Supreme Checkers

Software Design Document

Context

Drexel University | **SE-181: Intro to Software Engineering**
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Project Members

Christopher Clifford crc339@drexel.edu
Henry Dang hd349@drexel.edu
Peter Mangelsdorf pjm349@drexel.edu
Conner Pierce ccp49@drexel.edu
Thomas Trimbur tft27@drexel.edu

Faculty

Filippos I. Vokolos fvokolos@drexel.edu

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1.0 Introduction

1.1 Purpose

The purpose of this design document to provide design guidelines for the implementation of the Overlord-Supreme Checkers

game. This document will serve as a reference for the developers coding the game.

1.2 Scope

The major functionality of Overlord-Supreme Checkers is to provide an interface for two players to compete in an online match of checkers.

1.3 Definitions

1.3.1 Checkers

Tile A spot on the board upon which a piece could be placed or moved.

Man A regular checkers piece.

King A piece that can move diagonally backward.

Player A user who has connected to an opponent in the game and is about to begin the game, in the process of playing the game, or has finished the game. A player either controls the light or dark pieces. This term will be used to refer to the current player (the player whose turn it is).

Opponent A user who has connected to a game against the player. The opponent is also a player.

Move An action either player can take. This action involves moving a piece from one tile to another at least once, and may involve capturing another tile.

Turn A time frame in which either player makes one or more moves.

Pile A player's collection of captured opponent pieces.

Software

Photon Unity Networking or **PUN** A C# library for creating server- based networking applications.

2.0 Design Overview

2.1 Description of Problem

The problem is creating a way to play American checkers over the internet with automatic rules enforcement.

2.2 Technologies Used

This checkers game will use Unity3D as the core engine for rendering models and taking in user input. We will be utilizing Photon's PUN unity asset in order to handle the networking for the game.

The target platform will be Microsoft Windows and Linux, and the development environment will be Visual Studio Code and IntelliJ.

2.3 System Architecture

This system will be constructed from the following components:

- Game Model - All of the classes related to creating our checkers game, such as the Board, Piece, Player, etc. All of the game data during a checkers game is stored in-memory inside of the game model and updated/synchronized using Photon PUN.
- Photon PUN - A networking cloud service that integrates with the Unity engine through a marketplace asset and is used to handle data synchronization between clients.
- Game Interface - The UI that the player will interact with to play checkers.
- Local Storage - Storage for data across sessions, like names.

