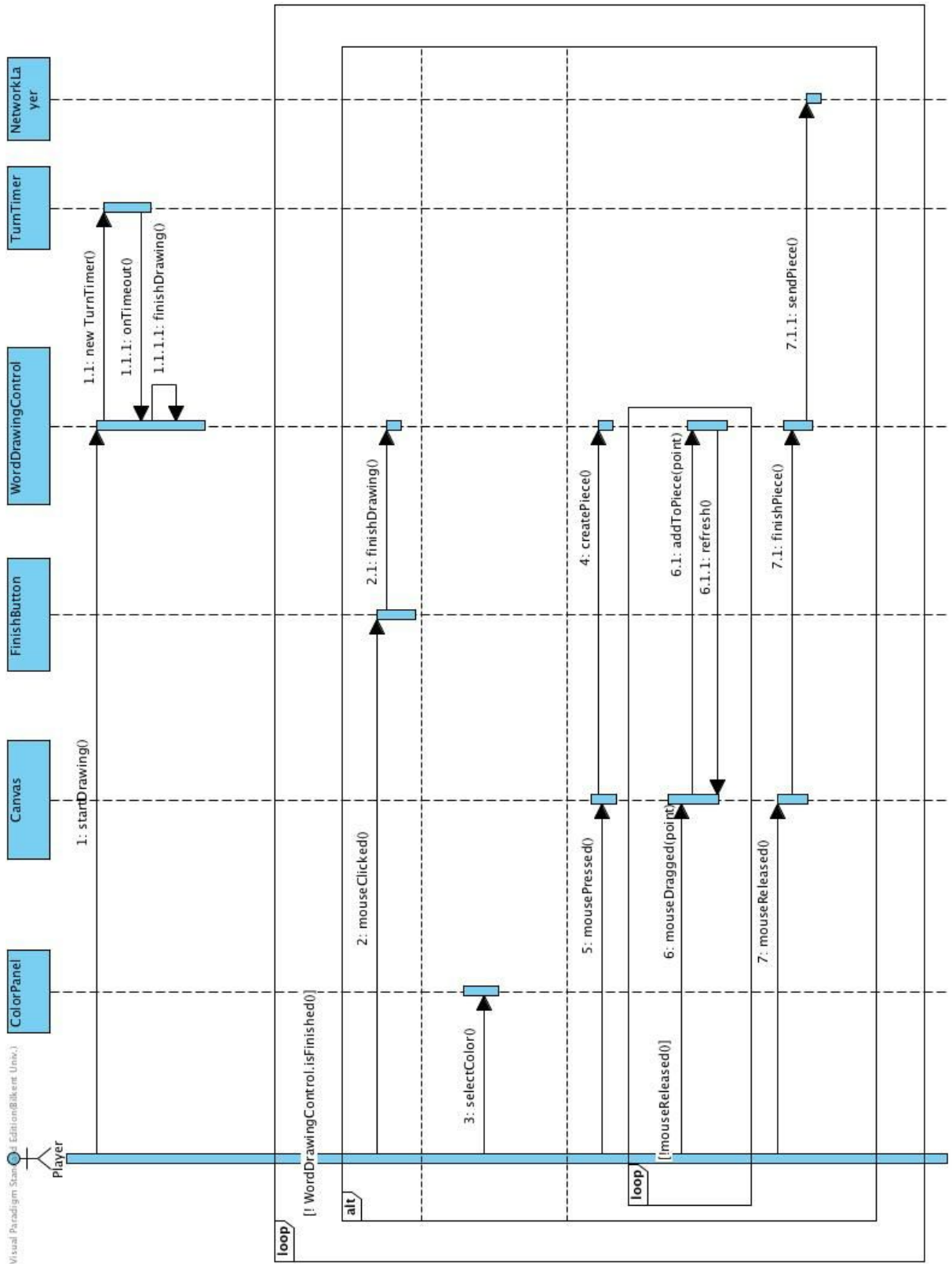


Figure 8. Sequence Diagram 4: "wordDrawing" Diagram

3.2.2.5. Scenario 5: "watchTheWord" Scenario

Scenario Name: watchTheWord

Participating actor instances: network:NetworkLayer

Flow of Events:

1. The coordinates of the drawn points come from the network to the passive player.
2. The points are drawn to the canvas as soon as they come according to their x,y coordinates and their colour.
3. If the required time, 45 seconds, didn't finish or if the active player (John, who draws) didn't click on the finish (check) button the first two step repeats.
4. If the required time, 45 seconds, finishes or if the active player (John, who draws) clicks on the finish (check) button, watchTheWord process ends and no data of points comes. Canvas stays in its last condition with the drawings.

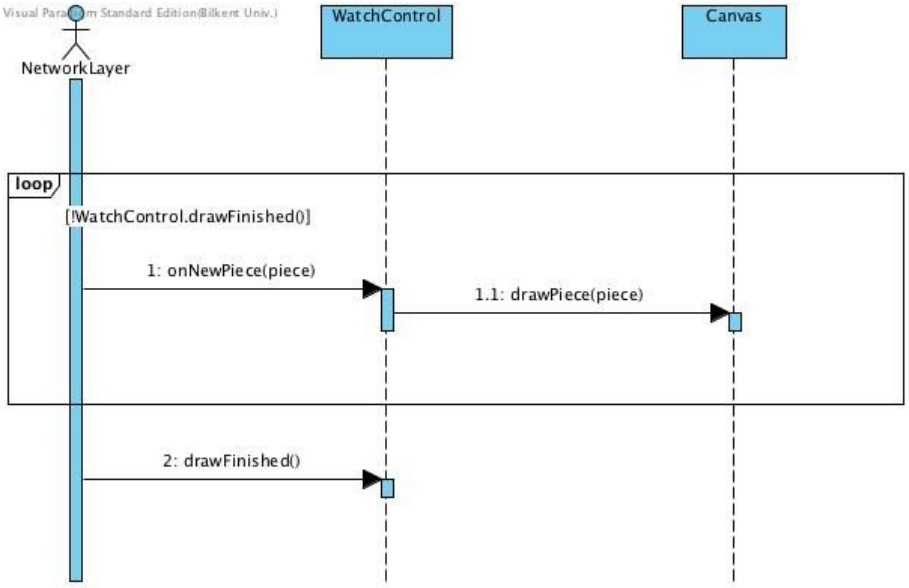


Figure 9. Sequence Diagram 5: "watchTheWord" Diagram

3.2.2.6. Scenario 6: "guessingWord" Scenario

Scenario Name: guessingWord

Participating actor instances: valerie:Player

Flow of Events:

1. System adds a box under Valerie's (the passive player's)canvas. Box consists of "_empty letter boxes for each letter that word has.
   Ex: Word: Flower -> _ _ _ _ _ _
   10 letters also given under the dashed lines. The letters have some extra letters as well as the word's letters.
2. Valerie starts to guess the word by clicking the letters with the same order as the word she guess has.
3. If she clicks on the wrong word she press Trash Bin button and clear button clear all the letters and Valerie starts the guess the word all over again!
4. If she can't find the word, Valerie clicks on the "?" button and that means she gave up from her turn. Her part ends.
5. When time is up to 45 seconds, the guessing time ends, therefore her part ends.
6. When her part ends, if the entered word correct guessing box colored to green. System gives 10 points to Valerie.

7. If it is false, first it is colored to red and 5 seconds later box colored into its original color and shows the correct word.
8. The round finishes.

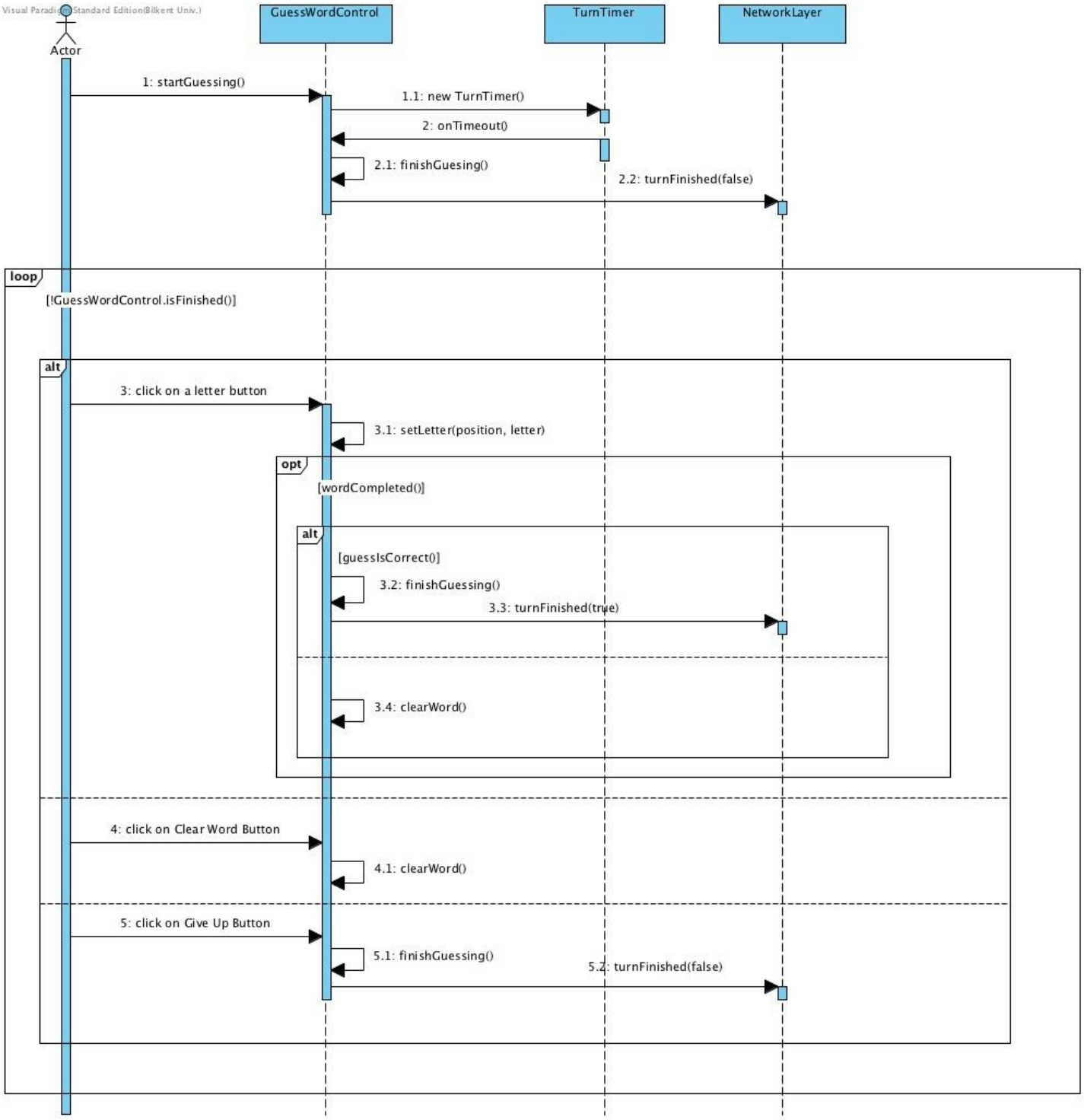


Figure 10. Sequence Diagram 6: "guessingWord" Diagram

3.2.2.7. Scenario 7: “roleExchanging” Scenario

Scenario Name: roleExchanging

Participating actor instances: valerie:Player john:Player network:Network

Flow of events:

1. At the end of each round, role of the active and passive player is changed and if passive player guesses the drawn word correctly,his/her point is updated.

2. The new canvas is sent to Valerie over the network. If she is active player, the next round she will be passive player.

3. The new canvas is sent to John over network. If he is passive player, the next round he will be the active player.

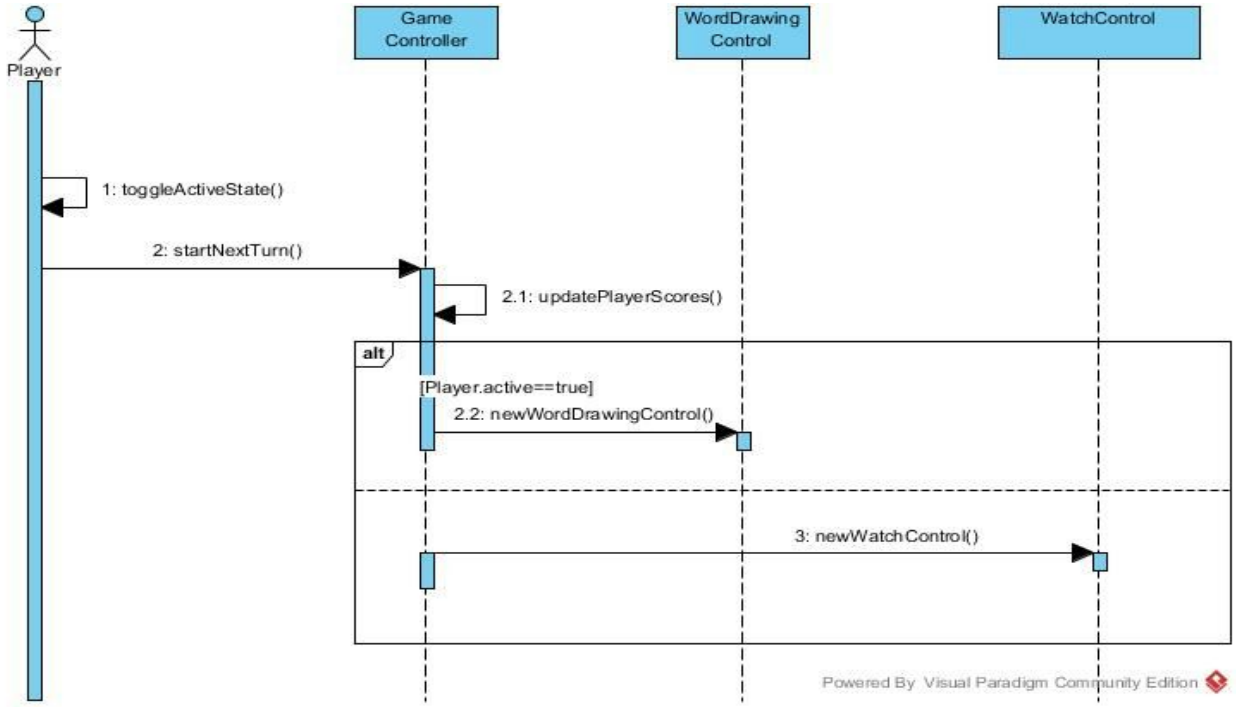


Figure 11. Sequence Diagram 7: “roleExchanging” Diagram

4. Design

4.1. Design Goals

- **Extendibility**: Project should be extendible. In the future, we can add some new features or modes. Our game should be improvable for new functions with little modifications.
- **User Friendliness:** Menus and the logic of the game should be easy to understand. Users should not use too much time with adapting the game environment.
- **Development cost:** Project development should not be expensive for developers. The only thing that costs some money is to rent a server by paying approximately $10 per month and it can be considered as cheap.
- **Readability:** Since the project is based on GUI methods, it is quite readable for programmers who have some GUI background.
- **Ease of use**: The usability level of the application should be high and this high level is provided by user friendly structure of the design. In addition to this, rules of the game is not hard to understand. The only thing that users need to do is just having fun.
- **Fault Tolerance:** Project should tolerate the system faults such as connection down. When the connection is over during the game, the game stops the rounds and then both of the users see their scores without closing the application.
- **Response time:** The quality of response time is essential for this project since the drawing process can be observed in real time by the guesser player. To improve the response time level, the projects requires a socket connection.

- **Memory:** The memory allocation space of the program is a very important point for this project's performance. To be played a lot of users, the program should not allocate too much space in their memory of their computers.
- **Minimum number of errors:** Project should include minimum number of errors. Since the structure of the projects is based on GUI implementation, the possibility of encountering with programming errors is quite low.

Trade-Offs

Functionality vs. Usability:

Since user-friendly design is essential to increase the application's usability, we need to focus on the ways how to make the usability level of application as high as possible. In that sense our game's functionality is not too complex to prevent its usability. For example, one can play the game with a help of mouse and a virtual keyboard to guess the word. No complicated special keys are needed to learn. No complex functions for users to get confused. Hence, decrease the usability of the game.

Performance vs. Memory:

Sometimes performance of a game and memory storage can be at odds. In order to have high performance for the game, its memory allocation should be low. Having 40-50 MB of space requirement would be sufficient for a high performance.

4.2. Sub-system Decomposition

Our system is divided into 4 subsystems, in 4 layers. The first three layers are contained within Draw It Java game application run on the players' computers whereas the last one is contained within the Java server application run on a web server machine When we were dealing with this process, we tried to implement the requirements of cohesion and coupling notations. Cohesion measures the dependence among classes and coupling measures the dependencies between subsystems. To make our project more efficient, we have to reach the situation which has maximum cohesion and minimum coupling as much as possible. When we were working on this, we focused on good demonstrations of classes with their proper relationships between each other and we tried to save every subsystems' features without dealing with problems which are related to the other subsystem.

