



Ivanhoe

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1. Introduction

This section is introduction of Ivanhoe and detail information about our project.

1.1 Motivation

Learning Software Design is a big topic of our target. Therefore, we believe the project of Ivanhoe is a good way to improve us about understanding Agile Development. This project is designing over TDD and JUnit test. Therefore, we could get familiar with those two technical skills. Design Pattern is technical important to Software Design; we could get the experience of learning how to implement Design Pattern into the program of Ivanhoe. And we could study the Scenario and how to evaluate each Scenario. We are looking forward to implement the network into the program because Ivanhoe is a multi-player game. It is very great to implement the network feature into the game.

1.2 Terminology

| Term | Definition |
|-----------------|---|
| Server | The host of Ivanhoe. It represent the model of the Ivanhoe which will distribute the newest information of the state of Ivanhoe |
| Client | The device of PC which represent the person of the player. It will running as the role of the player. |
| Rule Engine | The engine of the Ivanhoe. It will take all controls of the game. It run the procedure of the game. |
| Ivanhoe | The name of the game that running in the program. |
| Player | The representation of the client which will be participate in the game |
| Deadwood | The deck where the discard card go |
| Display | The player's display for played card |
| Hand | The player's hand which is represent what card the player has currently |
| UI | The GUI of the client that will represent the player |
| Request Message | The message comes from the client. It is the action message from the player who wants to join, player and quit game |
| MVC | Model-View-Controller, it is the one of major Design Pattern for game |
| Model | The model of the MVC which is the host of the game |
| View | The view of the MVC which is the UI of the game |
| Controller | The controller of the MVC which is the player of the game |

2. Networking Strategy

2.1 Server Strategy

Server is the host of the Ivanhoe. Server would run the game and control the procedure of the game. The responsibility of the server would be report the result of client's response to the Rule Engine of Ivanhoe. The key feature of server is communicating with clients over the network. Ivanhoe is a multiple player game. Therefore, the server be handling multi clients in every time. No matter how many requests is received, the server could handle it and report it to Rule Engine. Server would not response to clients if the Rule Engine recognize the request is not valid. When any clients are quit or accidentally exit the game, the server could be terminated the game by send the message to rest of the clients. The message is the information of the server is down due to client loss. The server is well implemented with the setting of the network which is allowed to change the setting of the number players in the game, the IP address and port number. It is implemented for running the game over the network in different devices. It is allowed the player play the game in anywhere.

2.2 Client Strategy

Client is the side of Ivanhoe player. Client is able to join the game and play the game and quit the game. The responsibility of the client is participated the game of Ivanhoe. Client is able to join the game and play. The key feature of client is communicating with server over the network. Client is treat as the player side of the Ivanhoe. Therefore, the client is able to do any corresponding action depend on the state of the game which means, client is able to update the newest information to Rule Engine. No matter what the client do, the client is not able to update anything unless server's response. Client is automatically received the any message from the server. And automatically update the message from the server to the UI. Client is free to report any actions from the players to the server. But the action is not response immediately unless the action is corresponding to the request action from the server. When the server is shut down. Client could receive the message of the server is down and the client could be automatically quit the server and terminated. The client is well implemented with the setting of the network which is allowed to change the setting of the IP address or port number. It is implemented for joining the game over the network. It is allowed the player to join if any game is open.

2.3 Message Strategy

The message is used for communicating between the network which record the data of the current state of Rule Engine. The message is serialized object that is secure to transfer over network. The responsibility of the message is carrying the data packet of Rule Engine. The key feature of the message is encapsulating the header and the body. The header represents the sender, receiver, the state of the game and the type of the state. And the body is player information which is designing by the data collection of HashMap. It is

really easier to manipulate for the program. The message could be generated by the Rule Engine which recording the current state of the game. It is including the information of each players and the state of the game. The message is designed by carrying the information. Therefore, the client will be able to use the message to update UI immediately.

2.4 Pros and cons Strategy

2.4.1 Pros of the Networking

- Server could update the information to client immediately
- Client could send message of any action in any time to server.
- Either Server or Client could not interrupt the Rule Engine in any time
- Server and client takes less control of the Rule Engine

2.4.2 Cons of the Networking

- Client could send lot of garbage messages to the server
- Server need handle some garbage messages from the client who is not current player

3. Game Design

3.1 Overall Architecture

Server is only transfer the message between Rule Engine and clients. Server would only send and receive the message from Client and Rule Engine. Client is only transfer the message between UI and server. Client would only send and receive the message from Server and send message by UI. Rule Engine is only control the game of Ivanhoe which would take control whole game. It would distribute the request and respond of each action of each player in every state.

3.2 Design Pattern

3.2.1 Motivation

MVC is the Design pattern of Model-View-Controller. It would separate UI from Game. MVC is a simple Design Pattern. Our target of Design Pattern in Ivanhoe is letting layer who can play the game as controller, and it would not take too much control about the game logic. According to Ivanhoe is a multiplayer game, Networking is also implemented to the Game. The MVC will make the program simple and better. And MVC is much clear to understand the game logic easily.

3.2.2 Design Pattern - MVC

The features of MVC could be divide three parts, Model which is the host of the game, View which is UI of current status of the game and Controller which is the representing the player. Rule Engine contains every data of the game and it handle any request in itself as the role of model. Model could handle different stage of the game, in our program, we handle different Request Message. UI displays the data message which is received from the Rule Engine to Client. UI is the view of the game which demonstrate the detail information of every player's information and the state of the game. Client Action Event is the action which will be generate by the player's action. Client Action Events represent the Controller of game. It performs as the role of the player in the game. It will send the Request Message to the Server.

3.3 Refactoring and Implementation

3.3.1 Elimination of duplicated code

- Remove the unused Game functionality from Display and hand
- Remove all unused game state and type in Game Configuration

3.3.2 Redistribution of responsibilities

- Networking was integrated with Rule Engine
- Server gave too much control to clients

- Client has some control of whole game over state
- Server Process Message by different state
- Communication between server, client and Rule Engine

3.4 Pros and cons Game Design

3.4.1 Pros of the MVC

- MVC would never clash with each other.
- Each other could swapped out
- Easy to unit test
- Separates game logic from UI Design

3.4.2 Cons of the MVC

- Difficult to convert from existing code
- They are not considering everything
- Complexity
- View and Controller closely coupled
- Changes in model format would need change in VC

3.5 Bells and Whistles

- Right click any face-up cards to display larger image of the card
- Robustness networking: handling loss of a player
- Robustness of game: preventing playing out of turn or invalid card
- Tournament Panel: Display players order, status and display total

4. Game Rules

Below are pdf pages of the official game rule for Ivanhoe.
Detail Information

Take on the role of a knight and join the prestigious tournaments at the king's court. Use your cards to win the jousting competitions, or fight with your sword, axe or morningstar. Rally your squires, gain the support of a maiden, and surprise your opponents. The first player to win four or five different tournaments becomes the overall victor.

GR-01

Players

Two to five

GR-02

Playing Time

20 to 60 minutes (increasing with the number of players)

Components

110 cards:



70 color cards (14 cards each in five colors)

20 supporter cards (16 squires and four maidens, all in white)

20 action cards (as described below)

25 tokens (five each in five colors)

OVERVIEW

The game consists of many consecutive tournaments. The player who starts a tournament determines which weapon (color) will be used in it. A tournament may start as jousting (purple), as a fight with swords (red), axes (blue) or morningstars (yellow), or as a fight without weapons (green). Usually a tournament is fought with the same weapon (color) throughout. However, some action cards allow the players to change the current tournament weapon (color).

GR-03

GR-04

A player who wins a tournament receives one token of the final color in which the tournament was fought. However, a player who wins a jousting tournament (purple) may take any color token (due to the prestige of the jousting tournament).

GR-05

GR-06

OBJECTIVE

With two or three players, the first player to obtain one token in each of the five colors wins the game.