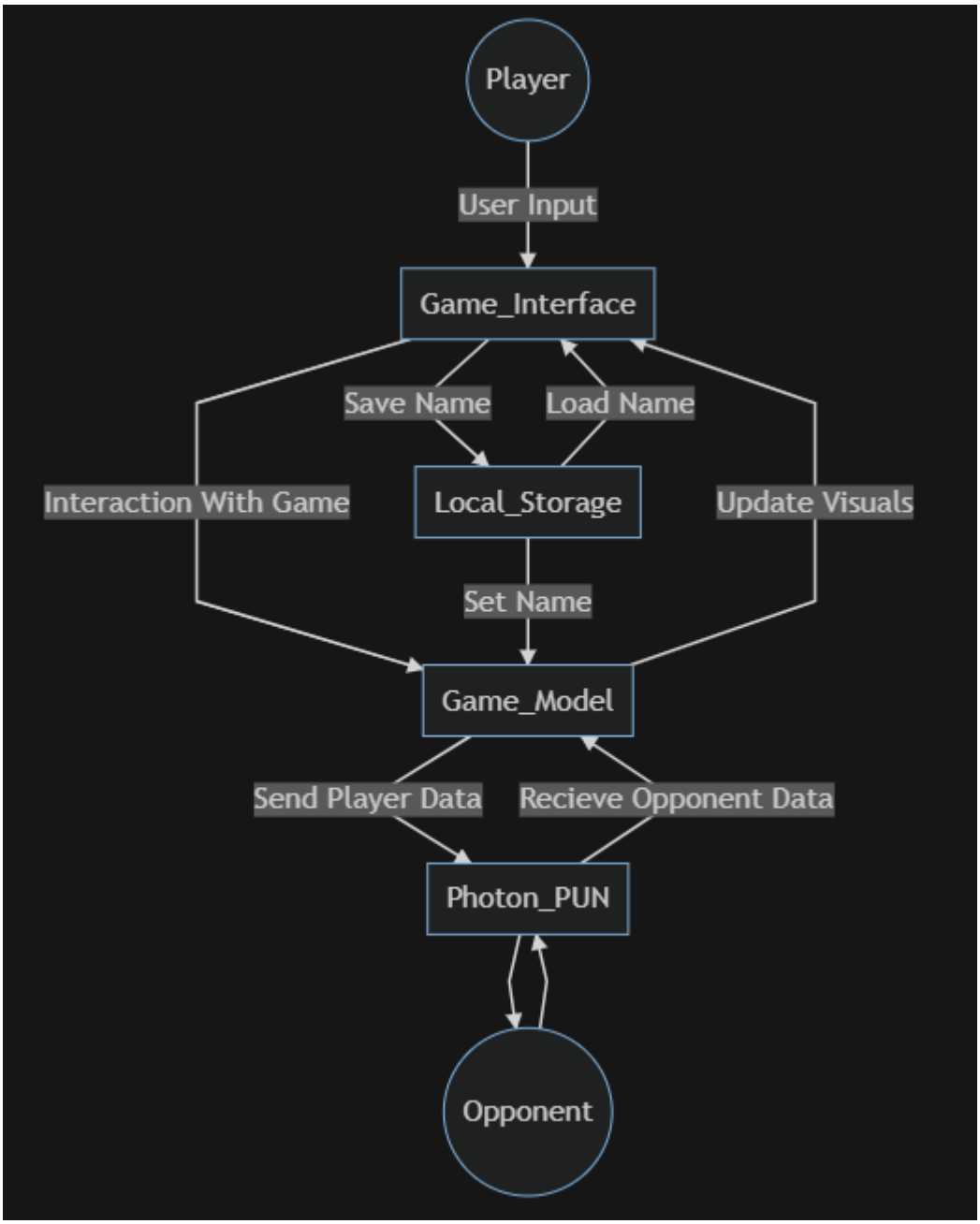