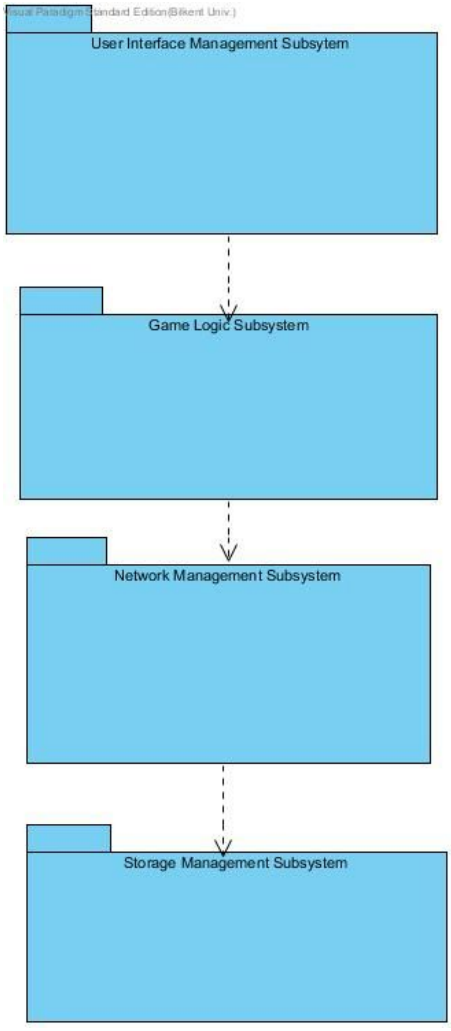


Figure 12. Subsystem Decomposition

4.2.1. User Interface Management Subsystem

This subsystem consists of classes to draw the dynamic User Interface and take input from the player. Since the project requires high qualified user-friendly design for users, User Interface Management Subsystem has a very important role in our design process. By focusing on the main game window screen, we describe our User Interface Management Subsystem with additional design classes. In order to increase the functionality level of the application, we use several important features such as colour panel, finish buttons, brush radius changing etc. To explain this subsystem, we can simply divide it into two main parts as drawing process and guessing process.

In drawing process, user is playing the game by just drawing the word and because of that his canvas object is activated by the application due to DrawBox. Every mouse movement on the canvas with left click is named as piece and these pieces are transferred to the guesser player. In addition to this, there is a colour panel which provides user to choose colours to make his drawings more understandable. Also there is a brush panel which helps user to change the radius to create more successful drawings. Both colour panel and brush panel are located on the `GameWindow`.

In watching and guessing process, guesser player watches the drawing in real time with his own canvas which is provided by WatchBox. After watching the drawing, the guessing process is started and the guesser player tries to guess the word which is located on his own canvas by using the guess box. In this case the canvas and the guess box are both provided by GuessBox. There are some additional features that are used for both two parts of the subsystem such as buttons and timer. Timer is used to limit players for their drawing and guessing process

and it is provided by GameWindow. Buttons' duties can be differentiated according to players' roles. There are three main buttons which are CheckButton, GiveUpButton and QuitButton. QuitButton is used for both drawing and guessing process to quit from game and to see the scoreboard. CheckButton is used in the drawing process to say that "I am done." and it finishes the countdown directly. GiveUpBotton means that the guesser player cannot find the word and he does not want to wait until the end of countdown. If we look at the big picture, there are three main parts which are GuessBox, DrawBox and WatchBox. All of these three parts are connected to the GameWindow. This is the demonstration of User Interface Management Subsystem of the "Draw It!".

These classes consist of the View part of Model-View-Controller architecture, which is explained in detail in the next section.

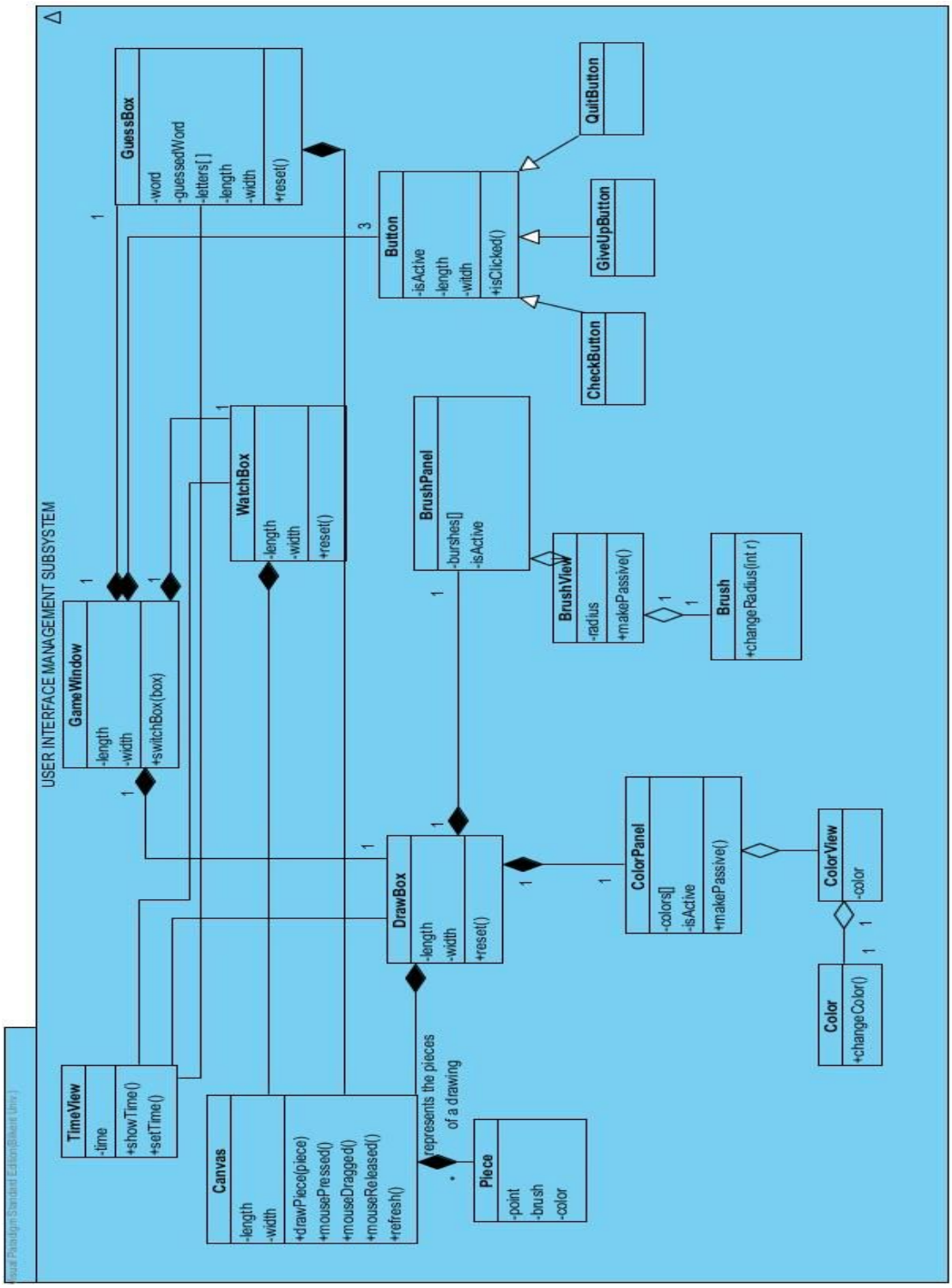


Figure 13. User Interface Management Subsystem

4.2.2. Game Logic Subsystem

This subsystem consist of controller classes that govern the gameplay. All the game logic, is contained within this subsystem. It is designed in such a way that for a different platform, User Interface Subsystem can be replaced with another implementation and the Game Logic Subsystem would still be able to provide the gameplay through its interface.

This subsystem contains the main class responsible from the program, `GameControl`. It also contains controllers with more particular responsibilities, such as `WatchController`, `GuessWordController` and `WordDrawingController`. These classes control certain stages of the gameplay.

In WordDrawingController, the drawing process is managed properly. In WatchController, the watching process of the guesser player is managed according to rules of the game. In the GuessWordController, the guessing process is managed with rules as well. The common point of these three classes is using time related classes which are TimeDelegate (interface) and TurnTimer. In addition to these, there is a Player class which is connected to the GameController class with players' Ip addresses, scores and user names.

In order to communicate with the other player and keep the game going, this subsystem is coupled with `Network Management Subsystem`. As described in the several sequence diagrams in the previous sections, in each gameplay scenario the player takes an action to advance in the gameplay, so `Network Management Subsystem` is notified by their actions.

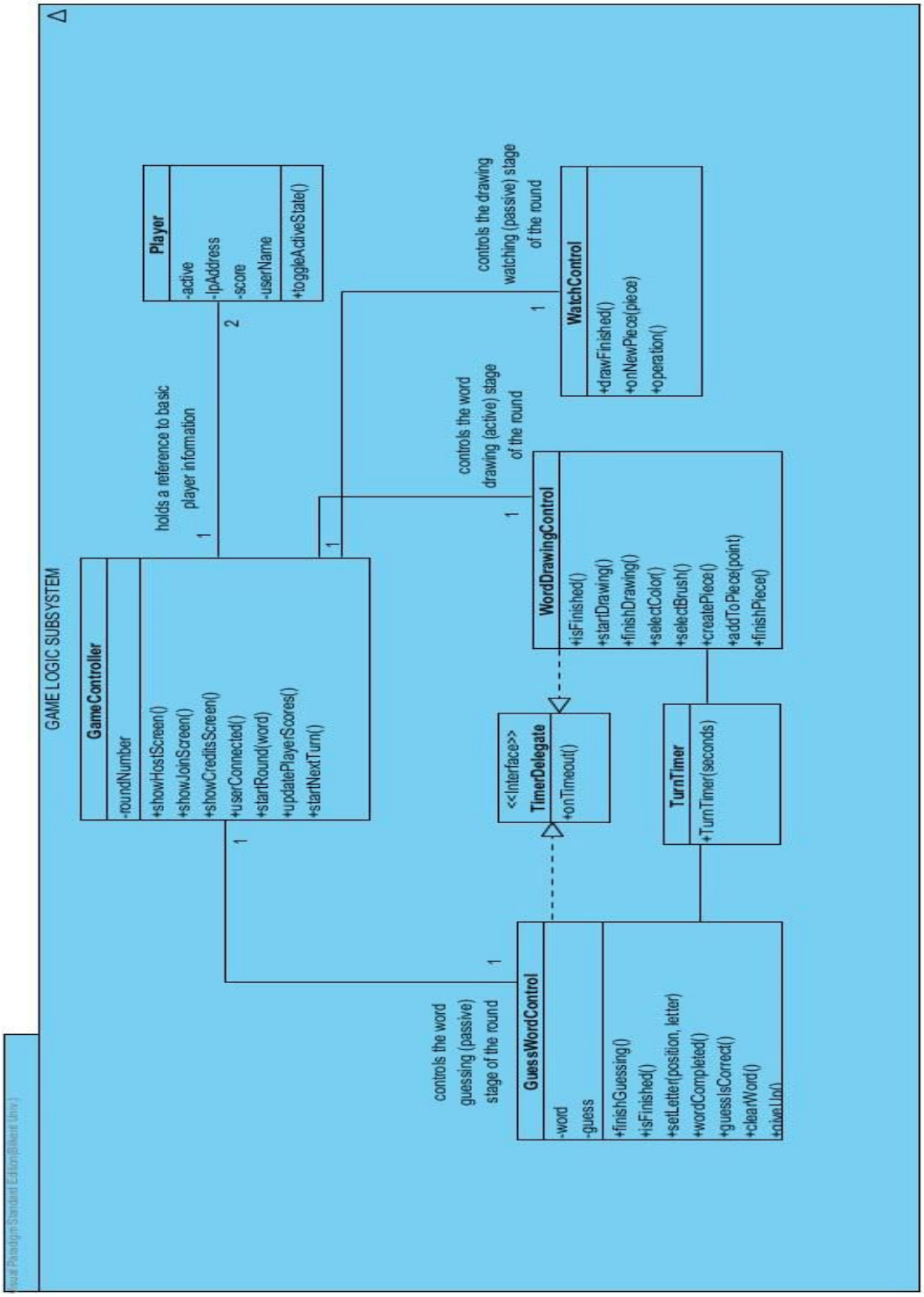


Figure 14. Game Logic Subsystem

4.2.3. Network Management Subsystem

Network Management Subsystem is responsible for the all networking tasks in the game. These tasks include managing communication between computers of players, retrieving and sending latest user information, high scores and retrieving a word.

Each game of Draw It is played by two players using different computers. Since players are supposed to play this game on their individual computers, there are two game instances needed and these instances need to be connected. This subsystem provides this feature in its P2PManager class, which handles a Peer-to-Peer connection between identical game instances. This is explained further in the next section.

This subsystem also manages the relationship between the game instances and the server, whose main purpose is storing and retrieving player account information and a word list. Game client can send a few different requests to the server, such as login, sign up, lookup a player, get a new word. Server handles these individual requests using different classes such as `AccountHandler` and `WordHandler`, according to the kind of the request.

When the IP address of the other player is known, `otherPlayer` in `GameSession` is updated. As a result, the game is ready to begin, P2PManager can use this information.

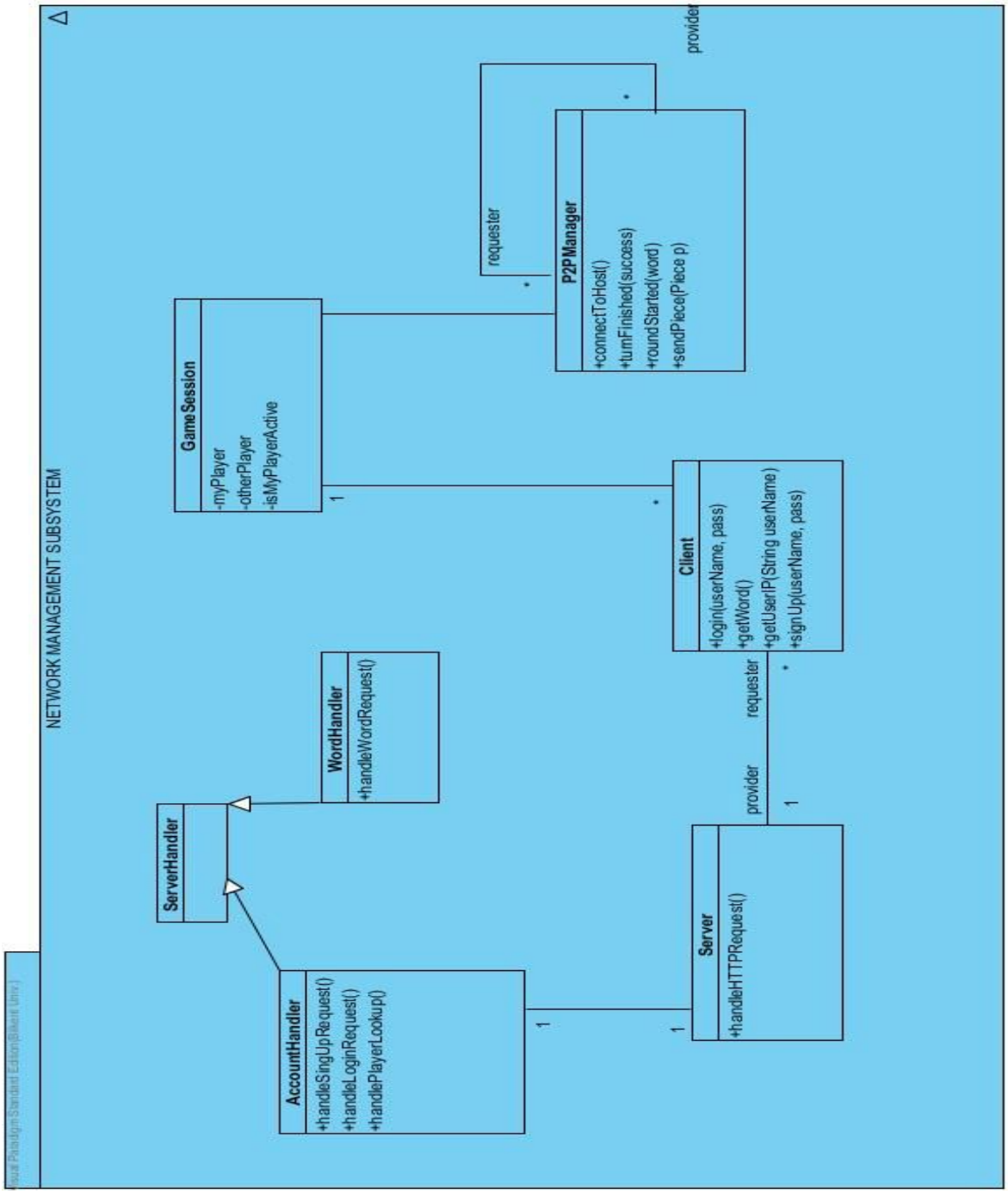


Figure 15. Network Management Subsystem

4.2.4. Storage Management Subsystem

This is a fairly simple subsystem that lies on the server. Its main duty is to provide persistent data storage for the Network Management Subsystem. As Network Management Subsystem receives a request on the server side, it needs to retrieve the relevant data and send it as the response. This subsystem is the middleware between the server part of Network Management Subsystem the database server software. It simply retrieves data from the database using JDBC and passes it to its caller, such as the Handlers in Network Management Subsystem.

