Literature Review

Benjamin Hedges and Zach Wilson
Kennesaw State University

Abstract—**This project aims to explore a model for online matchmaking by implementing and testing it in a simulated environment, focusing on how various algorithms, types of matchmaking systems, and the power of computers affect player queue times and match quality. The project will be documented and evaluated based on the model's performance and insights gained.**

I. INTRODUCTION

Server matchmaking in games has become a more relevant topic as the popularity of online gaming has risen. Many modern games explore different solutions to create fair matches for their players and as technology develops, more complicated ones emerge. Some examples include the shift from peer-to-peer networking to dedicated servers and the addition of skill-based matchmaking. Furthermore, more factors come into play when discussing finding high-quality matches for online games such as quality of computers, internet connection, and region. Overall this project seeks to explore these factors to find an optimal solution for modern online matchmaking such that, it is fun, fair, and efficient for all players.

II. LITERATURE REVIEW

The first resource titled "Multi-Parameterised Matchmaking: A Framework" considered for our work relates to skill-based matchmaking where players are matched into games based on their skill levels and match history [1]. This paper utilizes two skill rating systems commonly used in online games, ELO and TrueSkill, and proposes a framework, built from a heuristic to determine an optimal solution for skill-based matchmaking [1]. The findings from this article will be utilized in our model to develop a system to analyze the fairness of skill-based matchmaking systems compared to simple connection-based systems.

An additional article being considered explores a solution for hosting online games without a centralized server. It proposes that the networking load be shared amongst a group of clients that work together and monitor the status of the game, taking the load from a centralized server [2]. A particularly noteworthy concept used in this research is the "Ring Structure" model which aims to detect failures by ensuring each node can look up or down in the chain and transfer responsibilities in the event of a failure [2].

The third resource we will be using is called "Data Communications and Networking" particularly the Chapter involving TCP (23.4.9) since it is one of the best data communication methods for online multiplayer gaming.[3]. Along with other chapters and information in the textbook that we will utilize in our project. including Chapter 30 Quality of Service.

The fourth and final important document being used for this model details the difference between the use of dedicated servers and a peer-to-peer approach. It details the primary functions of a game server such as hosting sessions, managing players' networks, and handling the logic for the game state and processing [4]. It also highlights some key advantages and disadvantages that give us an idea of what to expect from the simulation model.

III. METHODOLOGY

Given our research on different methods to create online matches in games, we propose simulating several combinations of the models explored in this research. Our models will analyze the outcome of creating games using a peer-to-peer structure vs a dedicated server structure alongside whether to use skill-based matchmaking or not. In each model, parameters will be randomly simulated to test different algorithms, specifically skill-based matchmaking effectively. These parameters can also assist in determining the fairness of each match.

These simulations will be conducted using OMNet++, a software designed with networking simulations in mind. In total, two models will be tested, one using a standard dedicated server architecture and the other using the "Ring Structure" peer-to-peer structure. Each of these models will be thoroughly tested under two different matchmaking protocols, specifically skill-based and connection-based. The skill-based simulation will utilize the ELO system, which assumes that players' ranks fall under a normal distribution [1], so players' ranks will be assigned as such. From there, players will be matched with other players of a similar ELO rating and good connections to each other. On the other hand, the connection-based approach will simply match players with the only core parameter being connection strength. For each of these models, the model will then calculate networking variables such as connection times, ping, and packet loss. Additionally, it will calculate a game quality metric that will estimate the players' satisfaction based on the difference in average skill level between teams/players, queue times, average ping, and packet loss.

IV. EXPECTED RESULTS

For our simulation we expect the results to show significant or at least noticeable differences in both the queue times and the match quality between the different systems used. For SBM (Skill Based Matchmaking) we are expecting slightly longer queue times for the trade-off of a more fair and equal match, as all of the players will be closer in terms of skill. Now a simpler connection system will have a more efficient time but for the trade-off of a higher potential for an unfair match

which will impact the players' experience. For Peer-to-Peer we expect lower costs for servers at the trade-off of higher latency compared to dedicated servers which are the opposite. Our simulation will focus on and measure these trade-offs and their actual impact on the players' overall satisfaction.

V. Conclusion

This project will give a strong insight into the complexities of the matchmaking systems used in modern gaming by comparing different systems to determine their pros and cons. These findings will demonstrate the balance between several factors like fairness, efficiency, performance, and cost. By taking both a P2P (Peer-to-Peer) approach and dedicated servers and testing them with several different matchmaking algorithms we strive to propose an optimal matchmaking model that a plethora of different games and player bases can use. The end goal is to improve the quality of all online matchmaking gaming experiences by finding a solution that is the fairest, and cheapest option to bring an encompassing fairness to all who play.

References

[1] A. H. Christiansen, B. Friis Nielsen, and E. Gensby, "Multi-parameterised matchmaking: A framework," in *2018 IEEE Conference on Computational Intelligence and Games (CIG)*, 2018.

[2] M. Boroń, J. Brzeziński, and A. Kobusińska, "P2p matchmaking solution for online games," *Springer*, 2019.

[3] B. A. Forouzan, *Data communications and networking*. Mcgraw-Hill, 2013.

[4] N. Kostic, "What is a dedicated game server why use one?" *Phoenix NAP*, 2024.