GR-07

With four or five players, the first player to obtain four different color tokens wins the game.

GR-08

PREPARATION

Players draw from a pool of five tokens of different colors. The player drawing purple shuffles and deals eight cards to each player. Place the remaining cards as a facedown draw deck in the middle of the table. Place all tokens next to the deck (as the pool of tournament prizes).

GR-09

SEQUENCE OF PLAY

GR-10

The player seated to the left of the dealer starts the first tournament. Thereafter it is always the winner of the previous tournament who starts the next one. The player starting the tournament always takes the first turn. Play then progresses clockwise. Each player in his turn may conduct the following steps in the order listed:

GR-11

GR-12

1. Draw a new card
2. Play cards
3. Withdraw from the tournament



DRAW A NEW CARD

GR-13

A player begins his turn by drawing one card from the draw deck. There is no limit to the number of cards a player may have in his hand. When the last card is drawn from the draw deck, reshuffle the discard pile and place it face down to form a new draw deck.

GR-14

STARTING A TOURNAMENT

The player starting a tournament chooses the color in which the tournament will be contested. He may choose any color. He need not have a card of the chosen color, if he has a supporter in his hand. However, if the final color of the last tournament was purple, the winner must choose a different color for this next tournament. If the player who is to start the next tournament only holds action cards, he reveals his hand to prove this, and the next clockwise player begins the tournament.

GR-15

GR-16

The starting player of a tournament must play at least one card face up in front of him, either of his chosen tournament color or a supporter. He may play additional cards, including action cards, as in a normal turn if he wishes.

GR-17

PLAY CARDS

Apart from the player starting a tournament, a player is not required to play any cards in his turn. However, a player must play at least one card from his hand (a color card, a supporter or an action card) each turn to remain in a tournament. A player may play as many cards as he wishes. If a player decides to play color cards, they must match the tournament color.

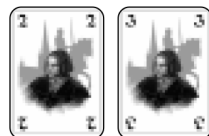
GR-18

GR-19

When a player plays color or supporter cards, he places them face up in front of himself in an area called his display. All card values must be visible, but cards should partially overlap to indicate the order in which they have been played: the first card lies under the second, the second under the third, and so on. The last card lies on top. When a player takes his next turn during the current tournament, he adds newly-played cards to the top of his display so that previously-played cards can still be seen.

At the end of his turn, a player's display must contain the highest total card value showing in order to remain in the tournament. If this is the case, he announces the value of his display to indicate the end of his turn.

GR-20



SUPPORTERS

Instead of or in addition to cards of the tournament color, a player may add supporter cards to his display. Supporter cards of value 2 and 3 are Squires. Each player may have in his display any number



of Squire cards. Supporter cards of value 6 are Maidens. Each player may have only one Maiden card in his display at any one time. If a player withdraws from a tournament while having a Maiden in his display, he must return one of his tokens to the prize pool, if he possesses one.

GR-21

GR-22



GREEN TOURNAMENTS

In a green tournament, all cards in the display are counted as 1 regardless of their printed values. The penalty for withdrawing from a tournament while having a Maiden applies to green tournaments as well (even though the Maiden only counts as 1 for a green tournament).

GR-23

ACTION CARDS

During his turn, a player may play any number of action cards from his hand. Action cards may only be played if they can be executed at that point in time. Apart from the SHIELD and STUNNED cards, all action cards are played face up on the discard pile, and executed right away.

GR-24

CHANGE THE TOURNAMENT COLOR

GR-25

UNHORSE: The tournament color changes from purple to red, blue or yellow, as announced by the player.

GR-26

CHANGE WEAPON: The tournament color changes from red, blue or yellow to a different one of these colors, as announced by the player.

GR-27

DROP WEAPON: The tournament color changes from red, blue or yellow to green.

A player may play some color cards, then change the tournament color, and then continue playing cards of the new color, all in one turn. On the other hand, a player may change the color of a tournament without playing any color cards at all.

After a change of the tournament color, all cards in the display still count, but all new cards played must match the new color. In a green tournament, all cards in the display are counted as 1. However, the cards keep their printed values with respect to any action cards played.

EXAMPLE: If all cards of lowest value are removed (see CHARGE below), only the green cards of value 1 are discarded, other color cards and supporters remain, because they have higher printed values.

AFFECT ONE OR MORE DISPLAYS

Various action cards may be played to affect the displays of one, several or all players. The one overriding rule for all action cards is that a player's display can never be reduced to

less than one card by the result of an action card. If a player's display shows only one card, this card cannot be removed, discarded or taken—though, it may be swapped for another card. If an action card would lead to the removal of the player's entire display, then the first (earliest-played) card remains in his display. After their initial entrance, all players still fighting in the current tournament will have at least one card displayed in front of them.

GR-28

GR-29 **BREAK LANCE:** Force one opponent to discard all purple cards from his display.

GR-30 **RIPOSTE:** Take the last card played on any one opponent's display and add it to your own display.

GR-31 **DODGE:** Discard any one card from any one opponent's display.

GR-32 **RETREAT:** Take any one card from your own display back into your hand.

GR-33 **KNOCK DOWN:** Draw at random one card from any one opponent's hand and add it to your hand, without revealing the card to other opponents.

The following action cards may affect more than one player.

GR-34 **OUTMANEUVER:** All opponents must remove the last card played on their displays.

GR-35 **CHARGE:** Identify the lowest value card throughout all displays. All players must discard all cards of this value from their displays.

GR-36 **COUNTERCHARGE:** Identify the highest value card throughout all displays. All players must discard all cards of this value from their displays.

GR-37 **DISGRACE:** Each player must remove all his supporters from his display.

GR-38 **ADAPT:** Each player may only keep one card of each value in his display. All other cards with the same value are discarded. Each player decides which of the matching-value cards he will discard.

GR-39 **OUTWIT:** Place one of your faceup cards in front of an opponent, and take one faceup card from this opponent and place it face up in front of yourself. This may include the SHIELD and STUNNED cards.

SPECIAL ACTION CARDS

GR-40

SHIELD: A player plays this card face up in front of himself, but separate from his display. As long as a player has the SHIELD card in front of him, all action cards have no effect on his display.

GR-41

STUNNED: Place this card separately face up in front of any one opponent. As long as a player has the STUNNED card in front of him, he may add only one new card to his display each turn.

The SHIELD and STUNNED cards are not part of the display. Only the OUTWIT card allows a player to move these cards, all other action cards affect the players' displays only. When a player withdraws from the tournament, his SHIELD and STUNNED cards go onto the discard pile.

GR-42

IVANHOE: This is the only card a player can play outside of his turn. A player can play it at any time as long as he is still in the tournament. Use this card to cancel all effects of any one action card just played.

WITHDRAWING

A player may withdraw from a tournament at the end of any of his turns. A player need not play any cards in a tournament before withdrawing. If a player withdraws from the current tournament, he discards all cards in front of him on the faceup discard pile next to the draw deck. If a player has a Maiden in his display when he withdraws, he must return one of his tokens to the prize pool, if he has any tokens. After a player withdraws from a tournament, he does not take further turns during that tournament.

GR-43**GR-44**

WINNING A TOURNAMENT

When there are only two players left in a tournament and one of them withdraws, the other player wins the tournament.

A player who wins a tournament receives one token of the final color in which the tournament was fought. However, a player who wins a jousting tournament (purple) may take any color token (due to the prestige of the jousting tournament). Each player may possess only one token of each color. Winning a tournament in a color for which a player already holds a token prevents one of his opponents from gaining the token, but does not otherwise help him win the game. The winner of a tournament also discards all faceup cards in front of him. If nobody has won the game (see Objectives section above), then the tournament winner starts the next tournament.

GR-45**GR-46**

PLAY HINTS

Each time a player withdraws from a tournament, he is increasing his hand size by one card (provided that he did not play a card in the turn of withdrawal). As winning a tournament occurs in another player's turn, the winner of a tournament will not increase his hand size. Playing more than one card during your turn usually reduces your hand and diminishes your power.