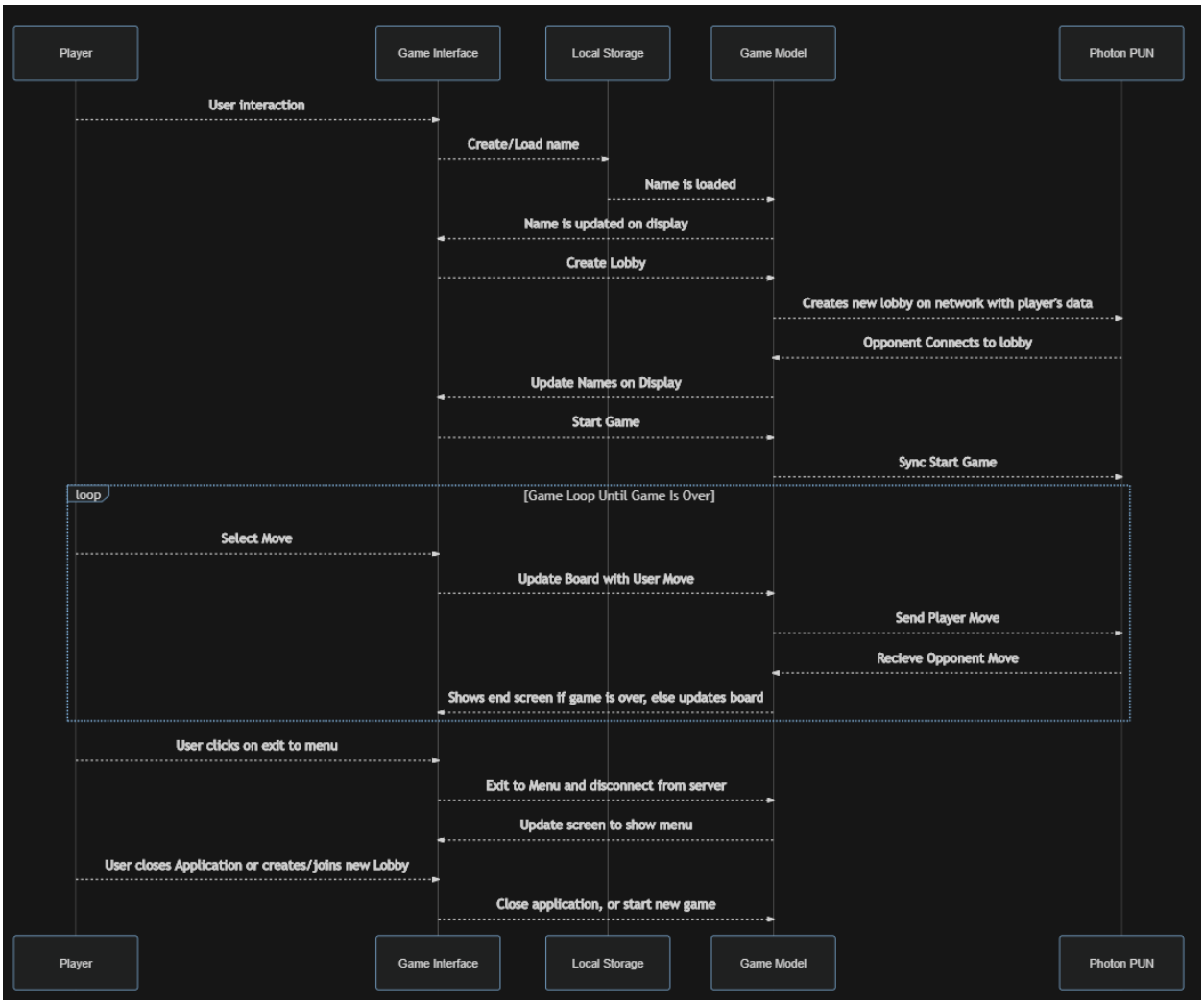