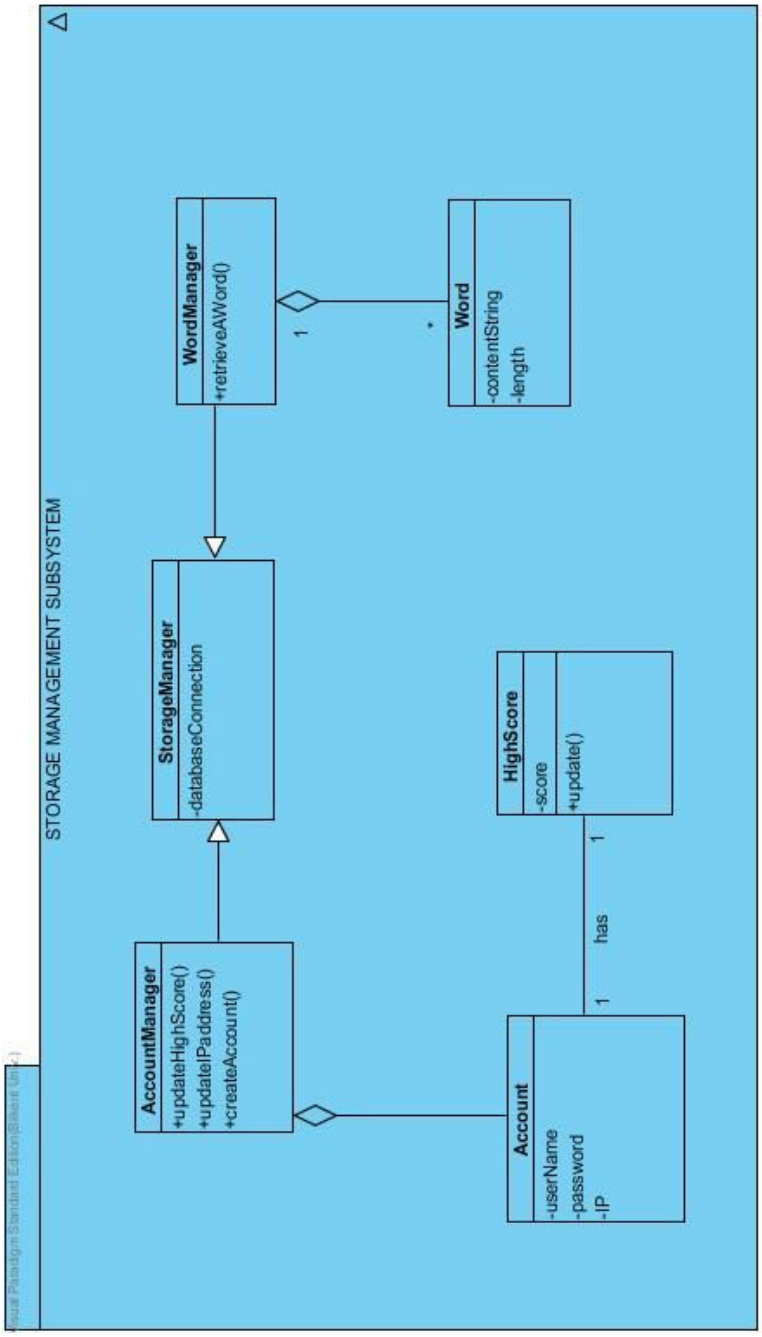


Figure 16. Storage Management Subsystem

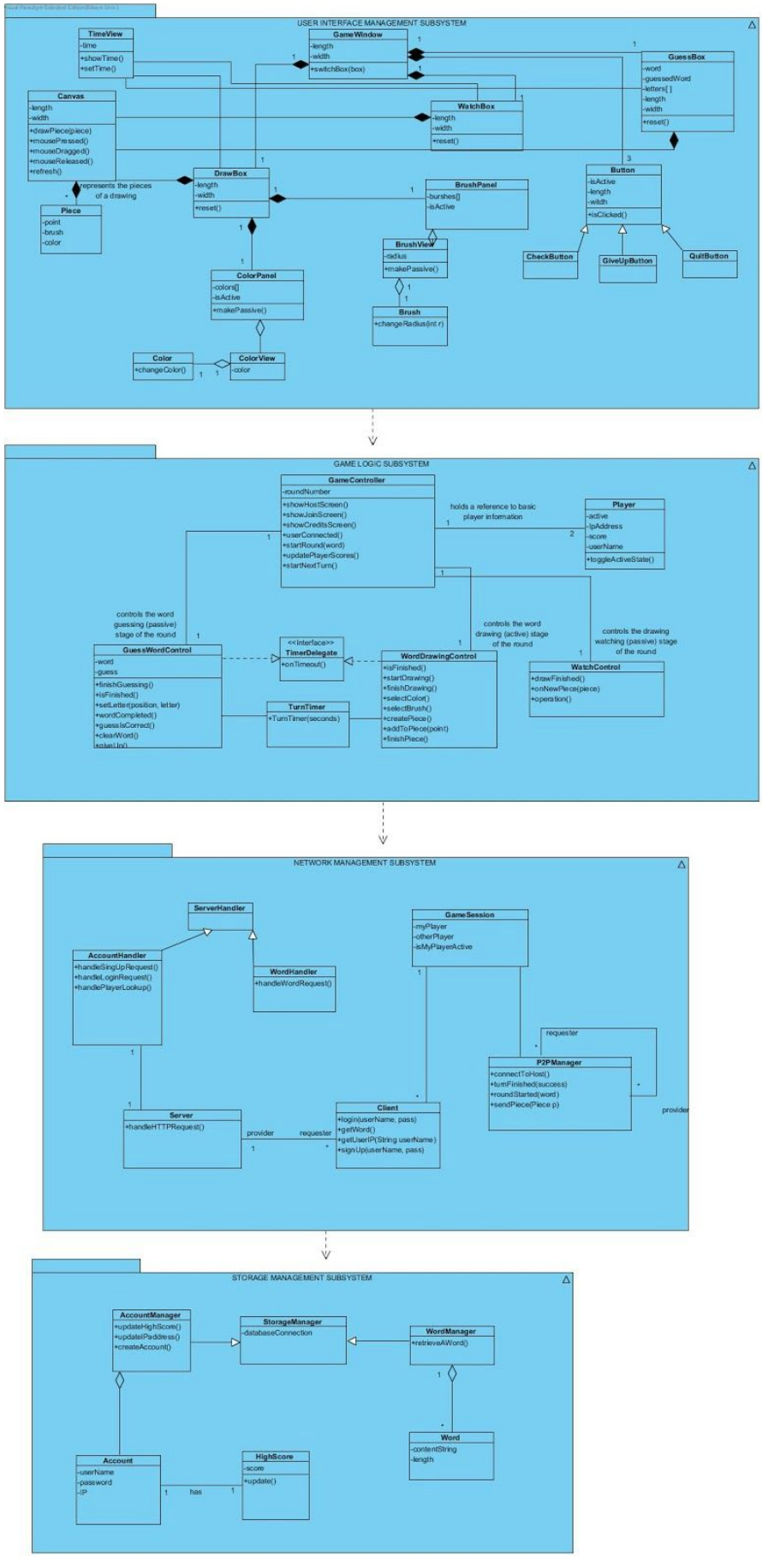


Figure 17. Overall Diagram Relations

As it is shown above, each of these four subsystems have consecutive relationships among each other. Game Logic subsystem is dependant to User Interface Management Subsystem. In addition to this, Storage Management subsystem depends on the Network Management subsystem which is dependant to the Game Logic subsystem.

4.3. Architectural Patterns

Our system is essentially a two-player graphical game on a network with a complementary server for account management. Hence our system uses a variety of architectural patterns, each of them to accomplish a different goal. Namely, the system uses Model-View-Controller architecture for managing the user interface in each of the game instances. The system also uses Peer-to-Peer architecture to set up and sustain the communication between two game instances. Finally the system uses a simple client-server architecture to simplify the game setup between two computers on the internet, keep high scores and retrieve a word from the most recent list of words.

4.3.1. Model-View-Controller

We use the Model-View-Controller pattern to organize the code in the game application. However, we use a different and simpler definition of Model-View-Controller pattern: “Ideally, a model object has no explicit connection to the user interface. Controller objects tie the Model to the View”.

(https://developer.apple.com/library/ios/documentation/General/Conceptual/CocoaEncyclopedia/Model-View-Controller/Model-View-Controller.html)

Our models are simpler classes which just represent some data, mainly because our models are either quite static (e.g. Player) or too dynamic (`Piece`s getting created all the time, as one of the players keeps drawing) and the data for creating new models often come from the network or the canvas, which naturally go through a Controller first. In this particular case, applying the Observer pattern would make the code more complicated and error-prone than it needs to be.

In our system, Game Logic Subsystem handles the Controller part of the MVC pattern. User Interface Subsystem handles the View part of the MVC pattern. Classes that represent data, such as Player or Piece handle the Model part of the MVC pattern.

4.3.2. Peer-to-Peer

In order to achieve our response time goal, the connection between the two game instances, which is briefly explained in Network Management Subsystem section, will be using Peer-to-Peer architecture. This way, the two game instances will talk directly to each other during the game. The messages to be sent through the connection will include notifying the other side about what the player has just drawn and what word a player guess for that drawing. This communication will be done over a TCP socket connection and data to be sent over will be Pieces and Words.

4.3.3. Client-Server

This system maintains the communication between the game application and the account management server by sending HTTP(S) requests. Every time a player launches the game, their current IP address detected from the network is sent to the server by sending a HTTP(S) request. Hence, every player is mapped with their most recent IP address. This way, when a player wants to join a game hosted by another player over the internet, all they need to do is type in the player's name (username). Then, by sending a simple HTTP(S) request, the game application can match the username with their most recent IP address. Having this server makes it easier for players to set up a new game. The players can simply type in a player name to host or join a game, instead of entering long IPv4 or even IPv6 addresses.

Another facility provided by the client-server architecture is retrieving a word from the same server. This is a fairly simple task, in which the client sends another kind of HTTP(S) request to our server, and the server retrieves a word from its word database and sends it back as the response of the request.

4.4. Hardware-Software Mapping

Our server machine is going to run a GNU/Linux operating system such as Ubuntu, and it will be running our server application listening on port 80/443. PostgreSQL Database Server will be running on the same machine to help the application server

Our game application will be Java program that runs on any major desktop operating system. The application, which is the client in this case, will communicate with the server over

the HTTP(S) protocol. To play the game with another player, the game application will talk to another identical game application over the network.

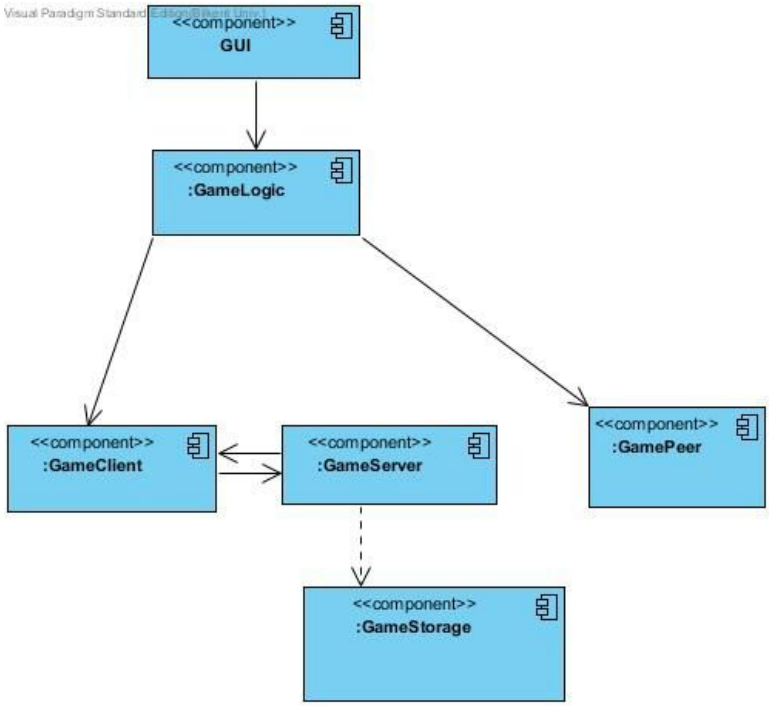


Figure 18. Component Diagram

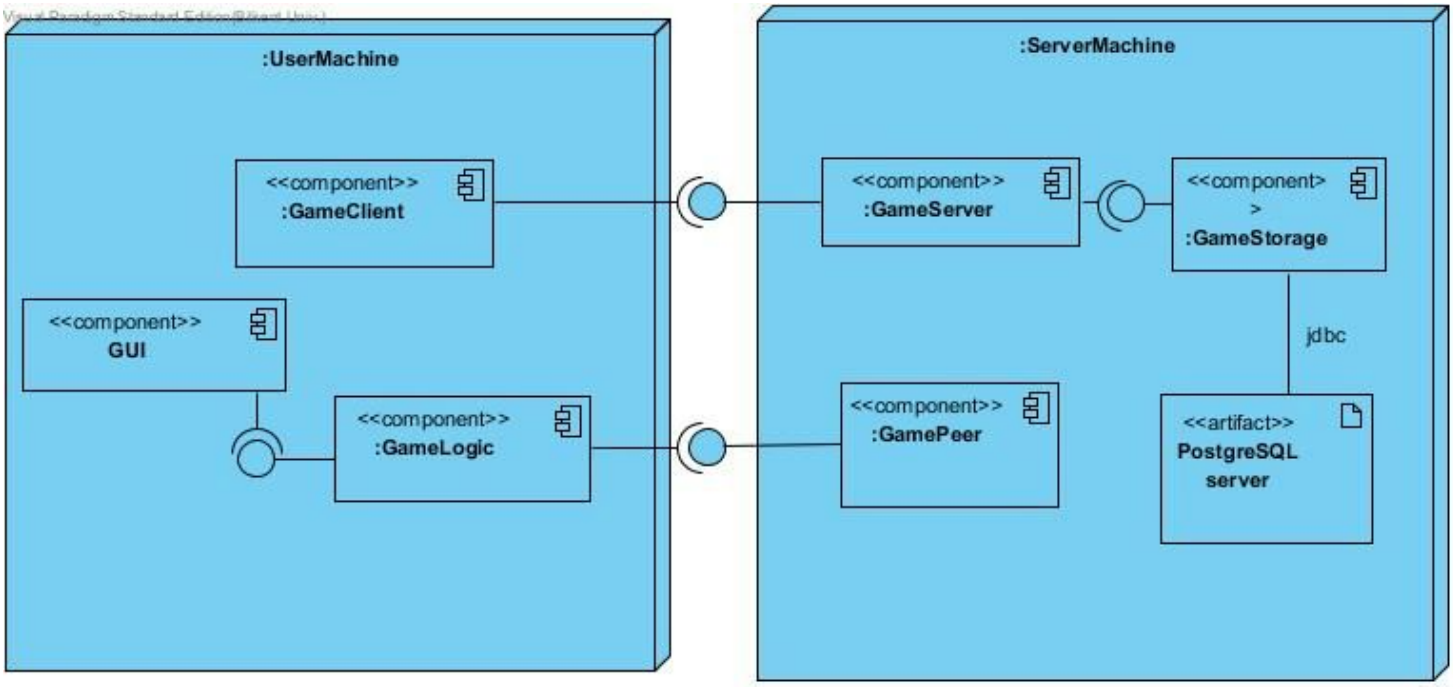


Figure 19. Deployment Diagram

4.5. Addressing Key Concerns

In this part, we describe the key points which are needed to ensure that subsystem decomposition can account for any constrains and addresses all the nonfunctional requirements during the implementation period. There are five main key concerns which are persistent data management, access control and security, global software control, boundary conditions and minimal server design.

4.5.1 Persistent Data Management

There are three persistent data objects in this system which are account (player), high score and words. Although our persistent data is not so large and complicated, we are going to use a relational database management system, such as PostgreSQL. In the year of 2015, using a powerful RDBMS along with JDBC offers a better overall solution, even on tiny datasets, than writing to and reading from a plain text file. A RDBMS ensures data integrity, and writing code that uses JDBC to talk to the database system is actually easier than writing code for an error-prone plain text file reader/writer. Each player decide their own usernames when they start to play the first game. They use their passwords to log onto their accounts. The second data object is high score. When users play the game, the scores of each player is stored and the game displays the high score to the players in descending order. Words are also stored in the database and retrieved by the game clients. This way, we can update the word list in the database and clients can use the newly-added words.

4.5.2 Access Control and Security

Since each player can login the game only with their username and password, their passwords should be hashed, salted, stored and protected by the server. Each player has their own username and password. In addition to this, it is possible to play the game with your friend's username and password. Only player account and high score are saved within the game. So the game does not save drawings or something else. For every turn, system clears the drawing canvas and the answers for the drawings.

Game playing is executed with player over an individual socket communication channel and this makes it hard to abuse the system, as long as Man-in-the-middle attacks are prevented by using secure communication channels. The game is available for everyone who downloads the game to the computer. Except from the game package, nothing else is protected on the computer.

4.5.3 Global Software Control

In this system, event driven control flow is decided to use because this system is promoted by object oriented software. And the flow of the system is under control of the events. With the Model-View-Control architecture of the system, the sequence of the program depends on events. These events are done by mouse clicks in our system. Each mouse click updates the views.