The card values in purple are highest, followed by red, blue, yellow and green (see chart on the back page of this rulebook).

SAMPLE TOURNAMENTS

First Tournament

Andy starts the game by drawing a card, then plays a Red 3 face up in front of him to begin a red tournament. He announces “3” to indicate the end of his turn.

Bill draws a card, then plays a Red 5 in front of him and announces “5.”

Chris draws a card and withdraws from the tournament.

Diane draws a card, plays a Red 4 and a Red 3, announcing “7.”

Andy draws, plays a Red 5 partially overlapping his Red 3, announcing “8.”

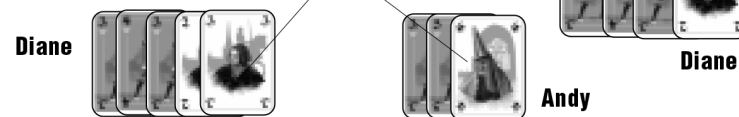
Bill draws, then withdraws and discards his displayed card.

Chris has already withdrawn, so she does nothing.

Diane draws, then plays a Red 3 and a Squire 2, announcing “12.”

Andy draws, then plays a Maiden 6, announcing “14.”

Diane draws then plays a Squire 3, announcing “15.”



Andy draws, then withdraws and discards his displayed cards. As he has a Maiden in his display he would normally lose one of his tokens, but he has none to lose.

Diane wins the tournament, takes a red token and discards her displayed cards.

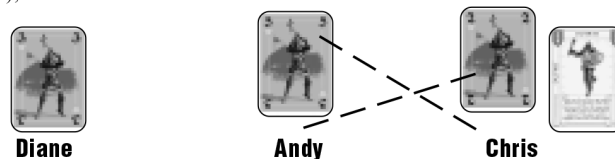
Second Tournament

Diane, having won the last tournament, leads the next tournament. She draws a card, then plays a Blue 3 in front of her, announcing “3.”

Andy draws, then plays a Blue 5, announcing “5.”

Bill draws and then withdraws.

Chris draws, plays a Blue 2 in front of her, then plays OUTWIT onto the discard pile (allowing her to place her Blue 2 into Andy's display, then she takes the Blue 5 from his display and places it in front of her); she announces “5.”



Diane draws, then plays a Blue 4, announcing “7.”

Andy draws and plays RIPOSTE onto the discard pile (allowing him to take the Blue 4 from Diane's display and place it into his own); he announces “6.”

Chris draws, then plays a Blue 5, announcing “10.”



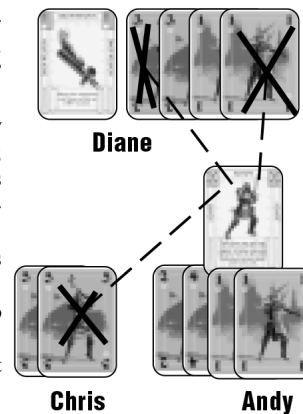
Diane draws, plays a Blue 3, then plays DROP WEAPON onto the discard pile, changing the tournament color from blue to green. She then plays two Green 1s into her display, announcing “4,” as she has four cards in her display.

Andy draws, then plays ADAPT onto the discard pile. Andy’s display contains one 2 and one 4; he has no doubles. Chris has two 5s; she must discard one of them. Diane’s display contains two 3s and two 1s, she must discard one 3 and one 1. Andy then continues his turn and plays two Green 1s, announcing “4.”

Chris draws. Her layout has been reduced to one card. She decides to withdraw.

Diane draws. Her layout has been reduced to two cards. She also withdraws.

Andy wins the tournament, takes a green token and leads the next tournament.



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Many thanks to all playtesters, in particular to **David Farquhar** for all his contributions to the development of the game.

CARD DISTRIBUTION

| | Values: | | | | | | |
|------------------------------|----------------|------------------------|---|---------------|-----------------|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 70 Color Cards | | | | | | | |
| 14 Purple (Jousting) | - | - | 4 | 4 | 4 | - | 2 |
| 14 Red (Sword) | - | - | 6 | 6 | 2 | - | - |
| 14 Blue (Axe) | - | 4 | 4 | 4 | 2 | - | - |
| 14 Yellow (Morningstar) | - | 4 | 8 | 2 | - | - | - |
| 14 Green (No Weapon) | 14 | - | - | - | - | - | - |
| 20 Supporters (White) | | | | | | | |
| 16 Squires | - | 8 | 8 | - | - | - | - |
| 4 Maidens | - | - | - | - | - | 4 | - |
| 20 Action Cards | | | | | | | |
| <u>Change Colors</u> | <u>Special</u> | <u>Affect Displays</u> | | 1 Retreat | 1 Countercharge | | |
| 1 Unhorse | 1 Shield | 1 Break Lance | | 2 Knock Down | 1 Disgrace | | |
| 1 Change Weapon | 1 Stunned | 3 Riposte | | 1 Outmaneuver | 1 Adapt | | |
| 1 Drop Weapon | 1 Ivanhoe | 1 Dodge | | 1 Charge | 1 Outwit | | |

5. Requirements

This section contains what features must be implemented. Each requirement has its own unique identifier, description, plus where the decision to come up with it can be traced to. The source of traceability may either be from the official game rules, assumptions, other requirements, or team decisions.

5.1 Functional Requirements

Functional requirements define what behavior and functionality the software must have. They have been categorized appropriately below, based on different game states of functionality

| ID | Functional Requirement | Traceability |
|-------------------------|---|--------------|
| Network Setup | | |
| FR-NS-01 | Network would initialize the Ivanhoe And open the port for player join | GR-09 |
| FR-NS-02 | Each Player would be able to join the network to play Ivanhoe | GR-01 |
| FR-NS-03 | Network would check the total of players joined the game | GR-01 |
| FR-NS-04 | Server would stop waiting for new players if all players joined | GR-01 |
| Setup | | |
| FR-S-01 | Initialize the deck to 110 cards | GR-02 |
| FR-S-02 | Deal eight cards to each players | GR-09 |
| FR-S-03 | Initialize the players order | GR-13 |
| FR-S-04 | Initialize the first player | GR-10 |
| Start Tournament | | |
| FR-ST-01 | The player who starts a tournament choose tournament color | GR-03 |
| FR-ST-02 | The winner of the previous tournament start next one | GR-11 |
| FR-ST-03 | The player starting tournament takes the first turn | GR-13 |
| FR-ST-04 | If previous color is purple, new tournament color cannot be purple again | GR-16 |
| FR-ST-05 | If player only have actions cards, he reveals his hand to prove this, and the next clock wise player begins the tournaments | GR-17 |

| Draw Card | | |
|------------------|---|-------|
| FR-DC-01 | There is no limit to the number of cards a player can have | GR-14 |
| FR-DC-02 | When the last card is drawn from the deck, reshuffle the deadwood pile as a new deck | GR-15 |
| Play Card | | |
| FR-PC-01 | Starting player of a tournament must play chosen tournament color or a supporter card first | GR-18 |
| FR-PC-02 | Player can only play the card match the tournament color | GR-04 |
| FR-PC-03 | Player must play one card from his hand, each turn to remain in a tournament | GR-19 |
| FR-PC-04 | Player decides to play color card, they must play a tournament color card or support card | GR-20 |
| FR-PC-05 | Each player may have only one Maiden card in the display at any time | GR-22 |
| FR-PC-06 | In green tournament, all cards in display are counted as value of one | GR-24 |
| FR-PC-07 | Action cards may only be played if it can be executed at that point in time | GR-25 |
| FR-PC-08 | Player's display shows only one cards, this card cannot be removed, discarded or taken-thought, it may be swapped for another card | GR-29 |
| FR-PC-09 | Playing Unhorse: The tournament color changes from purple to red, blue or yellow, as announced by the player | GR-26 |
| FR-PC-10 | Playing Change Weapon: The tournament color changes from red, blue or yellow to different one of these colors, as announced by the player | GR-27 |
| FR-PC-11 | Playing Drop Weapon: The tournament color changes from red, blue or yellow to green | GR-28 |
| FR-PC-12 | Playing Break Lance: Force one opponent to discard all purple cards from his display | GR-29 |
| FR-PC-13 | Playing Riposte: Take the last card played on any one opponent's display and add it to your own display | GR-30 |
| FR-PC-14 | Playing Dodge: Discard any one card from any one opponent's display | GR-31 |
| FR-PC-15 | Playing Retreat: Take any one card from your own display back into your hand | GR-32 |