Figure 1 above shows the connections between our high-level components.

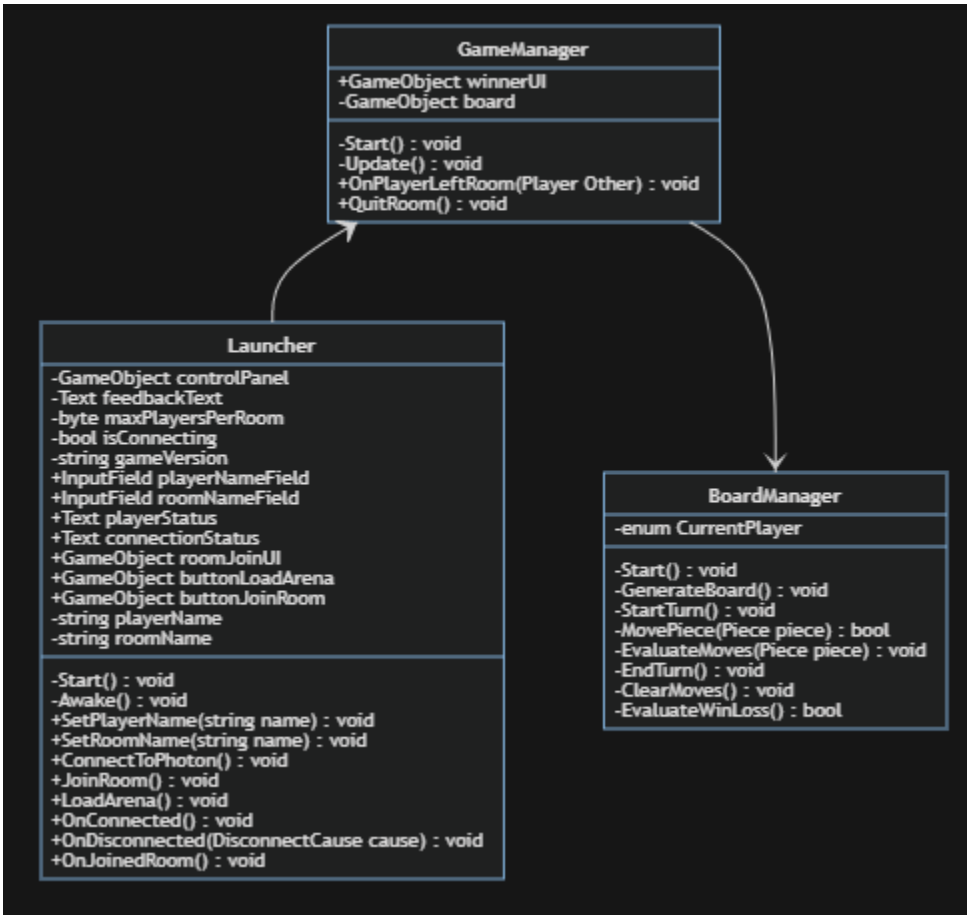
2.4 System Operation

Figure 2 shows the sequence of events that occur during a normal game of checkers.


Player
Game Interface
Local Storage
Game Model
Photon PUN
User interaction
Create/Load name
Name is loaded
Name is updated on display
Create Lobby
Creates new lobby on network with player's data
Opponent Connects to lobby
Update Names on Display
Start Game
Sync Start Game
loop
[Game Loop Until Game Is Over]
Select Move
Update Board with User Move
Send Player Move
Recieve Opponent Move
Shows end screen if game is over, else updates board
User clicks on exit to menu
Exit to Menu and disconnect from server
Update screen to show menu
User closes Application or creates/joins new Lobby
Close application, or start new game
Player
Game Interface
Local Storage
Game Model
Photon PUN

3.0 Networking Design Overview

The figure below shows the UML diagram of our networking interface.



Referenced this for network structure: https://www.raywenderlich.com/1142814-introduction-to-multiplayer-games-with-unity-and-photon

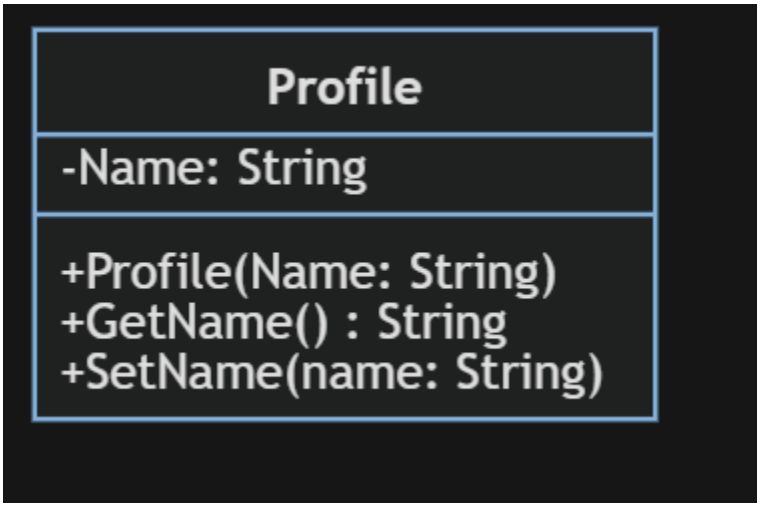
4.0 Requirements Traceability

Requirement	Description	Design Reference
R4.2.*	Matchmaking	6 - Photon & Networking Interfaces
R4.3.*	Environment	6 - Board & Piece Interfaces
R4.4.*	Start of Game	6 - Board Interface
R4.5.*	Gameplay	6 - Board Interface
R4.6.*	End of Match	6 - Board Interface
R5.1.*	Network Performance	3, 7
R5.2.*	Operating System Requirements	6
R5.3.*	Availability	6
R5.4.*	Security	7
R5.5.*	Usability	6
R5.6.*	Maintainability	6