Also user interface subsystem of this game takes inputs from the players and transfers them to the controller. Controller determines what kind of event it is and according to this information, it makes the necessary changes in the views. Since there are different objects that

make decisions on the events by evaluating the mouse clicks, it is possible to state that the control is a part of design that is distribution of dynamic behaviors.

4.5.4 Boundary Conditions

The boundary conditions is related with the starting and ending conditions of the system.

- **Initialization**

  Initialization of the system is beginning with the opening of the jar file. There is no need to set up anything. Additionally, this game can be run on the environment which java runtime is installed on the computer. The user should click double to the jar file of the game. This events starts the game and thus this enables players to join the game.

- **Termination**

  In order to leave the game, the player should click on the 'X' button on the game screen. This button ends the termination of the game. Also, the highscore section in the database is updated before the game termination.

- **Failure**

  When the connection between the players is collapsed, system tries to reconnect until it connects successfully and recovers the game. However, they will continue to play with a fresh round. When the connection between client and server fails, system also tries to reconnect. Another exception throws is that when a user enters wrong username and password. Game does not allow user to play the game.

4.5.5. Minimal Server Design and Code Reusability

Given the limited amount of time to implement the project, we are trying our best to minimize the time we will spend on developing the complementary server application. Hence, we designed our the server application to be as small as possible. We are going to share the model classes such as Account and Word between the game client application and server application. We are going to use a modern web framework for Java which allows us to get rid of unnecessary code and focus on our core tasks, which are basically retrieving from and saving to the database, after an authentication phase. Such a web framework is Play! Framework. For more information please visit https://playframework.com/.

5. Object Design

In this part, we will be referring to 3 different sub-titles: pattern applications, class interfaces and specifying contracts. Pattern applications part includes the design patterns that is used in the application. In the class interfaces part, the classes will be described in a more detailed manner. In the last part, the contracts will be defined for classes.

5.1. Pattern Applications

As design patterns helping us to keep our model simple, we decided to use 3 design patterns throughout our application: Façade, Command and Observer Patterns. By using these patterns, we aimed to increase our application's extensibility and support an ease for future modifications.

5.1.1. Façade Pattern

Façade Pattern is one of the structural patterns. Its aim is to create an interface class which unifies the set of interface objects in the system. As this unified interface makes the details more abstract, it gives an easy use for the subsystem. The advantage of using Façade is its efficiency. This pattern will be used in network and database parts of the implementation. Façade class knows which subsystem classes are responsible for a given request and it transfers the incoming request from client to the responsible subsystem object. With the usage of this pattern, the subsystem classes are implement the required functionality and handle back the request to the Façade class, that is why they don't have a direct connection with the other interface classes. Below we provide the illustration that we learned in class for the Façade pattern:

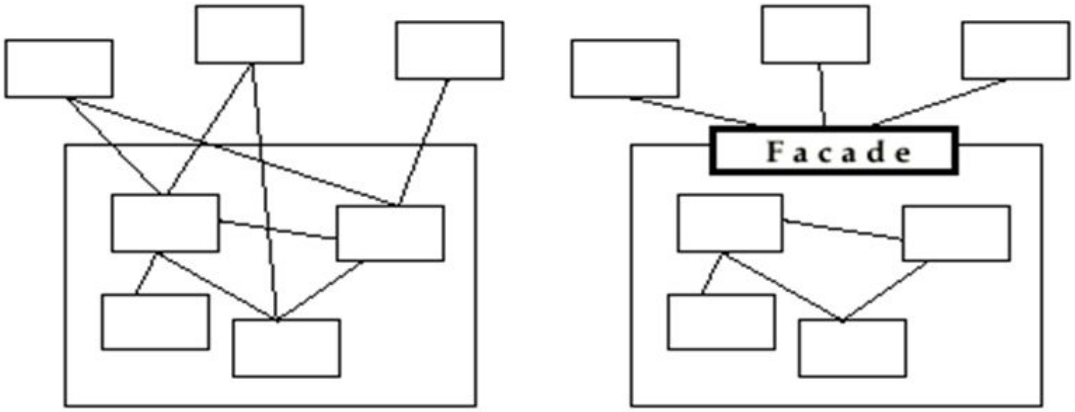


Figure 20. Façade Sample Diagram

In order to show that our Façade Pattern decision is suitable for our application, we decided to give both sample illustration of the pattern and our UML Class Diagram for network parts and compare them.

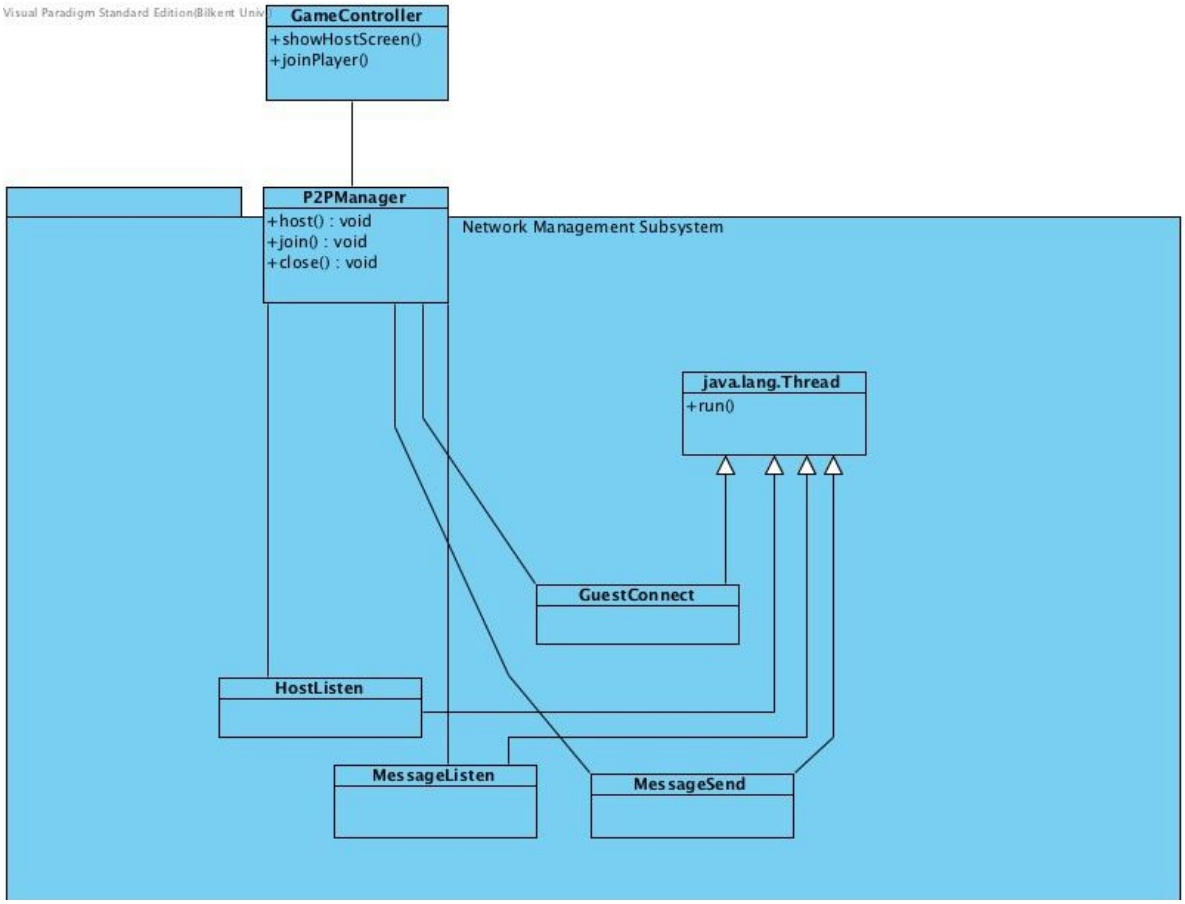


Figure 21. Façade Diagram

The most important purpose of Network Management Subsystem is to maintain a TCP socket connection between two identical game instances. P2PManager is the class that handles the socket connection. Instead of directly doing all the tasks to start to socket connection and keep it going, it leverages four different classes. These classes do individual tasks such as listening for a new socket connection, connecting to the host, listening for new messages from the peer and finally, sending a message to peer. All of theses tasks are obligatory to keep the socket connection but our GameController does not know about these classes. It simply tells the P2PManager to host a new game or join an existing host.

Any class out of Network Management Subsystem never reaches to those classes directly. Hence, this usage in our program is suitable for Façade pattern.

5.1.2. Command Pattern

Command Pattern is a behavioral pattern. Command Pattern's main idea is that, a request is wrapped under a specified object and this passes to the invoker object. Invoker object decides for the appropriate object that can handle the requested command. Later, invoker object passes back the command the corresponding object that execution of the command is made.

This pattern is suitable for our application because it allows our program to organize the highly dynamic parts of our program better. In Draw It, Pieces are the or groups of consecutive points drawn by users' mouse movements on the Canvas. As one player draws Pieces, they are sent through the network via P2PManager and drawn onto the other player's initially empty canvas. Pieces are basically "draw" commands, created by one of the sides and invoked by another side. This makes command pattern indeed suitable.

Below we provide the UML class diagram that we learned for Command Pattern:

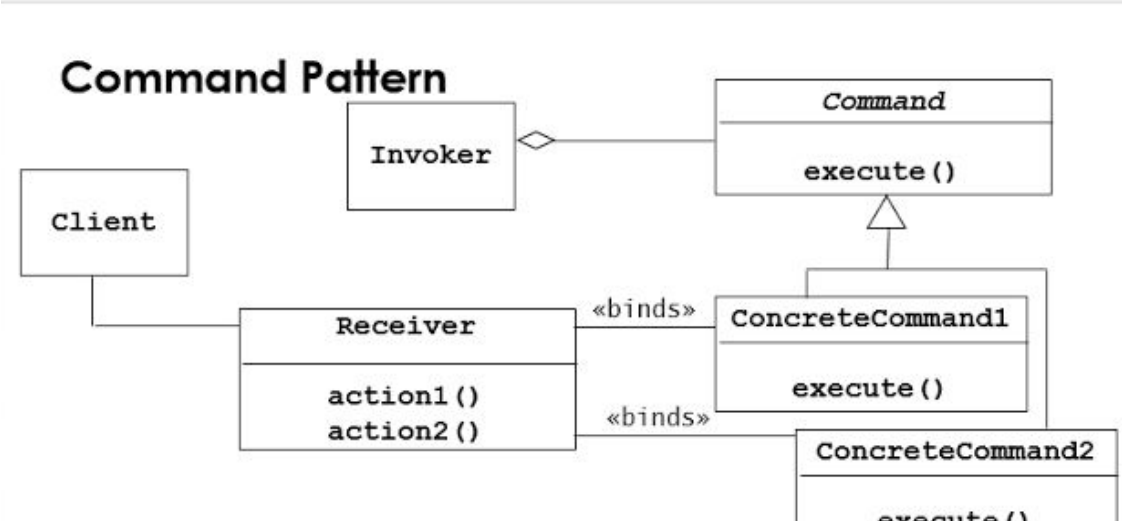


Figure 22. Command Sample Program

In this diagram, Client made a request to the reciever which is binding with a specific command (concreteCommand) that client made. Command abstract class inherits different types of concreteCommand classes. The invoker knows only the Command interface. the request is seen by invoker class with the help of Command interface and invoker class executes the desired client's command/requests. We used a similar idea when using Command Pattern in our application. Below you can see the UML presentation of the Command Pattern we used in our application and its explanation:

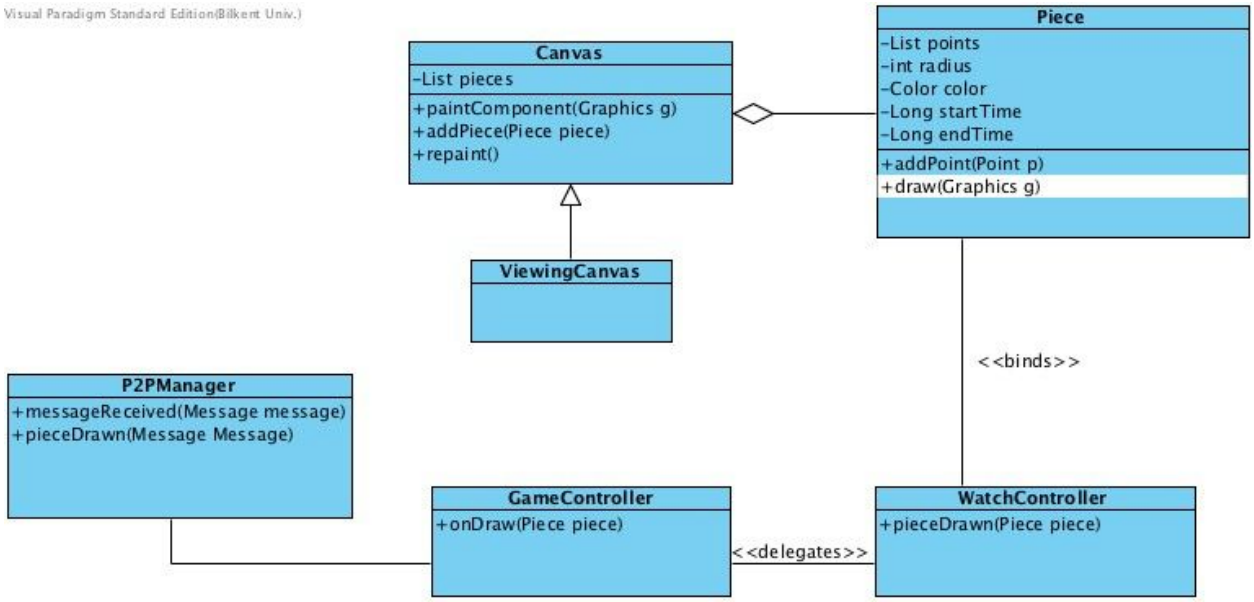


Figure 23. Comman Pattern

Here in the diagram, Piece is our command. Method **draw** is our execution method. In this setup, P2PManager is our client, which constructs a Piece object from a Message (explained later). GameController receives the piece from P2PManager via its onDraw method and it delegates this action to WatchController. WatchController passes this Piece to Canvas, which then repaints itself and *invokes* the **draw** method in the Piece.

5.1.3. Observer Pattern

Observer Pattern is another behavioral pattern that we used in our "Draw It!" game application. This pattern is basically used for handling state changes. In the observer pattern, there is a subject and observer. Subject part encapsulates the core parts, whereas observer part contains the user interface and views. Therefore, the main idea of this pattern is decoupling the abstraction from its views and handling the modification at its best. The Observer Pattern can be considered as the "View" of the MVC architectural style as well.

As this pattern maintains consistency within the views and state changes, we found it suitable in order to use in our canvas changes and player status changes. Another advantage of using this pattern is that as new pieces come to the player's computer canvas view should always need to be updated on real-time, and observer pattern provides the extensibility to adding new views without the burden of re-compiling.

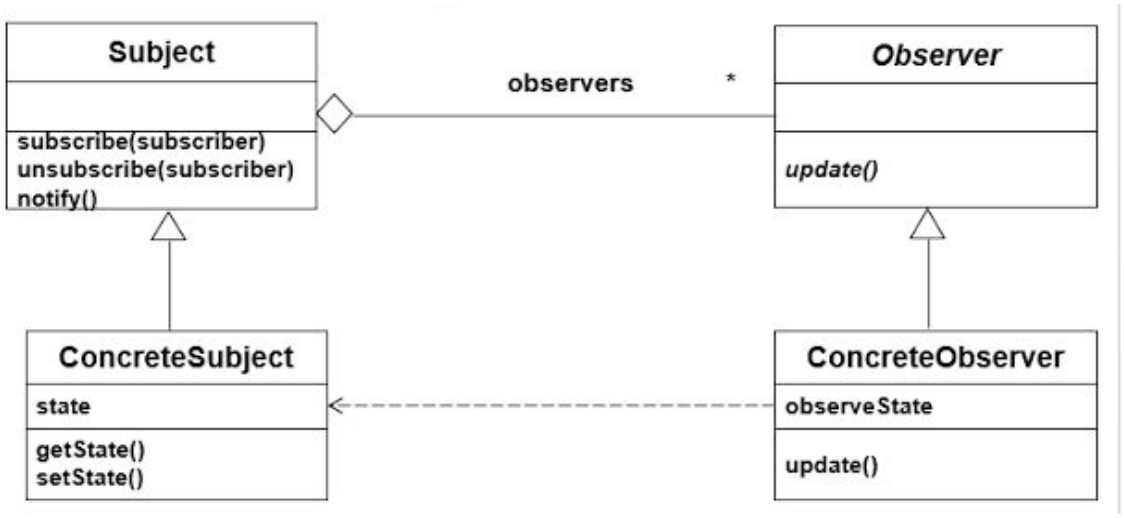


Figure 24. Observer Sample Diagram

In the above diagram, the subject which is also called publisher, represents an entity object. Observer, also named as subscriber connect with subject by using the subscribe method. Observer may have multiple views for an object's state. The state is always contained by the Concrete subject class which is an entity object. The state of the entity object can be seen and modified by views (concrete observer classes) by using getState and setState methods.