| | | |
|-----------------|---|-------|
| FR-PC-16 | Playing Knock Down: Draw at random one card from any one opponent's hand and add it to your hand, without revealing the card to other opponents | GR-33 |
| FR-PC-17 | Playing Outmaneuver: All opponents must remove the last card played on their displays | GR-34 |
| FR-PC-18 | Playing Charge: Identify the lowest value card throughout all displays. All players must discard all cards of this value from their displays | GR-35 |
| FR-PC-19 | Playing Countercharge: identify the highest value card throughout all displays. All players must discard all cards of this value from their displays | GR-36 |
| FR-PC-20 | Playing Disgrace: Each player must remove all his supporters from his display | GR-37 |
| FR-PC-21 | Playing Outwit: Place one of your face-up cards in front of an opponent, and take one face-up card from this opponent and place it face up in front of yourself. This may include the shield and stunned cards | GR-38 |
| FR-PC-22 | Playing Shield: A player play this card face up in front of himself, but separate from his display. As long as a player has the shield card in front of him, all action cards have no effect on his display | GR-39 |
| FR-PC-23 | Playing Stunned: Place this card separately faces up in front of any one opponent. As long as a player has the stunned card in front of him, he may add only one new card to his display each turn | GR-40 |
| FR-PC-24 | Playing Ivanhoe: This is the only card a player can play outside of his turn. A player can play it at any time as long as he is still in the tournament. Use this card to cancel all effects of any one action card just played | GR-41 |
| End Turn | | |
| FR-ET-01 | Player must have the highest total card value to remain in the tournament | GR-21 |
| Withdraw | | |
| FR-W-01 | Player withdrawing with a Maiden in the display must remove a token if there is one | GR-23 |
| FR-W-02 | After a player withdraws from a tournament, player cannot take further turns during that tournament | GR-42 |
| FR-W-03 | There are only two players left in a tournament and one of them withdraws, the other player wins the tournament | GR-43 |

| Win Tournament | | |
|-----------------------|--|-------|
| FR-WT-01 | A player who wins the tournament gets tournament color token | GR-05 |
| FR-WT-02 | A player winning purple tournament can chose any color tokens | GR-06 |
| FR-WT-03 | Each player may process only one token of each color | GR-44 |
| FR-WT-04 | Nobody has won the game then winner starts the next tournament | GR-45 |
| Game Over | | |
| FR-GO-01 | With two or three players, the first players to obtain one token in each of the five colors win the game | GR-07 |
| FR-GO-02 | With four or five players, the first player to obtain four different color tokens wins the game | GR-08 |

5.2 Non-Functional Requirements

Non-functional requirements deal with the quality of which the program must satisfy. Concerning aspects such as accessibility, usability, and maintainability which is relate to Rule Engine

| ID | Non-Functional Requirement | Traceability |
|-----------|--|---------------------|
| NFR-01 | Server would start and initialize the rule engine | FR-NS-01 |
| NFR-02 | Client would be able to join the game of Ivanhoe | FR-NS-02 |
| NFR-03 | Sever would wait for all player to join the game | FR-NS-03 |
| NFR-04 | Server would close the port when all players have joined | FR-NS-4 |

5.3 Assumptions

Throughout figuring out the problem space, assumption needed to be made in order to capture software requirements. Many of the requirements above would therefore trace back to items below. The following table identifies them along with their justifications.

| ID | Assumption | Justifications |
|-----------|--|---|
| A-01 | Player must start a new tournament if they can | It is pointless to have a game with no one wants to start |

| | | |
|------|---|--|
| A-02 | After winning a purple tournament, the previous tournament is purple regardless of the token chosen | The winning token color does not affect to previous tournament color |
| A-03 | It is possible to withdraw without entering a tournament | Entering the tournament is optional for players |
| A-04 | Can remain in the tournament without adding a card to display | Playing action card can raise your display total to highest and remain in tournament |
| A-05 | Can play action card on a player who is not in the tournament | Some action card would be affect to their hand or display |
| A-06 | Ivanhoe can be used when Shield is played | Shield does not protect against Ivanhoe |
| A-07 | Can play Stunned on a player with Shield | Stunned can bypass shield |
| A-08 | Shield only protect against action from other people | Your own action cards would affect your own display |
| A-09 | Player can only play one card at a time | Overcome the special case of Ivanhoe playing, easier to implement robustness check |

6. Use Cases

Use case depicts a scenario, the game engine, and the path of game logic that may follow. In this cases of Ivanhoe, it including the player over the networking.

6.1 Use Case Diagram

The diagram of the Ivanhoe over the networking to demonstrate how the Ivanhoe work



6.2 Use Cases

Each use case is detailed in its own table, describing their sequence of events depend on the game logic

| ID | Name | Description |
|-------|---------------|--|
| UC-01 | Create Server | <p>System create a game of Ivanhoe</p> <p>Actors: System</p> <p>Triggering Event: Server starts running the Ivanhoe Game</p> <p>Pre-Condition(s): No game is created yet.</p> <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Initialize the server setting <ol style="list-style-type: none"> 1.1. Set the number of players 1.2. Set the default IP and port 2. Run the server 3. Waiting for the player to join the game <p>Resulting Event: Server is ready for player join</p> <p>Traceability: FR-NS-01, NFR-01, NFR-02 GR-01, GR-09</p> |
| UC-02 | Join Server | <p>Player join the server to play</p> <p>Actors: Player, Rule Engine, System</p> <p>Triggering Event: Ivanhoe Server is running</p> <p>Pre-Condition(s): Player is not already in the Ivanhoe Server</p> <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Player joins the Ivanhoe Server 2. System add player to Rule Engine 3. Ivanhoe initialize the player information 4. System wait for all players to joined 5. System closes all waiting ports when all players joined <p>Resulting Event: System updates players list to Rule Engine</p> <p>Alternative Scenario: Not all players have joined: System waits until all players have joined</p> <p>Traceability: FR-NS-02, NFR-03, NFR-04 GR-01</p> |

| | | |
|-------|------------------|---|
| UC-03 | Setup | <p>Rule Engine set up the game</p> <p>Actors: System, Rule Engine</p> <p>Triggering Event: All players have joined the server</p> <p>Pre-Condition(s): Game is not set up yet</p> <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. System tells Rule Engine to setup Ivanhoe 2. Rule Engine initialize the deck 3. Rule Engine initialize the player orders 4. Rule Engine randomly choose first player 5. Rule Engine deal cards to each players 6. Deal card to first player <p>Result Event: Ivanhoe is setup</p> <p>Traceability: FR-S-01, FR-S-02, FR-S-03, FR-S-04, FR-S-05 GR-02, GR-09, GR-10, GR-13</p> |
| UC-04 | Start Tournament | <p>A player starts a new tournament</p> <p>Actors: Player, Ivanhoe, System</p> <p>Triggering Event: Ivanhoe is set up</p> <p>Pre-Condition(s): The Tournament did not start yet</p> <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Player prompted to choose a tournament color <ol style="list-style-type: none"> 1.1. Ivanhoe tells System to start game 1.2. System forwards message to Player 2. Player chooses a tournament color 3. Player sends tournament color choice to System 4. System forwards message to Ivanhoe 5. Ivanhoe update the tournament color <p>Resulting Event: Player has chosen a tournament color</p> <p>Alternative Scenarios:</p> <ol style="list-style-type: none"> 1. Previous color is purple: new tournament color cannot be purple 2. Player only have action cards: next clockwise player start tournament <p>Traceability: FR-ST-01, FR-ST-02, FR-ST-04, FR-ST-05 GR-03, GR-11, GR-16, GR-17</p> |
| UC-05 | Draw Card | <p>Player draws a card</p> <p>Actors:</p> |