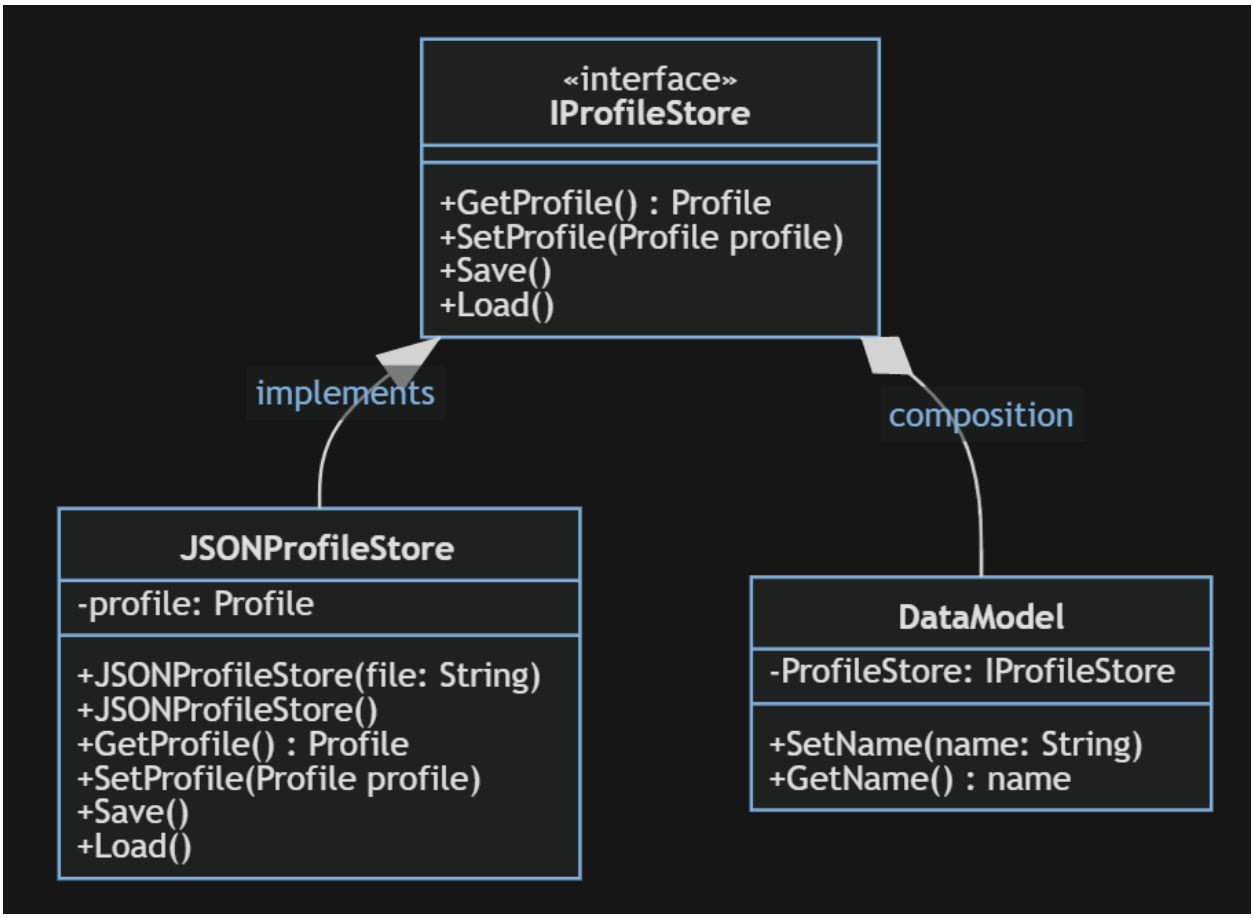
5.0 Data Model and Storage

Data Model

The figure below depicts the UML for the Profile data model.