Our applied observer pattern UML class diagram can be seen in below following by its explanation.

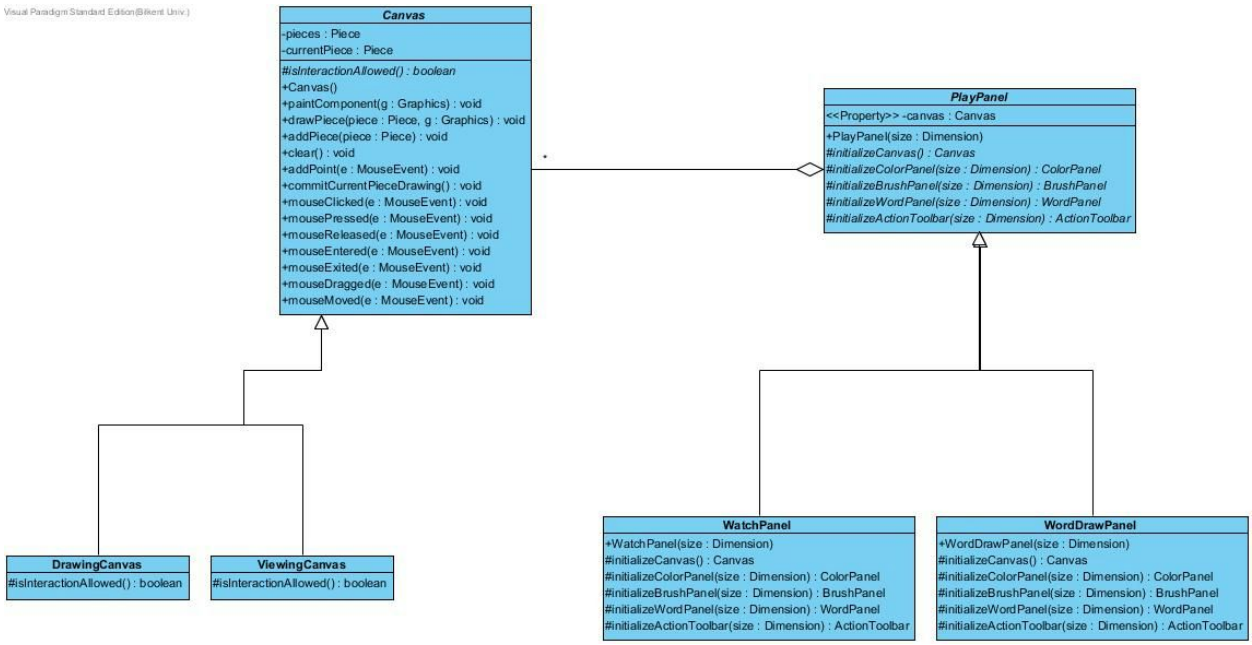


Figure 25. Observer Diagram

In our observer design pattern, we have a subject class which is named as Canvas, a main observer class which is named as PlayPanel, two sub observer classes and two observable classes. With any change on the canvas, both PlayPanel and sub classes of Canvas is affected directly without sending numbers of messages to each of these related classes. For example, if a player draws something on the canvas, all related classes like WatchPanel and WordDrawPanel get this drawing message from the Canvas class. By getting this message, both the active player's and the passive player's canvases are changed with this drawing and this process is done with a very efficient design pattern which decrease the level of coupling in the implementation.

Therefore, using observer pattern is suitable and enables us to create a more comprehensible implementation.

5.2. Class Interfaces

5.1.1. CONTROLLER PACKAGE:

Controller Package corresponds to our Game Logic Subsystem that contains our controller objects. We created this package in order to fulfill the design for MVC design pattern's Controller part. This package has one main GameStateController classes and the other control classes are inherited from it such as WordDrasController, WatchController and Status Controller. Each Controller class are mainly responsible for the interactions of their corresponding ui interfaces. They all have different duties on controlling the objects according to their specified names. The below figure represents a more detailed class diagram for the controller package. A more detailed description of the classes can be found below the figure.

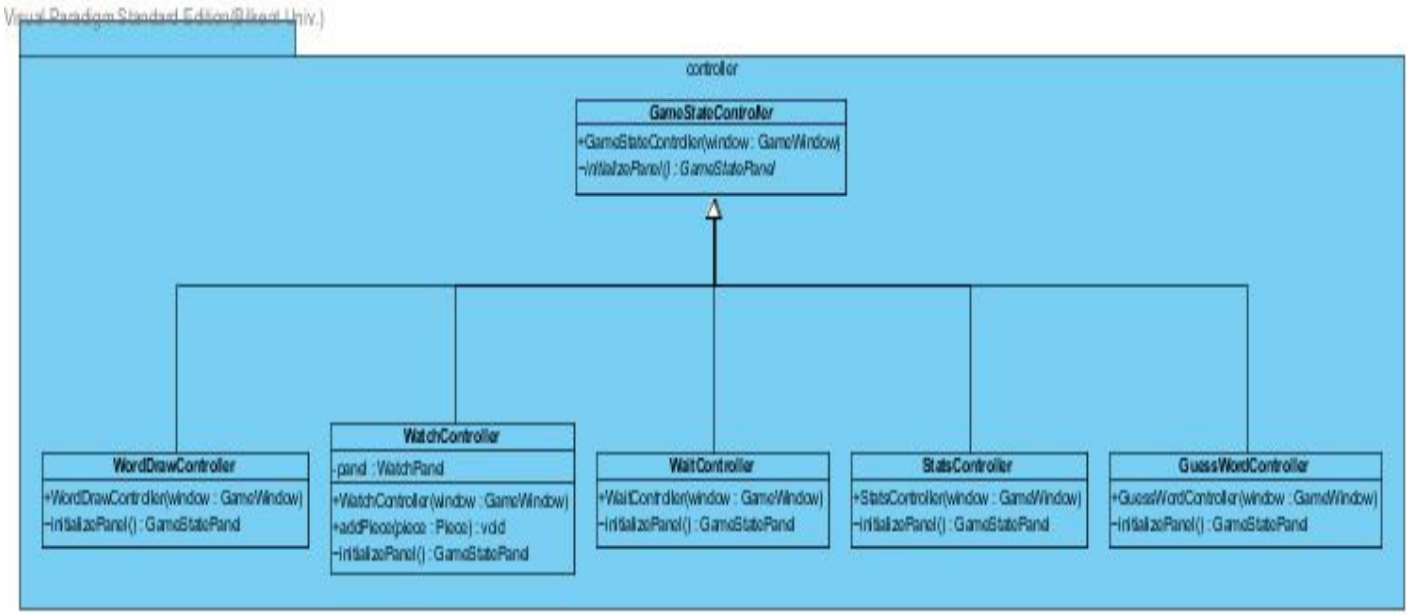


Figure 26. Controller Package

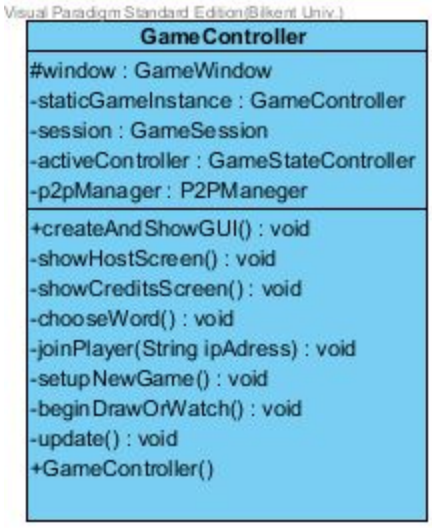
- **ChooseWordController:**

Constructor:

- **public ChooseWordController (GameWindow window):** Within the constructor it overrides the GameStatePanel initializePanel() method. Within this method it keeps the action listener for word buttons and returns the panel.

This class controls the word choosing screen for the active player in the game. By creating an object of this class, we can reach a big panel with 3 different words on it. These three words are got from the server connection.

- **GameController:**



Attributes:

- **protected GameWindow window:** The main window of the application that contains other panels within itself according to the game status.
- **private GameController: staticGameInstance:** It is used by stati mainWindow() method. It is an instance to be accessed from anywhere within the code.
- **private GameSession session:** This is the game session for the application. A session is a class that keep all the status of the game from the beginning of the application.
- **private GameStateController: activeController:** This part controls the game state, whether the game is in the word chosen part or drawing and watching part. There are 6 different states of the game and this instance controls them.
- **private P2PManager p2pManager:** This is the variable which we use to make our peer to peer connection for the game.

Constructor:

- **public GameController():** It returns the staticGameInstance which can be accessed from anywhere in the code.

Operations:

- **public void createAndShowGUI():** Creates the GUI instances within itself including the main window which has also 3 buttons (joinGame,) and title. According to the menu event listener it has within itself, when one of the buttons is clicked, it opens the related panel.

- **private void showHostScreen():** It changes the current panel to hostPanel.
- **private void showCreditsScreen():** It changes the current panel to CreditsPanel.
- **private void chooseWord():** It set the session's current round's status to chooseWord
- **private void joinPlayer(String ipAdress):** This method is for setting the game hoster as a player. It takes the ip adress of hosting player as parameter.
- **private void setupNewGame():** This method creates a new session by taking the two players (host and joining) and adds p2pManager as observer.
- **private void beginDrawOrWatch():** This method looks whether the player is active or not and according to the player type it sets the status as Draw or Watch.
- **private void update():** This method is used in the bgining of a new state and replace the active controller with changing state's controller.

This class creates and controls the main frame of the game. This class shows a menu to users firstly and according to option that users choose, the next step appears. All initial steps of the game is started by the GameController class. The game steps which are called as draw, watch, guess, wait, stats are sorted in this part and by sorting them, all of these sessions are appeared on the players' screen as a loop which continues until one of the players wants to logout.

- **GameStateController:**

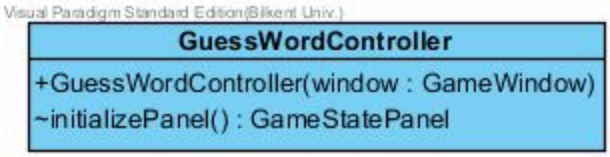
Constructor:

public GameStateController(): This constructor method is used to create a object which controls the game states.

Operations:

abstract initalizePanel(): This abstract method is used for initializing the game state panel.

- **GuessWordController:**



Constructor:

public GuessWordController(): This constructor method is used to create a object which controls the guesses.

Operations:

abstract initializePanel(): This method is used for initializing the game state panel by extending the GameStateController class.

This class controls the word guessing window for passive player in the game. This class is also extends the GameStateController class.

- **StatsController:**

Constructor:

public StatsController(): This constructor method is used to create a object which controls the stats of users.

Operations:

abstract initalizePanel(): This method is used for initializing the game state panel by extending the GameStateController class.

- **WaitController:**

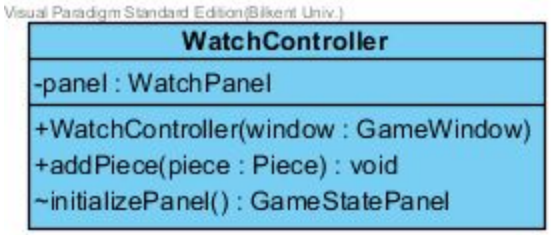
Constructor:

public WaitController(): This constructor method is used to create a object which controls the waiting process of passive users.

Operations:

abstract initalizePanel(): This method is used for initializing the game state panel by extending the GameStateController class.

- **WatchController:**



Constructor:

public WatchController(): This constructor method is used to create a object which controls the watching process of passive users.

Operations:

public void addPiece(piece:Piece): This method adds the piece, which is drawn by the active player, on the main panel.

abstract initalizePanel(): This method is used for initializing the game state panel by extending the GameStateController class.

Attributes:

private WatchPanel panel: This attribute is used for watching process and this panel is used by the passive player during the drawing process of the active player.

- **WordDrawController:**

Constructor:

public WordDrawController(): This constructor method is used to create a object which controls the drawing process of active users.

Operations:

abstract initalizePanel(): This method is used for initializing the game state panel by extending the GameStateController class.

5.2.2. MODEL PACKAGE:

Model Package mainly correspond to the model part of our MVC design pattern. This part keeps the entity objects within itself. It has an association between the UI package via its Piece class. In this package, we handle GameSession, Piece and Player objects as well as two different types of enumarations. The Figure 27. shows the class diagram for our model package.

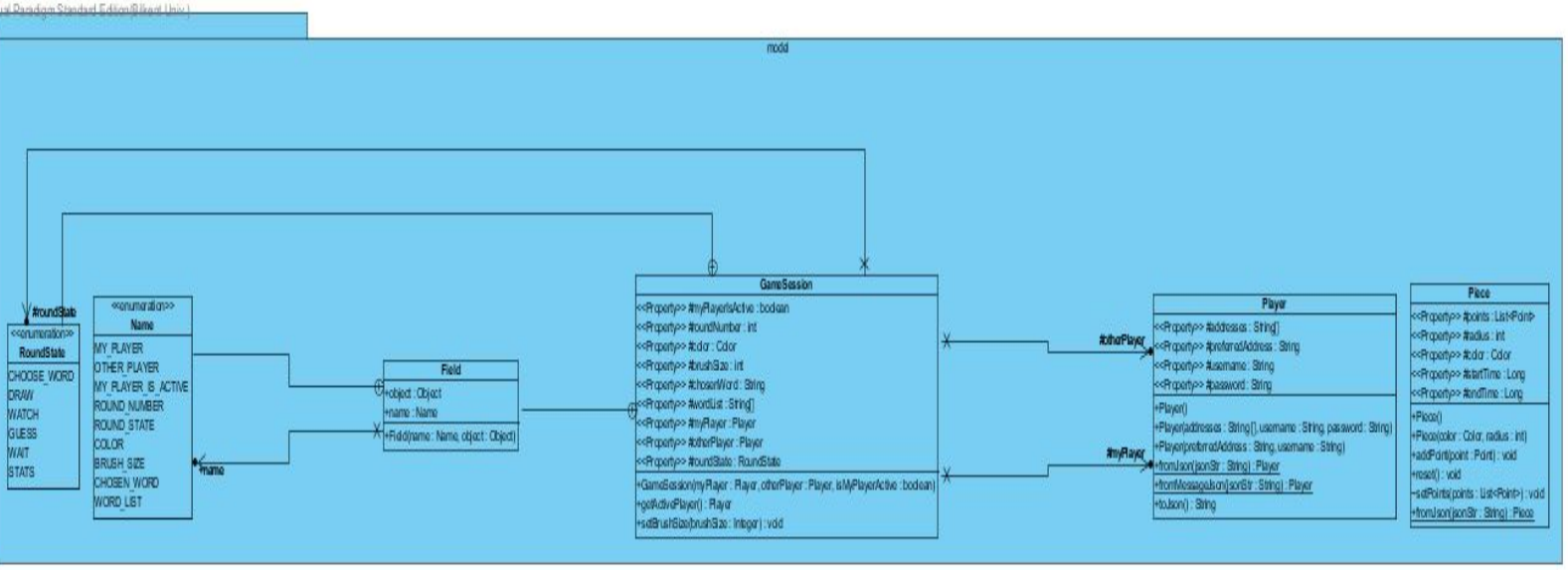


Figure 27: Model Package

- **GameSession:**

Constructor:

public GameSession(): This constructor method is used to create game session objects for each gameplay.

Operations:

public Player getActivePlayer(): This method returns the situation of a user about being active one or passive one. According to returned value from this method, the gameplay sessions are determined in the next steps.

Attributes:

protected Player myPlayer: This attribute is used to symbolize the the player is the one who is playing with this device.

protected Player myPlayer: This attribute is used to symbolize the the player is the one who is playing with the other device.

protected boolean myPlayerIsActive: This attribute is used to determine whether the player who is playing with this device is active or passive player for the current round.

protected int roundNumber: This attribute is used to determine the round number of the game.

protected RoundState roundState: This attribute is used to set the situation of the round by looking at the roles of the players.

protected Color color : This attribute is used to determine the color of the panels.

protected int brushSize: This attribute is used to determine the size of brush.

protected String chosenWord: This attribute symbolizes the word that is chosen by the active player.

protected String [] wordList: This attribute works as the array which stores all of the words that are served to the active player to draw.

This class is one of the most important classes for gameplay process in this application. Firstly, the constructor determines the player who is the active player as well as passive player for each round according to sorted gameplay steps which is listed with enumerated class. In addition to this, GameSession provides the brush with chosen size and chosen color to the active player. In short words, this class is a starting point for drawing, watching and guessing process with some particular settings.

- **Piece:**

Constructor:

public Piece(): This constructor is used to create a piece object.

public Piece(Color color, int radius): This constructor is used to create a piece object.

Operations:

public addPoint(Point point): This method is used to add the pixel point into the piece list.

public reset(): This method is used to reset the piece object.

public setPoints(List <Point> points): This method is used to set the pixel points of pieces.

public fromJason(String jsonStr): This method is used to get the pieces from jSon.

protected List <Point> points : This attribute is used to determine pixel points which create the piece by getting united in a list.

protected int radius: This attribute is used to determine the radius size of the brush.