| | | |
|-------|-----------|---|
| | | <p>Player, Ivanhoe, System</p> <p>Triggering Event: Player has chosen a tournament color</p> <p>Pre-Condition(s): When it is player's turn</p> <p>Main Sequence: <ol style="list-style-type: none"> 1. Ivanhoe deals card to Player 2. Ivanhoe sends updated information to System 3. System forwards message to Player </p> <p>Resulting Event: The player has drawn a card</p> <p>Alternative Scenarios: <ol style="list-style-type: none"> 1. When the last card is drawn from the deck: Reshuffle the deadwood pile as the new deck </p> <p>Traceability: FR-DC-02 GR-15</p> |
| UC-06 | Play Card | <p>Player wants to play a card</p> <p>Actors: Player, Ivanhoe, System</p> <p>Triggering Event: The player has drawn a card</p> <p>Pre-Condition(s): <ol style="list-style-type: none"> 1. It is player's turn 2. Player did not end turn yet 3. Player is not withdrawn </p> <p>Main Sequence: <ol style="list-style-type: none"> 1. Player sends card request to System 2. System forwards message to Ivanhoe 3. Ivanhoe handles the card effect 4. Ivanhoe sends updated information to System 5. System forwards message to all players </p> <p>Resulting Event: Player play a card</p> <p>Alternative Scenarios: <ol style="list-style-type: none"> 1. Card does not match tournament color: Card is not played 2. First card played in the tournament: Card must be tournament color or support 3. Player has Maiden card in the display: Cannot play another Maiden 4. In Green Tournament: All card in the display are counted as value of one 5. Playing action card: Can only be played if it can be executed at that point in time 6. Last card in display: No action card can remove this card 7. Shield in the display: No opponent's action card can affect </p> |

| | | |
|-------|----------|--|
| | | <p>display</p> <ol style="list-style-type: none"> 8. Stunned in the display: Cannot add more than one card to display per turn 9. Ivanhoe: Cancel the effect of any action card <p>Traceability:</p> <p>FR-PC-01, FR-PC-02, FR-PC-04, FR-PC-05 , FR-PC-06, FR-PC-07, FR-PC-08, FR-PC-22, FR-PC-23, FR-PC-24</p> <p>GR-18, GR-04, GR-20, GR-22, GR-24, GR-25, GR-29, GR-39, GR-40, GR-41</p> |
| UC-07 | End Turn | <p>Player ends their turn</p> <p>Actors:</p> <p>Player, Ivanhoe, System</p> <p>Triggering Event:</p> <p>Player wants to end their turn</p> <p>Pre-Condition(s):</p> <ol style="list-style-type: none"> 1. It is player's turn 2. Player did not end turn yet <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Player sends end turn to System 2. System forwards message to Ivanhoe 3. Ivanhoe check the total of player's display and finds next player 4. Ivanhoe checks for a winner 5. Ivanhoe sends "Play or Withdraw" to System 6. System forwards message to Player <p>Resulting Event:</p> <p>Player ends the turn</p> <p>Alternative Scenarios:</p> <ol style="list-style-type: none"> 1. Player display's total value is not highest: Ivanhoe withdraws the player <p>Traceability:</p> <p>FR-ET-01</p> <p>GR-21</p> |
| UC-08 | Withdraw | <p>Player withdraw the tournament</p> <p>Actors:</p> <p>Player, Ivanhoe, System</p> <p>Triggering Event:</p> <p>Player wants/needs to withdraw</p> <p>Pre-Condition(s):</p> <ol style="list-style-type: none"> 1. It is player's turn 2. Player did not withdraw yet <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Player sends withdraw to System 2. System forwards message to Ivanhoe 3. Ivanhoe check if player has Maiden 4. Ivanhoe check if there is a winner |

| | | |
|-------|----------------|---|
| | | <ol style="list-style-type: none"> 5. Ivanhoe sends next player “Play or Withdraw” to System 6. System forwards message to next Player <p>Resulting Event: Player withdraw the tournament</p> <p>Alternative Scenarios:</p> <ol style="list-style-type: none"> 1. Player withdraw with Maiden: Player must remove a token if there is one 2. Second last player withdraws from the tournament: The last player wins the tournament. <p>Traceability: FR-W-01, FR-W-02, FR-W-03 GR-23, GR-42, GR-43</p> |
| UC-09 | Win Tournament | <p style="text-align: center;">A player wins the tournament</p> <p>Actors: Player, Ivanhoe, System</p> <p>Triggering Event: The second last player withdraw the tournament</p> <p>Pre-Condition(s): Last non-withdrawn player in the tournament</p> <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Ivanhoe gives the tournament color token to player 2. Ivanhoe check if player win game 3. Ivanhoe sends “start new tournament” message to System 4. Server forwards message to Player <p>Resulting Event: Player wins the tournament</p> <p>Alternative Scenarios:</p> <ol style="list-style-type: none"> 1. Purple tournament: Player choose any tournament color token 2. Player wins the game: Ivanhoe game is over 3. Player already has tournament color token: Player does not get the tournament color token <p>Traceability: FR-WT-01, FR-WT-02, FR-WT-03, FR-WT-04 GR-05, GR-06, GR-44, GR-45</p> |
| UC-10 | Game Over | <p style="text-align: center;">A player wins the game</p> <p>Actors: Player, Ivanhoe, System</p> <p>Triggering Event: A player wins the tournament</p> <p>Pre-Condition(s):</p> <ol style="list-style-type: none"> 1. A player has all five tournament color tokens in 2-3 player game 2. A player has any four tournament color tokens in 4-5 player game <p>Main Sequence:</p> <ol style="list-style-type: none"> 1. Ivanhoe update the winner information 2. Ivanhoe send the winner information to System 3. System forwards message to Players |

| | | |
|--|--|---|
| | | <p>Resulting Event: Ivanhoe game is over</p> <p>Traceability: FR-GO-01, FR-GO-02 GR-07, GR-08</p> |
|--|--|---|

7. Design Decisions

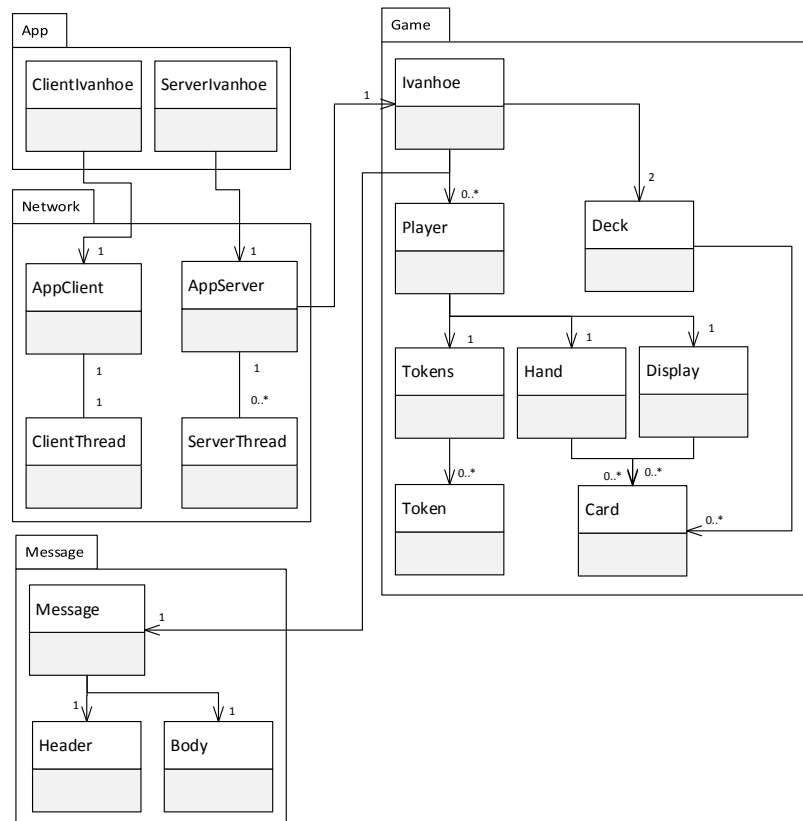
This section documents design decisions that have been taken with respect to classes and objects chosen for the system. Included is a Unified Modeling Language (UML) diagram.