The figure below depicts the UML for the data storage.



5.1 DataModel

DataModel provides a facade for the data storage library.

5.1.1 Attributes

Name	Type	Description
ProfileStore	IProfileStore	Used to access the player's profile.

5.1.2 Methods

SetName(name: String)

Input	The player's new username.
Output	Void
Description	Modifies the user's current username and saves it.

GetName(): String

Input	Void
Output	The player's current username.
Description	Retrieves the player's current username.

5.2 IProfileStore

IProfileStore is an interface that provides resources for accessing the user's profile.

5.2.1 Methods

GetProfile(): Profile

Input	Void
Output	The player's current profile.
Description	Retrieves the player's current profile from memory.

SetProfile(profile: Profile)

Input	The player's new profile.
Output	Void
Description	Modifies the player's current profile in memory.

Save()

Input	Void
Output	Void
Description	Saves the state of the player's current profile in memory.

Load()

Input	Void
Output	Void
Description	Loads the state of the player's current profile into memory.

5.3 JSONProfileStore

JSONProfileStore is an implementation of IProfileStore that stores the player's profile in a JSON file.

5.3.1 Attributes

Name	Type	Description
Profile	Profile	An in-memory state of the player's current profile.

5.3.2 Methods

GetProfile(): Profile

Input	Void
Output	The player's current profile.
Description	Retrieves the player's current profile from memory.

SetProfile(profile: Profile)

Input	The player's new profile.
Output	Void
Description	Modifies the player's current profile in memory.

Save()

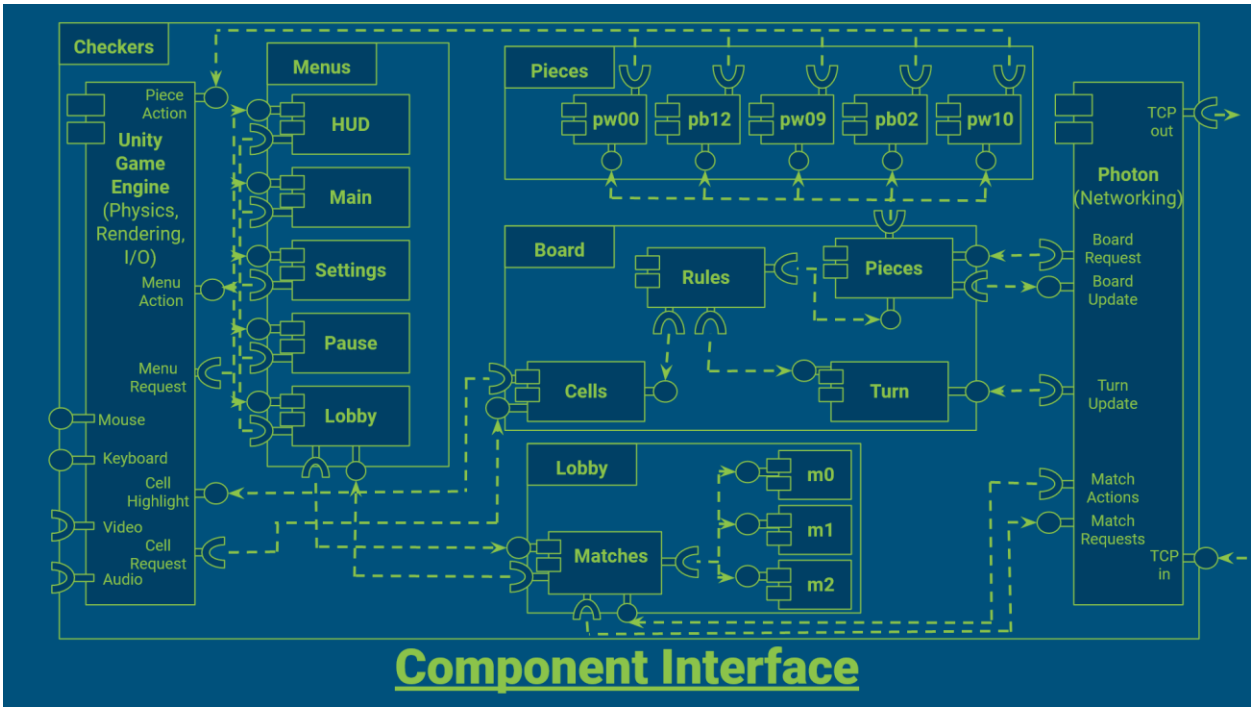
Input	Void
Output	Void
Description	Saves the state of the player's current profile to a JSON file.