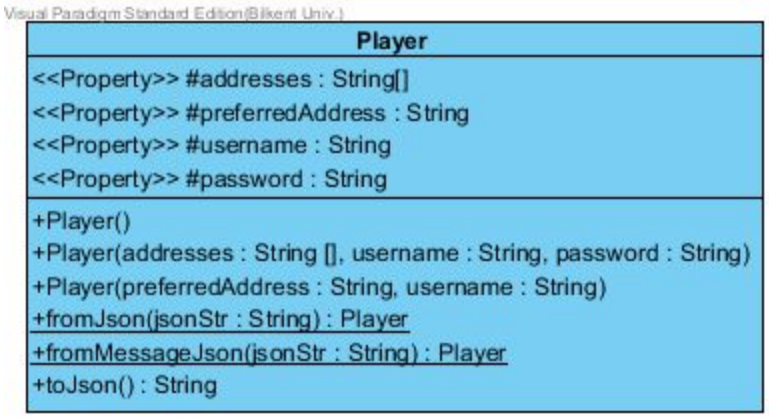
protected Color color: This attribute is used to determine the color of the panels.

protected Long startTime: This attribute is used to determine the starting time point of the single drawing movement.

protected Long endTime: This attribute is used to determine the ending time point of the single drawing movement.

This class deals with the drawing movements which starts with clicking on the mouse and ends when the active player releases the mouse. Each piece is composed of pixels and these pieces are stored in a list for the following gameplay process.

- **Player:**



Constructor:

public Player(): This constructor is used to create a player object.

public Player(String [] adresses, String username, String password): This constructor is used to create a player object.

public Player(prefferedAdress): This constructor is used to create a player object.

Operation:

public Player fromJson(String jsonStr): This operation is used to get the player's information from the json.

public Player fromMessageJson(String : jsonStr) : This operation creates a player object by using the json.

public String toJson(): This operation is used to send the player's info to the json.

Attributes:

protected String[] addresses: This attribute is used to store addresses of players into an array.

protected String preferredAdress: This attribute is used to provide connection between host and guest player. By using the server, not directly, the guest player uses the address of the host player.

protected String username: This attribute is used to specify users' name in the game server.

procted String password: This attribute is used to specify users by using their own passwords.

This class is implemented to set up the player's qualities. Each player has three components that are username, address and password. And also player prefer an address to play. It is taken from the player as preferred address.

5.2.3. USER INTERFACE PACKAGE

This package is referring to our User Interface Manager Subsystem. For the MVC design pattern, it corresponds to the view part. This package contains the boundary objects such as panels. This package is specially crucial for us because it enables our application's interaction with user. All panels and their custom made instances (such as brush panel, brush and color swatch) are contained in this package. Below you can find the general class diagram for our package.

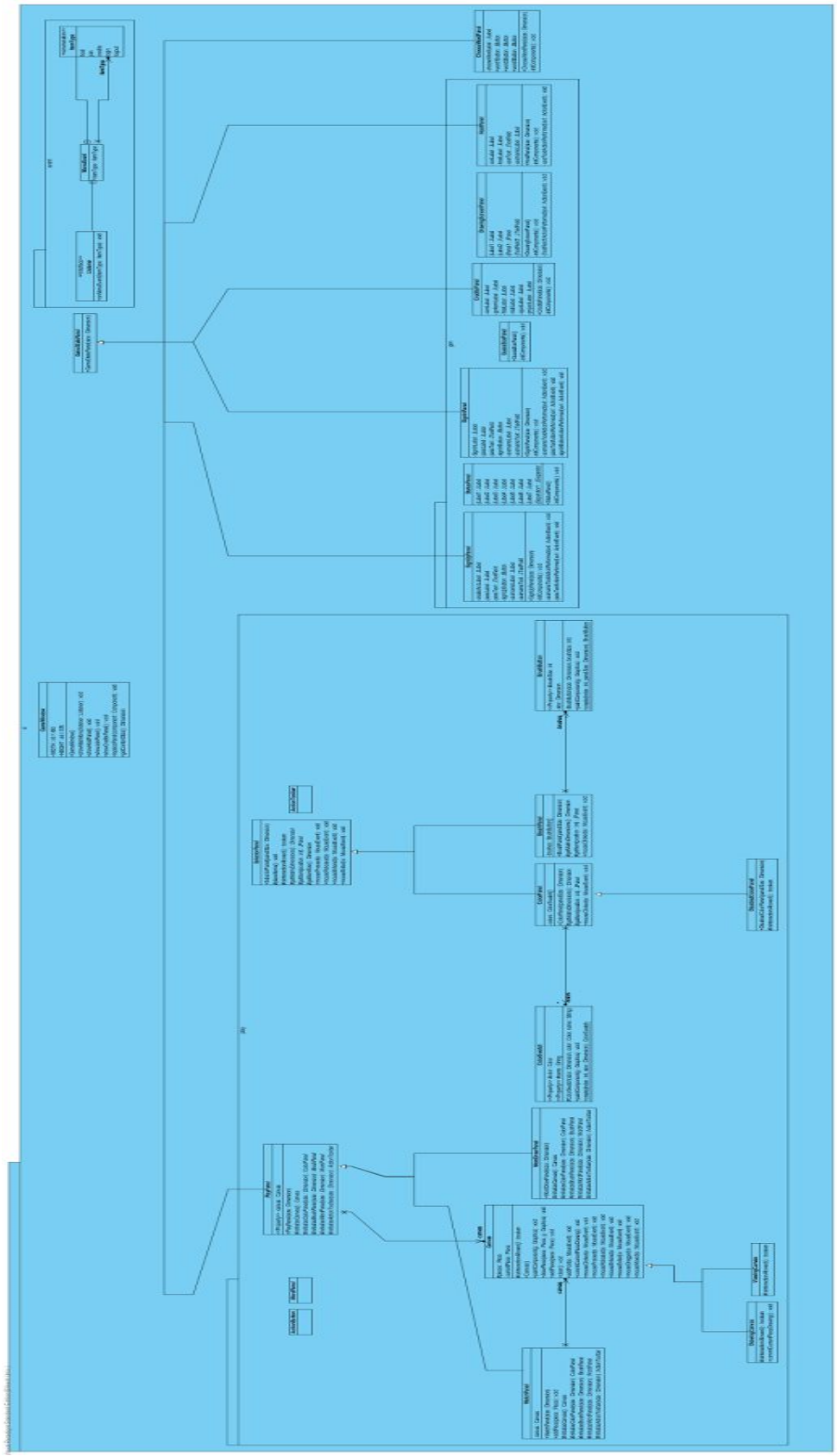


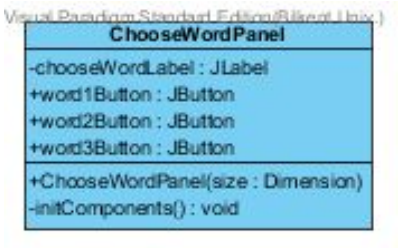
Figure 28: UI

package

UI PACKAGE:

In addition to sub-packages, UI package itself contains a few classes. These classes are the main classes needed within the application. It includes classes like GameWindow, GameStatePanel.

- **ChooseWordPanel:**



Attributes:

- **private JLabel chooseWordLabel:** This variable is used for indicating ChooseWord Panel's title. It is a Java Swing component.
- **public JButton word1Button:** This component is a button. On the button the first word choice is written if user wants to draw this specific word s/he needs to click on it.
- **public JButton word2Button:** This component is a button. On the button the second word choice is written if user wants to draw this specific word s/he needs to click on it.
- **public JButton word3Button:** This component is a button. On the button the third and the last word choice is written if user wants to draw this specific word s/he needs to click on it.

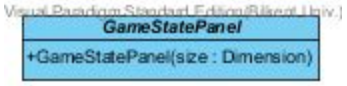
Constructor:

- **public ChooseWordPane(Dimension size):** This is the constructor method for ChooseWordPanel class. It width and length is strict on the parameter it gets. It calls a super method in order to create a panel with the given sizes. It also calls InitComponents() which initializes the specific Java Swing components for this panel.

Operations:

- **private void initComponents():** This method initializes all the necessary Java Swing compoenent for the ChooseWordPanel class such as labels and buttons.

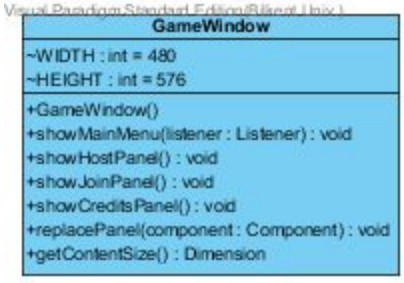
- **GameStatePanel:**



Constructor:

- **public GameStatePanel(Dimesnion size):** This is the constructor method for GameStatePanel class. It width and length is strict on the parameter it gets.

- **GameWindow:**



Attributes:

- **abstract int width:** This int variable has a strict integer for width of the window which is 480.
- **abstract int heighth:** This int variable has a strict integer for height of the window which is 576.

Constructor:

- **public GameWindow:** This is the constructor method for GameWindow class. It sets the contentPane's layout and sets the desired size for window.

Operations:

- **public void showMainMenu(Listener listener):** This method creates a new main menu and sets the menu event listener to menu panel.
- **public void showHostPanel():** When clicked on the host button this method calls the replace panel method in order to change the current panel into showHostPanel.
- **public void showJoinPanel():** When clicked on the host button this method calls the replace panel method in order to change the current panel into showJoinPanel.
- **public void showCreditsPanel():** When clicked on the host button this method calls the replace panel method in order to change the current panel into showCreditsPanel.
- **public void getContentSize():** This method returns the strict width and height which are 480,576 respectively.

UI PACKAGE- GEN:

This is a sub-package for our User Interface package. Since we have many class in the User Interface package, we decided to divide ui packages in relevant parts. Gen package contains the static panels which we will be use directly. Within the application there won't be any change in these panels. Below, there is the general class for the UI - GEN package.

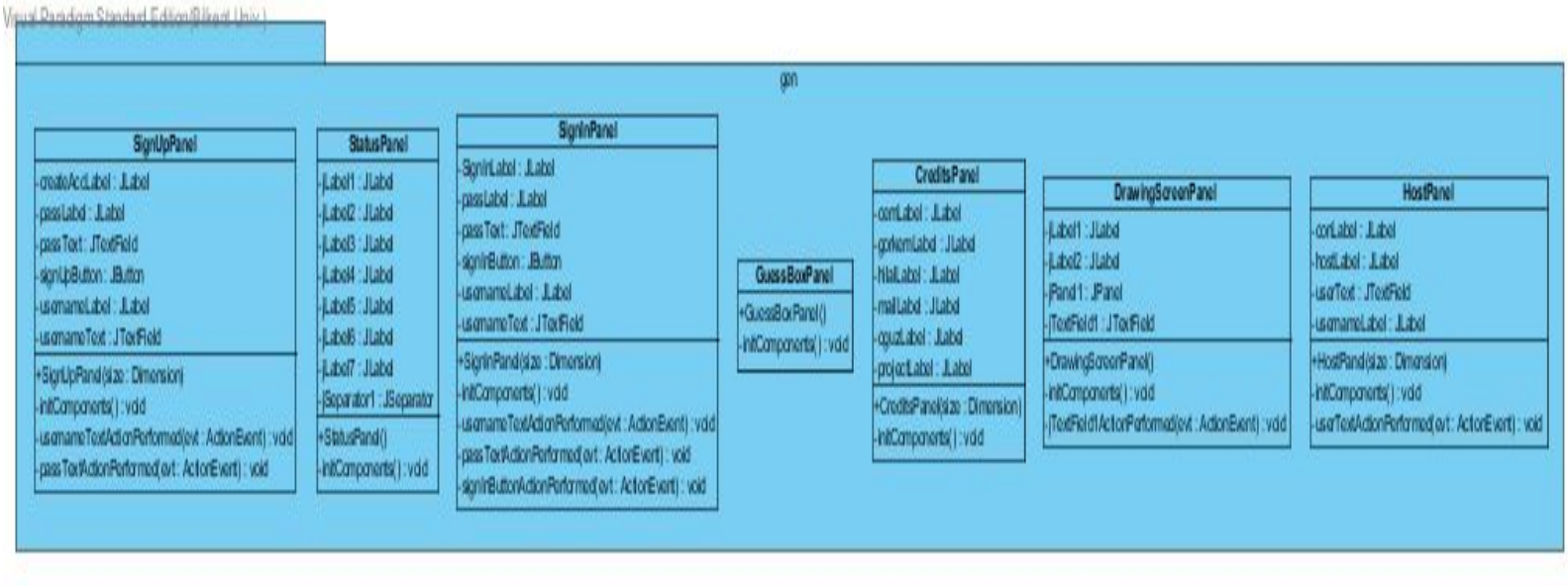
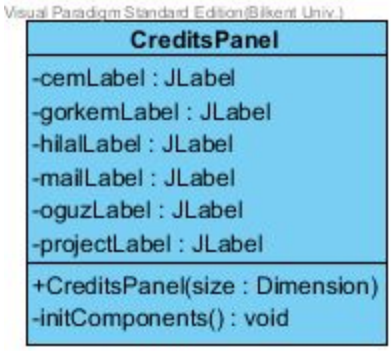


Figure 29: UI Gen package

- **CreditsPanel:**



Attributes:

- **private JLabel cemLabel:** This is a JLabel component. It is used in CreditsPanel to show one of our team members who worked in project which is Cem.
- **private JLabel gorkemLabel:** This is a JLabel component. It is used in CreditsPanel to show one of our team members who worked in project which is Görkem.
- **private JLabel hilalLabel:** This is a JLabel component. It is used in CreditsPanel to show one of our team members who worked in project which is Hilal.
- **private JLabel oguzLabel:** This is a JLabel component. It is used in CreditsPanel to show one of our team members who worked in project which is Oğuz.
- **private JLabel mailLabel:** This is a JLabel component. It is used in CreditsPanel to show our teams email adress.
- **private JLabel projectLabel:** This is a JLabel component. It is used in CreditsPanel to showthe panel's title.

Constructor:

- **public CreditsPanel():** This is the constructor method for CreditsPanel class. It sets the panel's size.

Operations:

- **private void initComponents():** This method initializes all the necessary Java Swing component for this class such as labels and buttons.

- **GuessBoxPanel:**

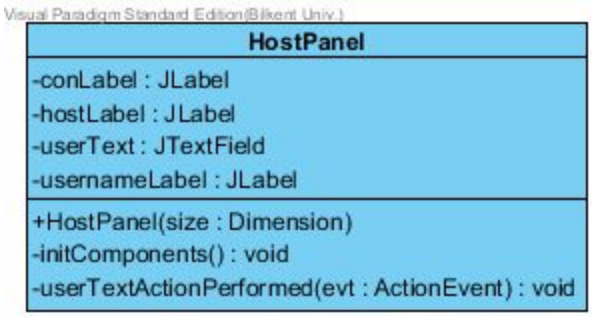
Constructor:

- **public GuessBoxPanel():** This is the constructor method for GuessBoxPanel class. IT calls initComponents method.

Operations:

- **private void initComponents():** This method initializes all the necessary Java Swing component for this class such as labels and buttons.

- **HostPanel:**



Attributes:

- **private JLabel conLabel:** This is a JLabel component. It is used in HostPanel to show connection title.
- **private JLabel hostLabel:** This is a JLabel component. It is used in HostPanel to show host title.
- **private JTextField userText:** This is a JLabel component. It is used in HostPanel class, this is where the host player should enter his/her name.
- **private JLabel userNameLabel:** This is a JLabel component. It is used in HostPanel to show userName title.

Constructor:

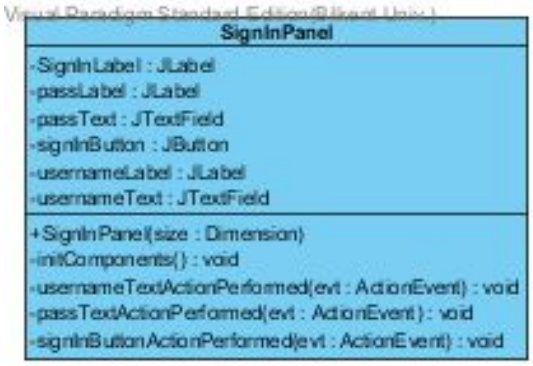
- **public HostPanel(Dimension size):** This is the constructor method for HostPanel class. It sets the panel's size by taking dimension parameter.

Operations:

- **private void initComponents():** This method initializes all the necessary Java Swing component for this class such as labels and buttons.

- **private void userTextActionPerformed():** This method takes an event and listens whether a username typed or not.

- **SignInPanel:**



Attributes:

- **private JLabel signInLabel:** This is a JLabel component. It is used to show signIn title.
- **private JLabel passLabel:** This is a JLabel component. It is used to show password title.
- **private JTextField passText:** This is a JLabel component. This is where the Host player enter the password.
- **private JButton signInButton:** This is a JButton component. This is where the sign in button displayed.
- **private JLabel userNameLabel:** This is JLabel component. It is used to show username title.
- **private JTextField userNameText:** This is JTextField component. This is where the username entered.