7.1 Decisions

| ID | Design Decision | Traceability |
|-------|--|----------------|
| DD-01 | Use a peer-to-peer model for networking | Group Decision |
| DD-02 | Separate the networking from Rule Engine | Group Decision |
| DD-03 | Client has no control over game state | Group Decision |
| DD-04 | MVC is the design pattern for Rule Engine | Group Decision |
| DD-05 | Convert object using Object-Oriented Programming | Group Decision |

7.2 Structural Model (UML)

UML Class Diagram



8. Object Specification

This section is demonstrating Object Specification of the Project. Below of the table are described the all objects for the program of Ivanhoe

8.1 ClientIvanhoe

| | |
|--|-------------------------------|
| Class Name: ClientIvanhoe | |
| Responsibilities: Create New GUI Client for Ivanhoe | Collaborators: ClientPanel |

8.2 ServerIvanhoe

| | |
|--|--|
| Class Name: ServerIvanhoe | |
| Responsibilities: Create New GUI Server for Ivanhoe | Collaborators: HostPanel, AppServer |

8.3 AppClient

| | |
|--|--|
| Class Name: AppClient | |
| Responsibilities: Initialize Client Network | Collaborators: ClientPanel, Message, ClientThread |

8.4 AppServer

| | |
|--|---|
| Class Name: AppServer | |
| Responsibilities: Initialize Server Network | Collaborators: HostPnael, Message, Ivanhoe, Player, ServerThread |

8.5 ClientThread

| | |
|---|-----------------------------|
| Class Name: ClientThread | |
| Responsibilities: Initialize Client Thread | Collaborators: AppClient |

8.6 ServerThread

| | |
|---|-----------------------------|
| Class Name: ServerThread | |
| Responsibilities: Initialize Server Thread | Collaborators: AppServer |

8.7 Message

| | |
|---|--------------------------------|
| Class Name: Message | |
| Responsibilities: Initialize Header and Body | Collaborators: Header, Body |

8.8 Header

| | |
|--|----------------|
| Class Name: Header | |
| Responsibilities: Initialize Header | Collaborators: |

8.9 Body

| | |
|--------------------------------------|----------------|
| Class Name: Body | |
| Responsibilities: Initialize Body | Collaborators: |

8.10 Token

| | |
|---|----------------|
| Class Name: Token | |
| Responsibilities: Display Information of Token | Collaborators: |

8.11 Tokens

| | |
|--|---|
| Class Name: Tokens | |
| Responsibilities: Add Token to Tokens Remove Token from Tokens Check if Tokens Contain Token Clean Tokens Check if Tokens Has Four Unique Token Check if Tokens Has All Token Display Information of Tokens | Collaborators: Token Token Token Token Token Token Token |

8.12 Player

| | |
|---|---|
| Class Name: Player | |
| Responsibilities: Withdraw Player Clear the Display Check If Has Token Give Token to Player Add Card to Display Add Card to Hand Check If Player is Withdrawn Display Information of Player | Collaborators: Display Tokens, Token Tokens, Token Display, Card Hand, Card Tokens, Hand, Display |

8.12 Card

| | |
|---|----------------|
| Class Name: Card | |
| Responsibilities: Check Two Card Equal Is Action Card Is Supporter Is Maiden Is Ivanhoe Display Information of Card | Collaborators: |

8.13 Deck

| | |
|---|--|
| Class Name: Deck | |
| Responsibilities: Initialize the Deck Add Multiple Same Cards to Deck Add Single Card to Deck Remove Given Card from Deck Shuffle the Deck Check If Empty Deck Clear the Deck Check If Contain Card Copy Cards from Different Deck | Collaborators: Card Card Card Card Card Card Card Card Card |

8.14 Display

| | |
|---|--|
| Class Name: Display | |
| Responsibilities: Increase Number of Card Played Reset Number of Card Played Check If Display is Empty Check Display for Purple Card Check Display for Value Card Check Display for Support Card Check Display for Shield Check Display for Stunned Add Card to Display Remove Card from Display Check Display for Maiden Card Update Display with Status Is Tournament green Does Display has Shield Does Display has Stunned Display Information of Display | Collaborators: Card Card Card Card Card Card Card Card Card Card |

8.15 Hand

| | |
|------------------------------------|----------------|
| Class Name: Hand | |
| Responsibilities: | Collaborators: |
| Check If Only Last Card in Hand | Card |
| Add Card to Hand | Card |
| Play Card from Hand | Card |
| Check If Only Action Cards in Hand | Card |
| Check If Ivanhoe is in Hand | Card |
| Check If Maiden is in Hand | Card |
| Display Information of Hand | Card |

8.16 Ivanhoe

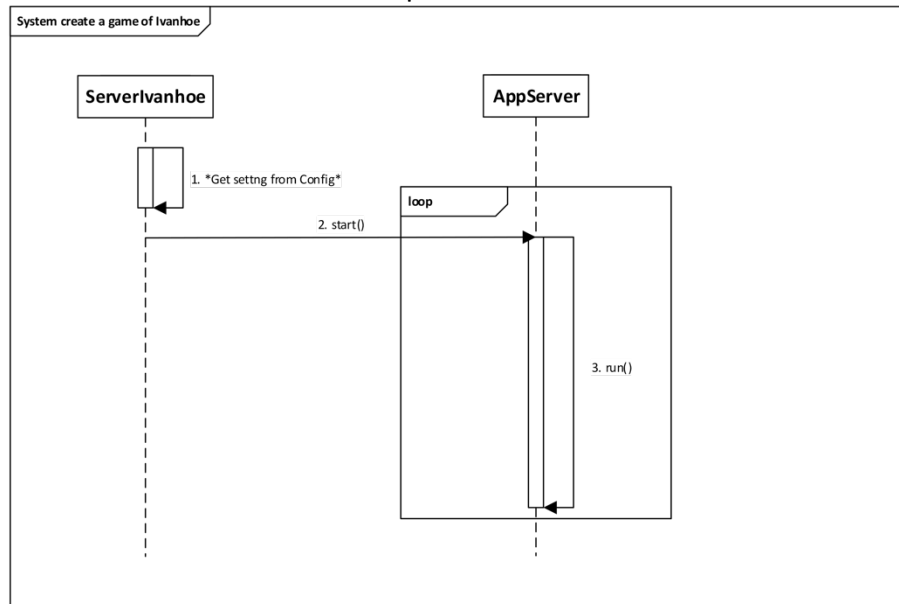
| | |
|--------------------------------------|---|
| Class Name: Ivanhoe | |
| Responsibilities: | Collaborators: |
| Initialize the Ivanhoe Game | Player, Deck |
| Initialize the Hand of all players | Player, Deck, Card |
| Initialize the Player Orders | Player |
| Select the First Player | Player |
| Setup the Game of Ivanhoe | Player, Deck, Card |
| Deal Card to Current Player | Player, Deck, Card |
| Select Tournament Color | Player, Message, Display |
| Check If Player Play or Withdraw | Player, Message, Tokens, Token, Deck, Display, Card |
| Check Which Token to Remove | Player, Message, Tokens, Token |
| Check If There is A Winner | Player, Message, Tokens, Token, Deck, Display, Card |
| Play A Card | Player, Message, Deck, Hand, Display, Card |
| Check If Player Play Ivanhoe | Player, Message, Deck, Hand, Card |
| Change Tournament Color | Player, Message, Deck, Card |
| End Turn | Player, Message, Deck, Hand, Display, Card |
| Win Purple Tournament | Player, Message, Tokens, Token |
| Process Message | Player, Message, Tokens, Token, Deck, Hand, Display, Card |
| Update Current Player to Next Player | Player, Display, Card |
| Discard Display from All Players | Player, Display |
| Check If Player Total is Highest | Player, Hand, Display, Card |
| Player Play Card | |
| Update State | |
| Update Tournament Color | Player, Display |
| Add Player | Player |
| Remove Player | Player |