Load()

Input	Void
Output	Void
Description	Loads the state of the player's current profile into memory from a JSON file.

6.0 Interface

6.1 Diagram



6.2 *Unity*'s Architecture

- The *Unity* Game Engine makes heavy use of the *Component* design pattern
- It does so in support of an *Object Oriented Entity Component System*
- A game is composed of *Scenes*
- Each *Scene* has a collection of *GameObjects*
- Each *GameObject* is a *3D Primitive* with attached *Scripts* (called *MonoBehaviors*)
- All *MonoBehaviors* are extended from the base *MonoBehavior* and concern a set of *Lifetime Events* and *Lifetime Methods*
- These *Lifetime Methods* are a way of embedding side-effects within every *GameObject*, such as *2D Image Rendering*, *Physics Rendering* (position), and *Input/Output*
- These *GameObjects* differentiate between themselves by which *MonoBehaviors* they happen to have attached to themselves
- The *Scene* organized *GameObjects* under a tree of *Parent-Child* relationships
- Any *GameObject* can be *serialized* to a *Prefab*, similarly to the *Prototype* software pattern
- This allows multiple instances of the same *GameObject* to exist within a scene
- A Common organizational pattern in *Unity* is the use of *Empty GameObjects*, that have no *MonoBehaviors*, and simply hold other *GameObjects*
- *Photon*, our *Networking Solution*, also embeds itself within *GameObjects*

6.3 Representing *Unity*'s Architecture

- We can generally represent *GameObjects* in *Unity* as *Components*
- *Empty GameObjects* can be represented as *Projects* (holding *Components*)
- Since *Unity* handles *2D Image Rendering* (show piece positions), *Physics Rendering* (*move* the pieces to new positions), and *Input/Output Management* (mouse, keyboard), we include it as a *Component* in the diagram, despite it actually being a capability embedded in every *GameObject*
- Likewise, *Networking* is shown as a separate *Component*, despite also being included in every *GameObject*
- Instead of focusing on all *Network*, *Physics*, and *Image Rendering* interactions, we show particular interactions, such as *Cell Highlighting*, *Piece Movement*, and *Cell Selection*

6.4 Major Concerns

Menus **(Project)**

- each *Menu* has a very similar interface it shares with the *Unity Game Engine*
- each *Menu* adjusts a broad range of things, such as *Settings*, but otherwise has few strong dependencies with other *Components*
- These largely communicate with on-screen, flat (2D) images and the *Unity Game Engine* itself to adjust variables

Unity Game Engine **(Component)**

- *Unity Game Engine* is largely a broad collection of side-effectful computation
- It handles *User Input*, *User Output*, *Menu Interaction*, and *Board Interaction*

Pieces **(Project)**

- this is simply to demonstrate that the *Pieces* (Component) of the *Board* (Project) must be able to reference many *Piece-s* (Component-s) and set their *Physical Position* given their *Logical Position*

Board **(Project)**

- This is the largest part of the project we are developing
- It encompasses the most responsibilities, and is shown as separate *Components* to illustrate this
- The *Rules* (Component) includes number of hops, hop distances, promotion, capturing, rule delegation
- The *Turn* (Component) simply tracks whose turn it is separate from the *Piece Positions*
- The *Cells* (Component) is how players interact with the board, and highlights particular cells, checks what pieces are in particular cells, and communicates those changes through the *Rules* (Component) to the *Pieces* (Component)
- as such, the majority of the *Relevant State* (Logical Piece Positions), carried across *Turns*, is contained to the *Pieces* (Component)