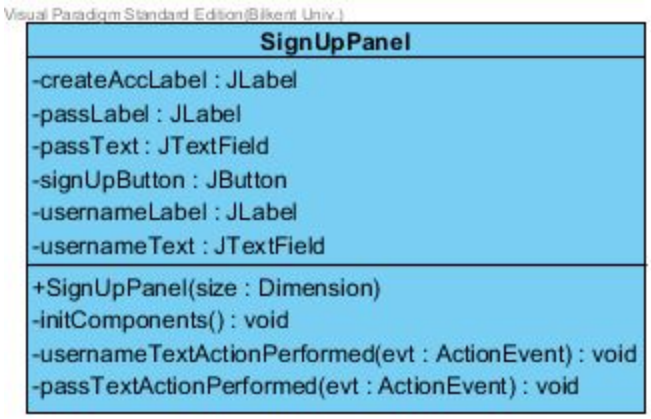
Constructor:

- **public signInPanel (Dimension size):** This is the constructor method for SıgnInPanel class. It sets the panel's size by taking dimension parameter.

Operations:

- **private void initComponents():** This method initializes all the necessary Java Swing component for this class such as labels and buttons.
- **private void userNameTextActionPerformed():** This method takes an event and listens whether a username typed or not.
- **private void passTextPerformed():** This method takes password from the player.
- **private void signInButtonActionPerformed():** This method takes an event and listens whether a username typed or not.

- **SignUpPanel:**



Attributes:

- **private JLabel createAccLabel:** This is a JLabel component. It is used to show create account title.
- **private JLabel passLabel:** This is a JLabel component. It is used to show password title.
- **private JTextField passText:** This is a JLabel component. This is where the Host player enter the password.
- **private JButton signUpButton**: This is a JButton component. It is used to show signUp button.
- **private JLabel userNameLabel:** This is a JLabel component. It is used to show username title.
- **private JTextField passText:** This is a JTextfield component. It is used to show password text.

Constructor:

- **public signUpPanel (Dimension size):** This is the constructor method for SıgnInPanel class. It sets the panel's size by taking dimension parameter.

Operations:

- **private void initComponents():** This method initializes all the necessary Java Swing component for this class such as labels and buttons.
- **private void userNameTextActionPerformed():** This method takes an event and listens whether a username typed or not.
- **private void passTextActionPerformed():** This method takes an event and listens whether a username typed or not.
-

UI PACKAGE- PLAY:

This package has the classes when we are needing when the game starts. For example, Canvas, ColorSwatch, WordDrawPanel and the others are only necessary when we actually play the game and they should be interactive according to game and player. Again, below diagram shows the classes contained by this package.

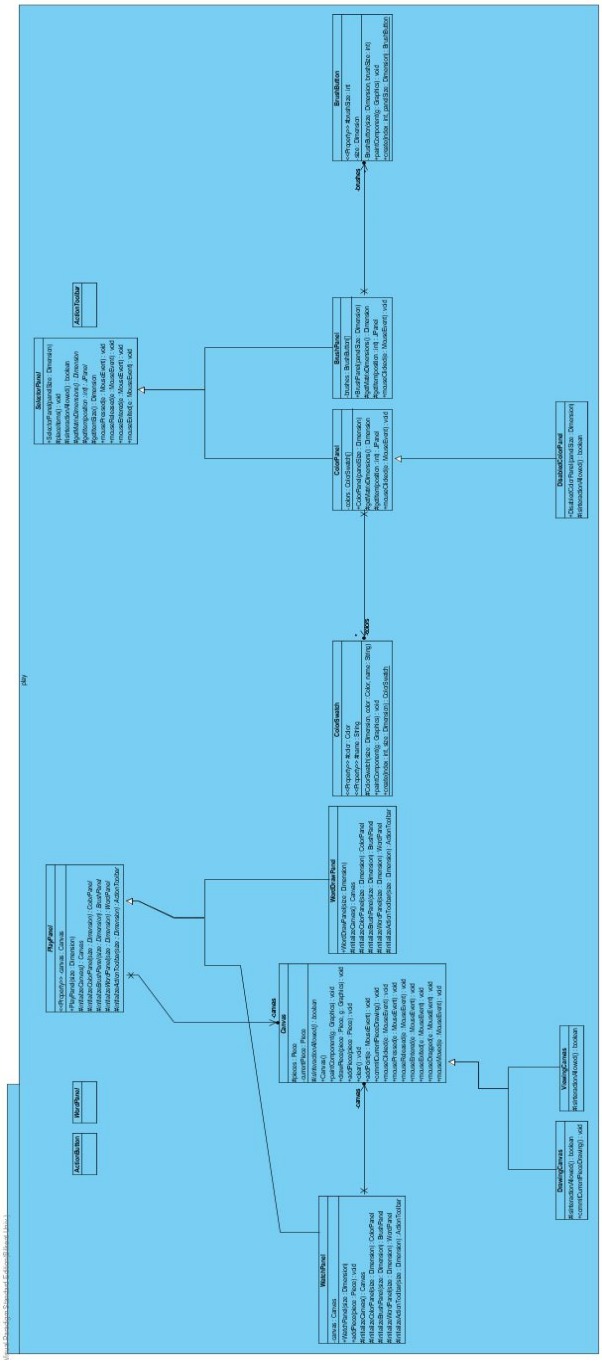
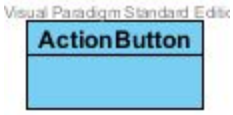


Figure 30:UI Play Package

- **ActionButton:**

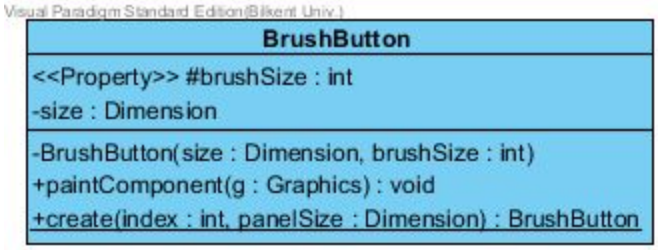


The action button is implemented to connect an action and its properties to a button.

- **ActionToolbar:**

The action toolbar is implemented to connect an actions. And it is extended by JPanel.

- **BrushButton:**



Constructor:

public BrushButton(Dimension size, int brushSize): This method is used to create brush button object.

Operations:

public Dimension getMatrixDimension(): This operation is used to get the dimensions of the matrix.

public JPanel getItem(int position): This operation returns the particular item.

public void mouseClicked(MouseEvent e): This method is used to deal with the clicking actions of the mouse.

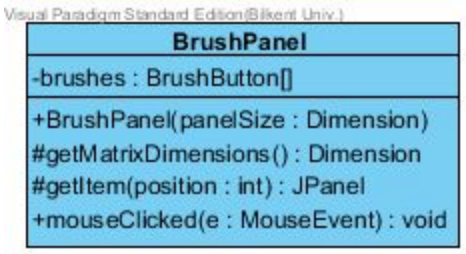
Attributes:

protected int brushSize : This attribute is used to determine the size of the brush.

private Dimension size: This attribute is used to determine the size of the each of brush size box.

This class deals with a single button which is located on brush panel. By using case conditional method, there are 6 different radius sizes for brush.

- **BrushPanel:**



This class deals with the brush panel which serves 6 different brush sizes to active player in drawing session. It is implemented as 3 rows, 2 columns matrix with ascending radius size order.

Attributes:

- **private BrushButton Brushes:** This is a Brush component. It is used to show create account title.

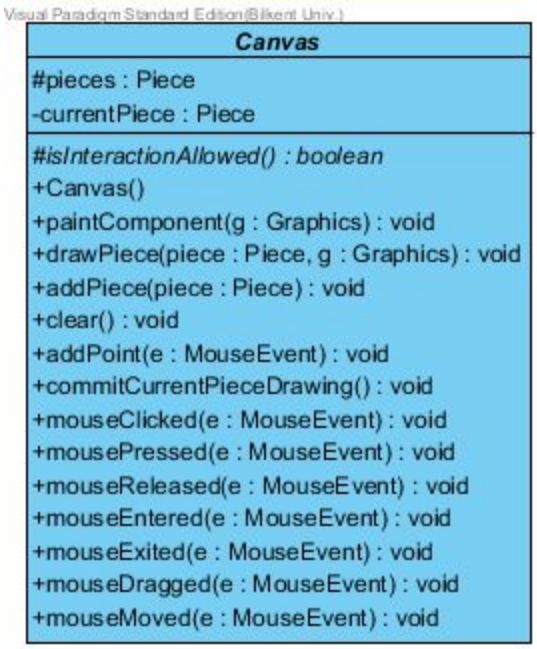
Constructor:

- **public BrushPanel(Dimension panelSize):** This is the constructor method for BrushPanel class. It sets the panel's panelSize by taking dimension parameter.

Operations:

- **private void getMatrixDimension():** This method gets matrix dimensions.
- **public BrushPanel(Dimension panelSize):** This method takes an event and listens whether a username typed or not.
- **public void mouseClicked(MouseEvent e) :** This method

- **Canvas:**



This class is completely about the canvas that active player draws and passive player watches. In drawing session, every drawn piece is added into the list to store it until end of the round. The image that the passive player sees refreshes itself after every piece addition into the list. At the beginning of every round, the canvas is refreshed itself with white screen.

- **ColorPanel:**

Constructor:

public ColorPanel(): This method is used to create a color panel object.

Operations:

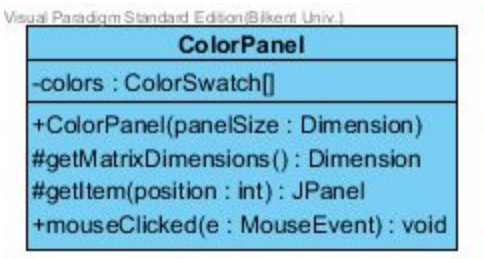
public Dimension getMatrixDimension(): This operation is used to get the dimensions of the matrix.

public JPanel getItem(int position): This operation returns the particular item.

public void mouseClicked(MouseEvent e): This method is used to deal with the clicking actions of the mouse.

Attributes:

protected ColorSwatch[] colors: This attribute stores the different colors in the same array.



This class deals with the color panel which lists 20 different colors to active player for drawings. It is implemented as 10 rows, 2 columns matrix.

- **ColorSwatch:**

Constructor:

public ColorSwatch: This method is used to create a color swatch object.

Operations:

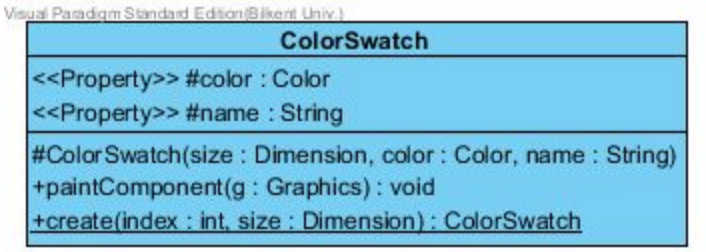
public void paintComponent(Graphics g): This method is used to fill the rectangle of each colors in color panel.

public ColorSwatch create(int index, Dimension size): This method is used to add new color views into the color panel.

Attributes:

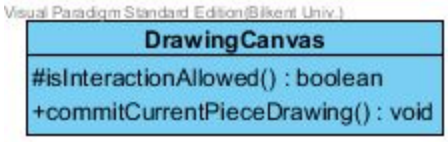
protected Color color: This attribute is used to specify colors.

protected String name: This attribute is used to give names to the new colors.



This class is implemented for a single option which is located on the color panel. By using case conditional method, there are 20 different color options for brush. This case method is done by using paint color codes (such as Black : #000000). These colors are served in squares.

- **DrawingCanvas:**

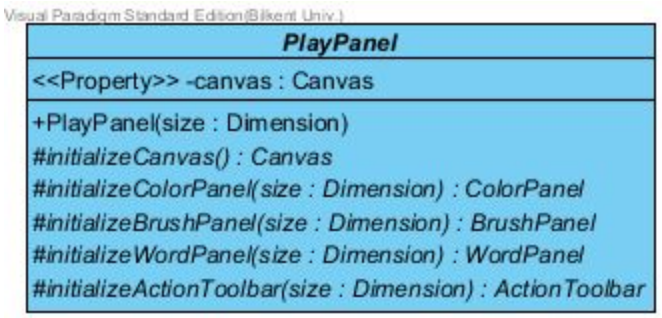


Operations:

public boolean isInteractionAllowed(): This method returns true if the player is the one who is active.

This class is implemented to show the drawing canvas. It allows actions on the drawing panel. And also it holds the pieces that are drawn and sends them immediately to the other panel which is for the passive player.

- **PlayPanel:**



Constructor:

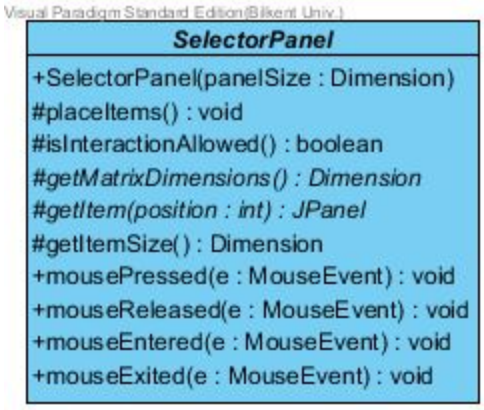
public PlayPanel(Dimension size): This method is used to create a play panel.

Operations:

initializeCanvas(): This initializes the canvas

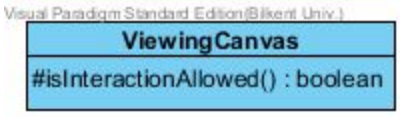
This class deals with the positions and dimensions of important panel related things such as canvas, color panel, brush panel etc.

- **SelectorPanel:**



This class is mainly implemented for placing the items into color panel and brush panel. In short words, it determines the positions of options for active player in the drawing screen.

- **ViewingCanvas:**

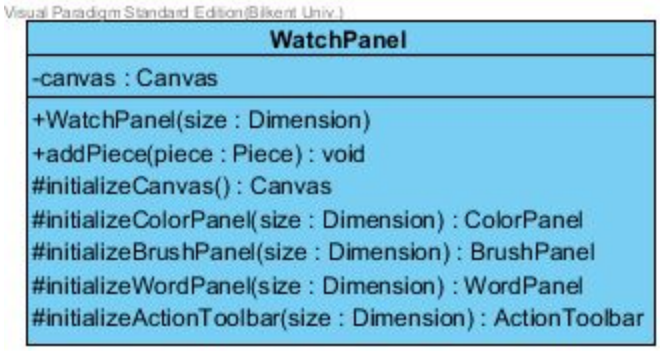


Operations:

public boolean isInteractionAllowed(): This method returns true if the player is the one who is active.

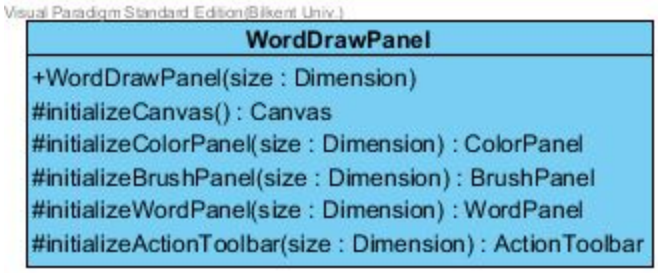
This class is implemented for passive player. The passive player just see the drawings that are made by the active player. All other actions are not allowed.

- **WatchPanel:**



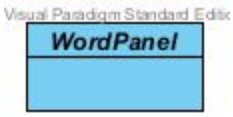
This class is implemented to watch the drawing. It has yellow background. It creates viewing canvas. It takes pieces from the active player. On the watch panel, we can just see brush. Color panel is disabled. All other action are not allowed. Word panel is also not active for the watch panel.

- **WordDrawPanel:**



This class is implemented to draw word for active player. Firstly, it initialize the drawing canvas, color panel and brush panel. Word panel initialization and ActionToolBar initialization is made ready but these are empty for this class.

- **WordPanel:**



This class is just implemented to show word on a panel.