9. Interaction Diagrams

Contained below are UML 2.0 Interaction Diagrams as Message Sequence Chart. Each correspond to the previous bound use case maps

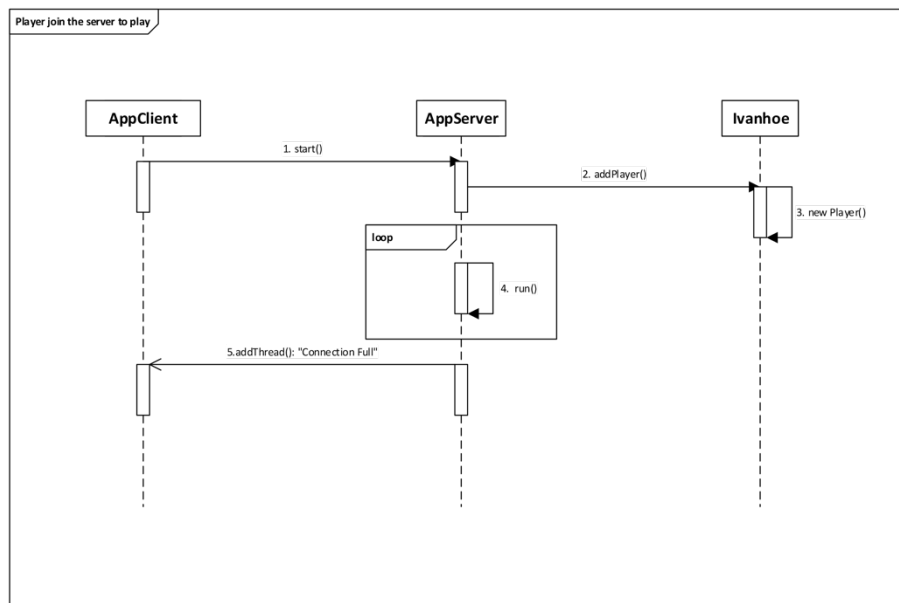
9.1 MSC-01

Corresponds to UC-01



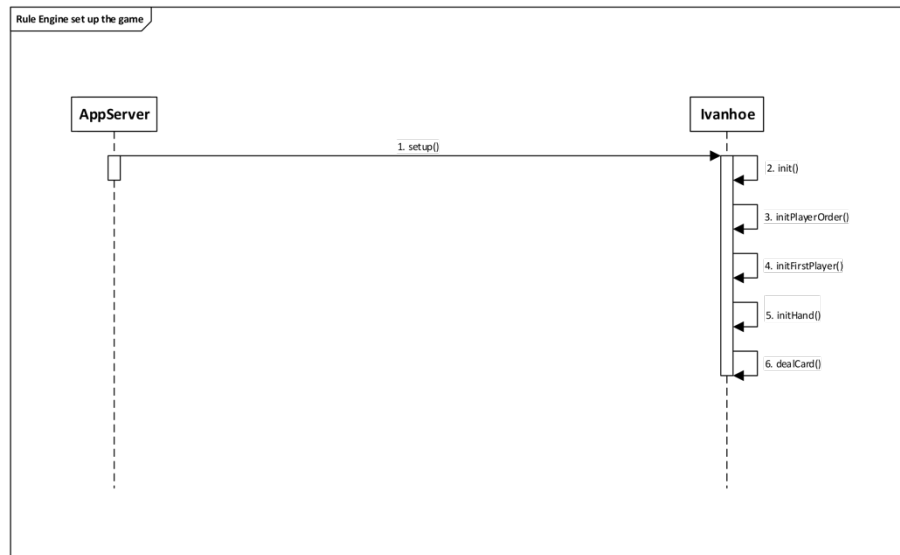
9.2 MSC-02

Corresponds to UC02



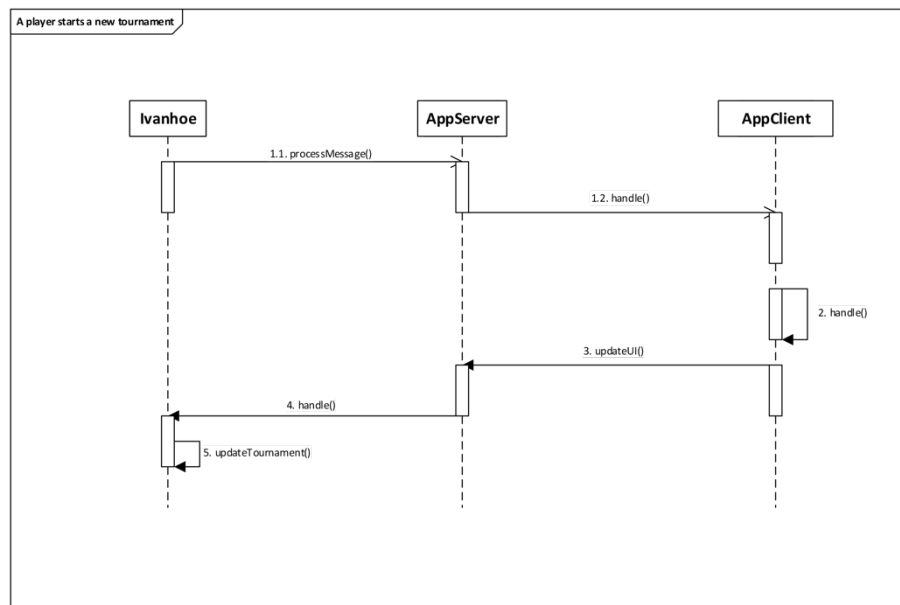
9.3 MSC-03

Corresponds to UC-03



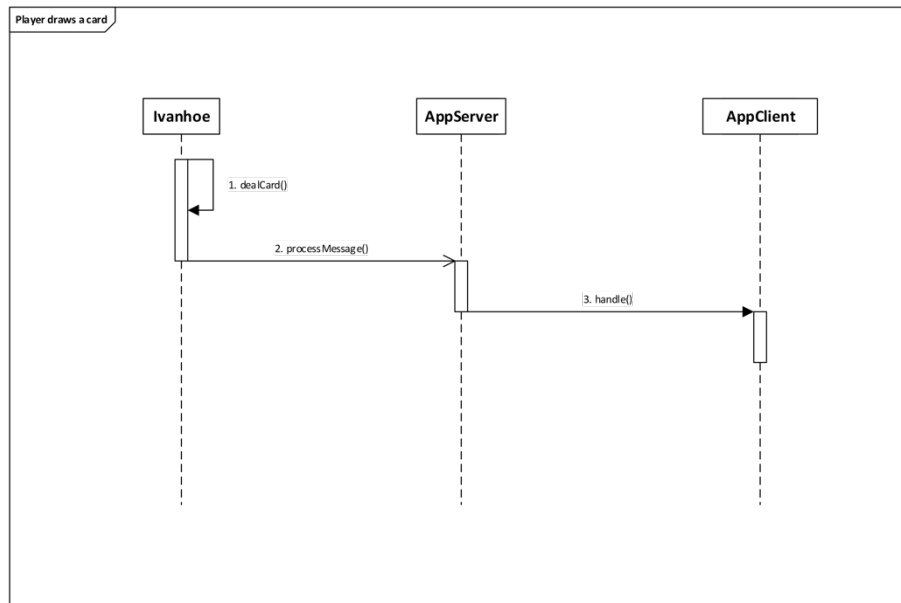