- The *Pieces* (Component) and *Turn* (Component) are therefore the only parts of the *Board* (Project) that needs to communicate with the *Photon* (Component) to issue and receive updates with the other *Player*

Lobby (Project)

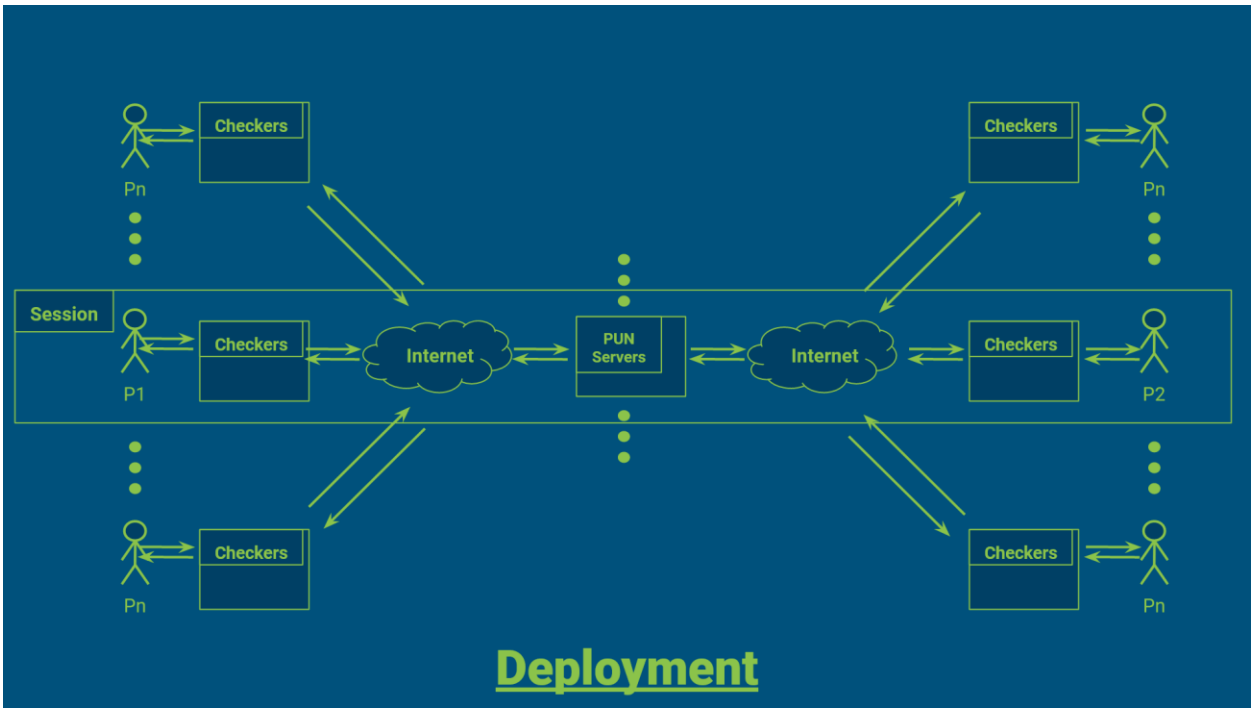
- This tracks what *Matches* other *Players* have created and allows *Unmatched Players* to join those *Players* who have opened a *Match* to play
- The *Matches* (Component) issues and receives updates using *Photon*

Photon (Component)

- This enables the *Game* to work, by exchanging *Board State* in generic *TCP* Game Status Packets
- The *Messages* include *Board State* (positions, turns), *Match State* (username), and *Match Actions* (join, leave, create)

7.0 Deployment

7.1 Diagram



7.2 Notes

- Many *Sessions* can occur
- Many *PUN Servers* (Photon Unity Networking) can exist
- Many *Players* can exist
- All communications are done through the *Internet*