5.2.4. NETWORK PACKAGE:

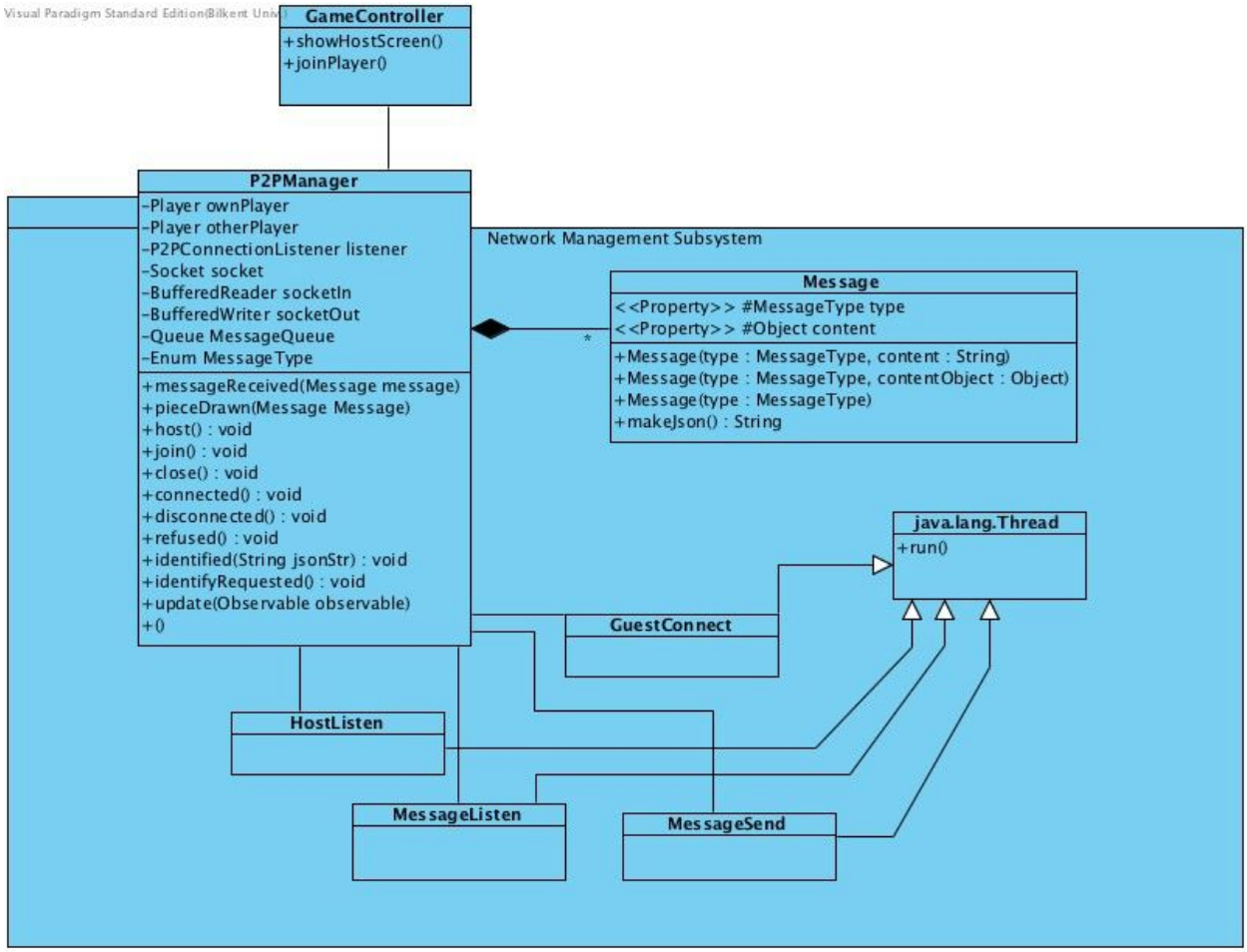
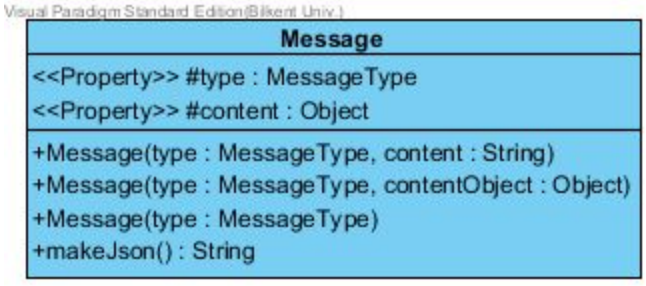


Fig XX:XX

- **Message:**



A message consists of two thing: A message type and the content. Content is type of Object, which should be json-convertable. Message objects are often translated to json and back from json. Here is a sample json representation of a Message object with MessageType: Draw, content: Piece:

{"type":"DRAW","content":{"points":[{"x":138,"y":31},{"x":139,"y":31},{"x":143,"y":31},{"x":147,"y":31},{"x":149,"y":31},{"x":152,"y":31},{"x":154,"y":31},{"x":155,"y":31},{"x":156,"y":31},{"x":157,"y":31},{"x":157,"y":31}],"radius":4,"color":{"value":-4079167,"falpha":0.0},"startTime":1449522069336,"endTime":1449522069830}}

A MessageType can be one of the following:

CONNECT: Message received when a socket connection is established.

DISCONNECT: Message received when a socket connection is lost.

REFUSED: Message received when a join request is refused i.e. there is no host at the other side.

IDENTIFY: Message sent by the host to the guest, to ask some details about the player.

WORD_CHOSEN: Message sent by the active player to the other player to notify that the new round starts.

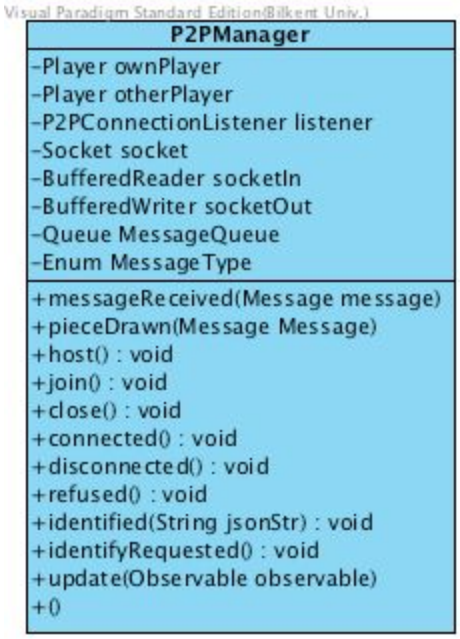
DRAW: Message sent by the active player each time they draw a new piece on the canvas.

GUESS_LETTER: Message sent by the guesser player that indicates they guessed a new letter in the word.

WORD_GUESSED: Message sent by the guesser player indicating that they guessed the word right.

TIMEOUT: Message sent by the either side to indicate that they missed

- **P2PManager:**



Attributes:

- **private Player ownPlayer:** This is the player of the current computer.
- **private Player otherPlayer:** This is the player of the other computer.
- **private P2PConnection listener:**
- **private Socket socket:**
- **private BufferedReader sockettIn:**
- **private BufferedReader socketOut:**
- **private Queue messageQueue:**
- **private Enum MessageType:**

Constructor:

- **public messageRecieved(Message message):**

Operations:

- **public messageRecieved(Message message):**
- **public PieceDrawn(Message message):**
- **public void host():**
- **public void join():**
- **public void closed():**
- **public void connected():**
- **public void disconnected():**
- **public void refused ():**
- **public void identified(String jSonStr):**
- **public void identifyRequested():**
- **public void update(Observable observable):**

5.3. Specifying Contracts

Color Panel Class:

1. //Color panel has 20 different colors.

context ColorSwatch **inv:**

colors = new ColorSwatch[20];

To increase the quality of the drawings, our program serves 20 different colors to the players. By using these different colors, players are able to draw the most proper images of given words.

Color Swatch Class:

2. // Colors can be changed by using set method. Later Color Swatch

//array will be used by Color Panel class. (This function has 21 different cases; 1 default and 20

//different colors)

context ColorSwatch::ColorSwatch create (int index, Dimension size) **post:**

```
switch (index) {
 case 0:
   return new ColorSwatch(size, Color.decode("#FFFFFF"),
       "White");
       ...
```

Choosing the color process is done in this code segment by using the case conditional coding method. Each of case is specified for a different color by using the color codes. For example, we used #00A0EC for blue color in the 15th case.

Brush Panel Class:

3.// Brushes can have 6 different sizes.

context BrushPanel **inv:**

```
brushes = new BrushButton[6];
```

The program offers 6 different brush sizes to users and by using these different sizes, users are able to draw more detailed images. To do this, we have a BrushButton array which collects these 6 different size brushes.

Brush Button Class:

4.// Brush size can be changed according to brush button index it has. Later Brush button //array will be used by Brush Panel class. (This function has 7 different cases; 1 default and 6 //different sizes)

context BrushButton:: create(int index, Dimension size) **post:**

```
switch (index) {
  case 0:
    return new BrushButton(panelSize, 2);
...
```

Choosing the brush size process is done in this code segment by using the case conditional coding method. Each of case is specified for a different size by using the different radius sizes. For example there is a brush size in case 0 which draws a circle which has 2 pixels radius.

Canvas Class:

5. // X and Y coordinates of a specific point can be filled with following line of this method

context Canvas::drawPiece(Piece piece, Graphics g) **post:**

```
g.fillOval((int)point.getX(), (int)point.getY(),
piece.getRadius()*2, piece.getRadius()*2);
```

A single brush movement is the composition of pixels according to its size. For the chosen size and position of a single brush movement, this function creates and fills an circle.

6. // draw piece method can draw the current piece only if i is not null

context Canvas:: paintComponent (Graphics g) **pre:**

```
if(currentPiece != null) {
        drawPiece(currentPiece, g);
```

}

This function creates the image that is just drawn on the canvas if it is not an empty thing. This drawing process is done after the active player releases his mouse movement.

7. // canvas is repainted when a new piece is drawn/added by active player. The new piece added //to pieces array as well.

context Canvas:: addPiece (Piece piece) **post:**

pieces.add(piece);

repaint();

This function sends every drawn pieces into the array which collects the whole drawing on the canvas for the current round. In addition to this, this function refreshes itself with the new pieces.

8. // When active player click the mouse, draw what s/he wants to draw while clicking the mouse and this function makes these pieces as complete piece.

Context Canvas:: commitCurrentPieceDrawing() **post**

```
if(currentPiece != null && isInteractionAllowed()) {
        currentPiece.setEndTime(System.currentTimeMillis());
        addPiece(currentPiece);
        currentPiece = null;
```

This function works when interaction is allowed so it is just allowed to active player. This function is makes the pieces complete.

9. // Canvas can be checked to see whether it is drawable or not (active player can draw but //passive player cannot)

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10. // When watching and drwaing status starts canvas background should always be white.

context Canvas::Canvas() **pre:**

setBackground(Color.***white***);

Game Session Class:

11. // Player status can be checked by looking isMyPlayerActive() method

context GameSession:: isMyPlayerActive **post:**

return myPlayerIsActive;

This function is used for determining the player's status. For example if a player is active, this function returns true and this returning value can be used in the following code segments to activate or inactivate the canvases of players.

12. //Draw It! application has 6 different round states as enum

context GameSession **inv:**

public enum RoundState {

CHOOSE_WORD*, *DRAW*, *WATCH*, *GUESS*, *WAIT*, *STATS

}

This enum usage is for the consecutive events in our projects. The drawing, watching, guessing, waiting and seeing stats are executed consecutively according to rules of the game and enum provides us a very efficient method in this case.

13. // Game should always start from first round. Therefore, in the beginning round should always set to 1.

context GameSession **inv:**

this.roundNumber = 1;

Game Window Class:

14. // Application's window frame has final height and width

context GameWindow **inv:**

final int WIDTH = 480;

final int HEIGHT = 576;

Dimensions of the application frame is determined in this part. We consider appropriate to use 480 pixels for width and 576 pixels for height in this project.

PlayPanel Class:

15. // Application's play window frame has bounds.

context PlayPanel **inv:**

canvas.setBounds(16, 39, 360, 360);

The boundary of the playing canvas is settled in this part. !!!

16. // The dimensions of the application's color panel is determined in this part.

context PlayPanel **inv:**

ColorPanel colorPanel = initializeColorPanel(new

Dimension(64, 320));

The dimensions of the color panel is (64,320). This is appropriate for our application.

17. // The boundary of the color panel is set.

context PlayPanel **inv:**

colorPanel.setBounds(396, 39, colorPanel.getSize().width,

colorPanel.getSize().height);

The bounds of color panel is determined in this part of the code. The width of the color panel is 396 and the height of the color panel is 39.

18. // Brush panel has dimension.

context PlayPanel **inv:**

BrushPanel brushPanel = initializeBrushPanel(new

Dimension(64, 96));

The dimensions of the brush panel is specified in this part of the code. Dimensions are (64,96)

19. // Brush panel has boundaries in PlayPanel class.

context PlayPanel **inv:**

brushPanel.setBounds(396, 360,

brushPanel.getSize().width,brushPanel.getSize().height);

The boundaries of the brush panel is assigned as (396,360). 396 is stands for width of the brush panel and 360 is stands for height of the brush panel.

SelectorPanel Class:

20. // ???

context selectorPanel::Dimension getItemSize() **post:**

```
return new Dimension(getSize().width /
getMatrixDimensions().width,
        getSize().height / getMatrixDimensions().height);
```

GameController Class:

21. // Before starting the draw or watch part of the game, player type should be checked

// and according to result the player's type game state should be given

context: GameController: beginDrawOrWatch() **pre:**

```
if(session.isMyPlayerIsActive()) {
        session.setRoundState(GameSession.RoundState.DRAW);
}
else {
        session.setRoundState(GameSession.RoundState.WATCH);
}
```

N. // Word alternatives should be request from the server at the beginning of each round in order to be chosen by the active player.

context GameController **pre**:

```
switch (session.getRoundState()) {
case CHOOSE_WORD:
        client.requestWordsFromTheServer(this) // listener is GameController
        break;
```

CreditsPanel Class

22. // The size of the credits panel is assigned here.

context CreditsPanel **post:**

setPreferredSize(new java.awt.Dimension(480, 576));

The dimensions of the Credits panel is determined with this code. the dimension is set by (480, 576)

P2P Manager Class

23. // For a specific game we only accept one socket connection. If it is already full one cannot start connection.

context P2PManager **pre:**

```
if(socket == null)  {
   GuestConnect connect = new GuestConnect(hostPlayer);
   connect.start();
```

N. // Score can be updated

context GameClient **post**:

```
switch (session.getRoundState()) {
        case STATS:
          this.updatePlayerStats(session.getMyPlayer()) // Makes a HTTP request // to the server
```

```
                    break;
```

N. // Three words should come from the server at the beginning of each round in order to be chosen by the active player.

context GameClient **post**:

```
void onWordsReceived(String[] words) {
        if(words.length != 3) {
                throw new Exception();
        }
}
```

Classes on the server side

N. // For a player to sign up, we only accept usernames that are not existing in the database

context Player **post**:

```
String checkUserSQL = "SELECT id FROM `players` WHERE `username` = ?"
// ...
PreparedStatement checkExistingUserstatement = connection.prepareStatement(checkUserSQL);
ResultSet set = checkExistingUserstatement.executeQuery();
if(set.next()) {
        throw new UserAlreadyExistsException();
}
```

N. // For a player to sign in, make sure their username & password combination are correct.

```
String playerPassword = hashPasswordInput(passwordInput);
```

```
Player playerInDb = getPlayerWithUsername(usernameInput);
if(playerInDb.getPassword().equals(playerPassword) {
        // Authenticated!
}
else {
        throw new UnauthorizedException();
}
```

N. // For a player to make a player lookup, make sure they are authenticated.

```
public class Lookup extends Controller {
        public static Result lookupPlayer() {
                Player player = getAuthenticatedPlayer();
                if(player == null) {
                        throw new UnauthenticatedException();
                }
        }
}
```

N. // For player to set a high score, make sure they are authenticated.

```
public class SetHighScore extends Controller {
        public static Result lookupPlayer() {
                Player player = getAuthenticatedPlayer();
                if(player == null) {
                        throw new UnauthenticatedException();
                }
        }
}
```

6. Conclusions and Lessons Learned

6.1.Overview Of The Report - Conclusions

In the Analysis Report, we made the first step towards the Object-Oriented Design Concept which is designing the project. We prepared a detailed design for "Draw It!" application. Our report has two main parts one is Requirement Analysis and the other is Analysis section.

In the Requirement Analysis section, we first give an overview about our application. We explained Functional, Non-Functional Requirements and the application's constraints. Our criteria was to consider all possible situations for the user can perform. Therefore, we tried to find all possible situations and create scenarios based on these information. While designing our models, we always keep in mind to fulfill these requirements and scenarios we came up with. At the end of this part, we provide Use Case Model and User Interface, because the interaction between application and user is very important, we explain them as easy and as understandable as we can.

In the second part, Analysis Model, we gave more detailed explanation of our application by using Object and Dynamic Models. This part is where we gave more specific design decisions about the application. In the Object Model, we first gave the Domain Lexicon which is very essential for the understandability of our application. We tried to clarify ambious words and we noted our key words. By specifying these crucial words, we became ready to identify our design in a more detailed manner. We provide Class Diagram. In the Dynamic Model part, we gave Start Chart and Sequence Diagrams which are also very essential for the design of our implementation. We tried to be as specific as we can in order to have a solid design that we can implement.

Before submitting our final report, we prepare our object design section which includes pattern applications, class interfaces and specifying contracts. For the pattern application part, we choose 3 design patterns which we found more suitable than other patterns for our application. These patterns are Façade, Command and Observer patterns. Our choices to choose these patterns were based on the idea to make our project less complex and our code more reusable for a future time. For the class interfaces, as we are finalised our class designs, we provide description for each class we have along with their class diagram. In the last part, we defined 30 contracts and provide explanation for them.

To sum up, our purpose to writing this report was to design and implement our application easily in the future. We tried to make it as precise as possible in order to better understand our problem and solution domains.Only by thinking deeply about the process, we can came up with a better design and solution. This report will be our future reference and guide for our following process in the "Draw It!" project. That is why we understand the importance of this report and we took it seriously and tried our best.

6.2. Lessons Learned

While studying on this project we learned that software engineering is not a process that contains only implementation. In order to create a real sustainable project, one should always apply the object oriented design steps. We learnt also while making a project designing phase also as important as implementation process. Requirement Analysis, Analysis, System Design and Object Design steps are very important for a project. Now that we learn how to apply them

on a project, we can say that dealing with a project is hard because of the fact that changes occur all the time. However, the above procedures are make this process less complex and more flexible for us and provide us a better environment to realize our project. Also, we learnt to be a part of a team and we should work parallel to each other in order to be more organized and in order to produce better projects.