9.4 MSC-04

Corresponds to UC-04



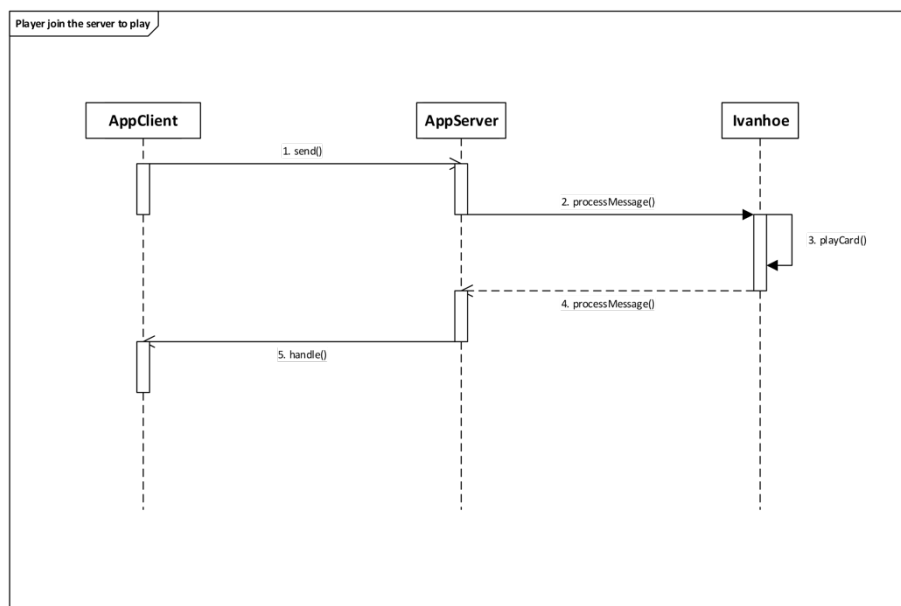
9.5 MSC-05

Corresponds to UC-05



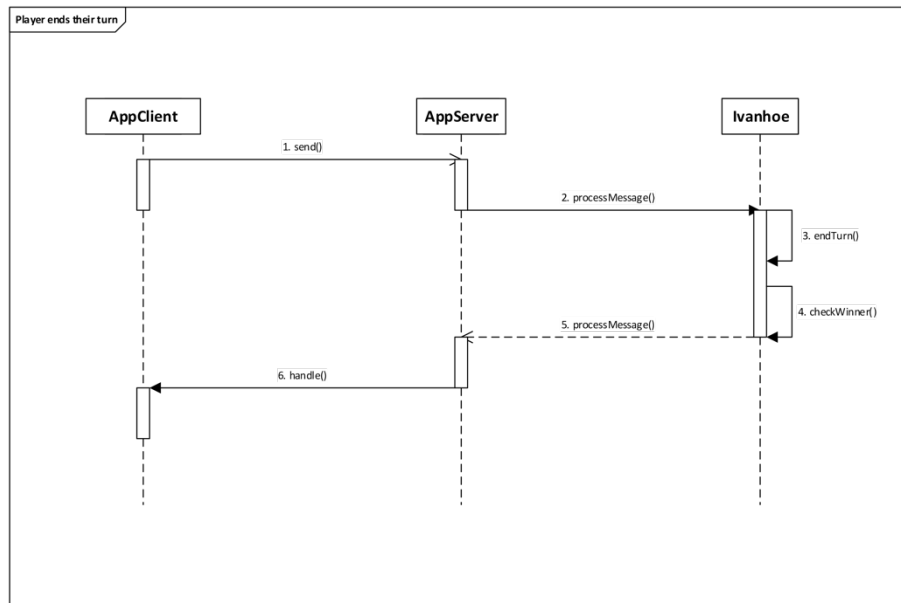
9.6 MSC-06

Corresponds to UC-06



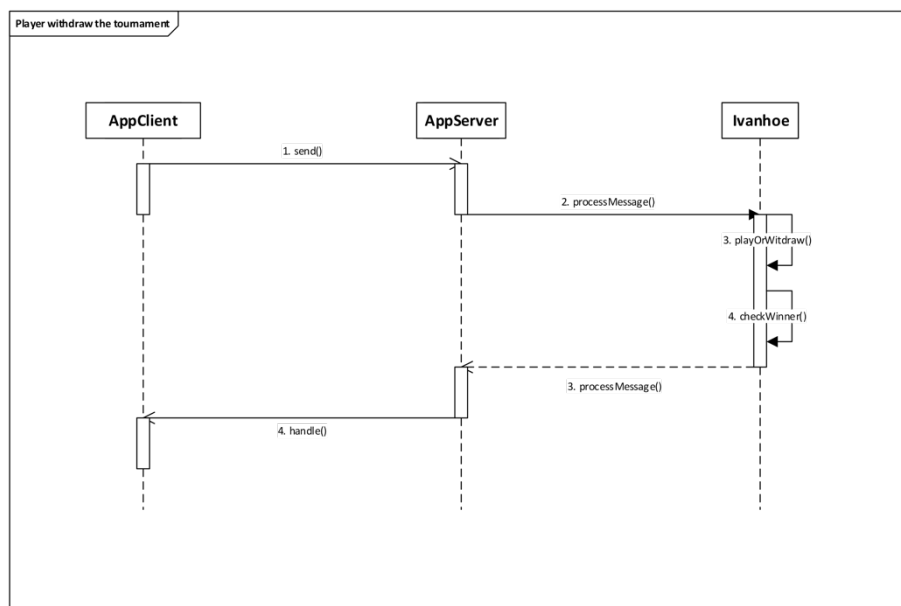
9.7 MSC-07

Corresponds to UC-07



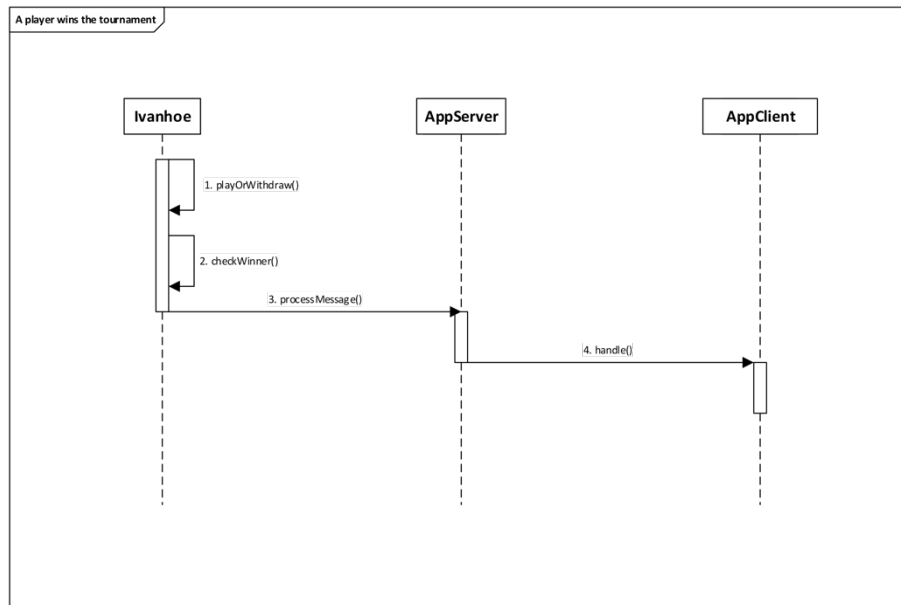
9.8 MSC-08

Corresponds to UC-08



9.9 MSC-09

Corresponds to UC-09



9.10 MSC-10

Corresponds to UC-10

