



WPI

Exploring the Effects of Latency Compensation Techniques on Player Performance and Experience in FPS Games

Ivan Klevanski, Alex Mitchell, Yihong Xu, Sitsanok Young

Acknowledgements

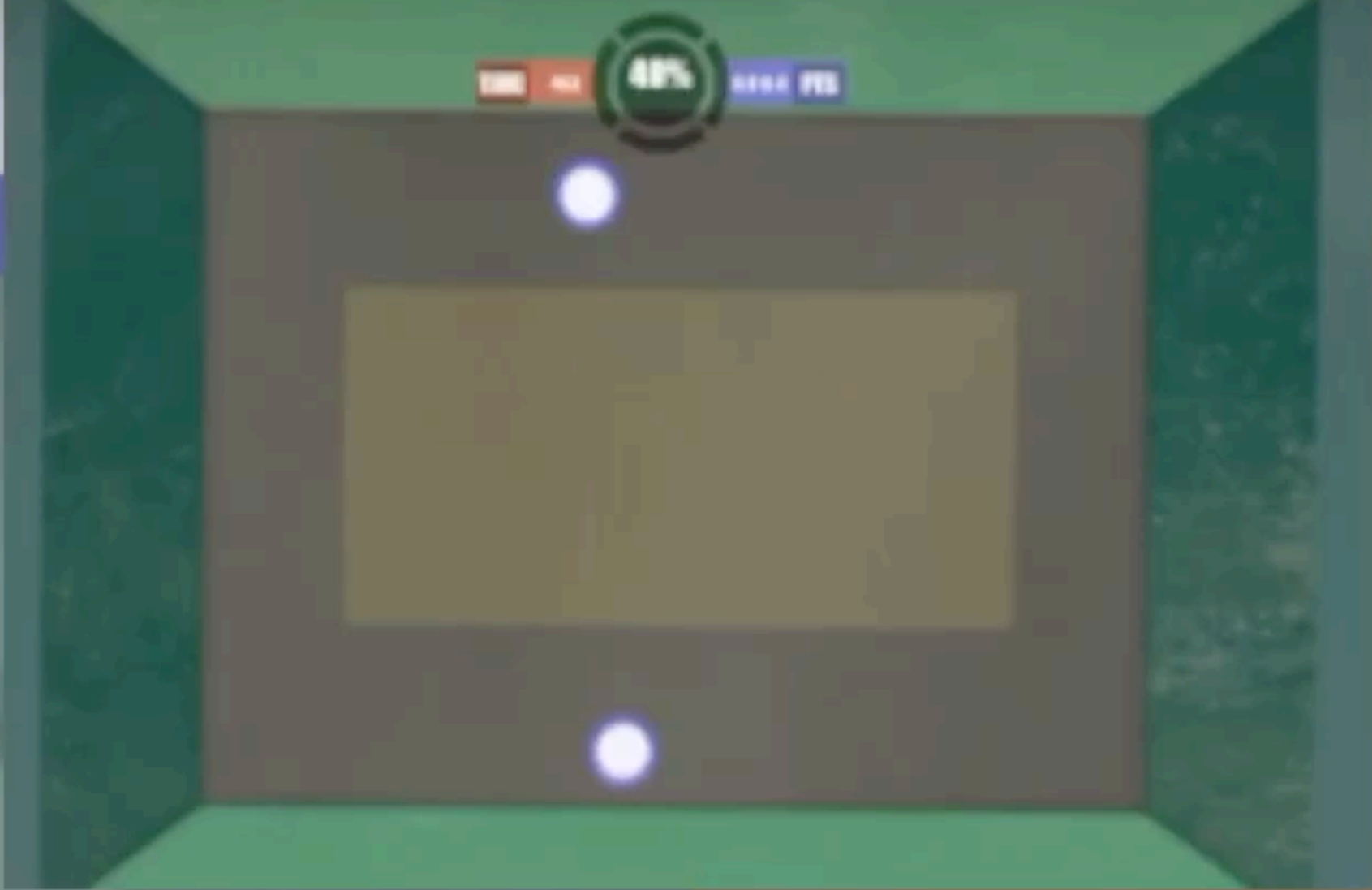
Advisor: Professor Mark Claypool

NVIDIA: Ben Boudaound, Josef Spjut, Joohwan Kim

WPI Contributors: Samin Shahriar Tokey, Alexander Hayden, Ben Peters, Mattheus Faria, Miles Gregg, Jonathan Hsu, Pari Nguyen



TIME 44.3
40% SHOOTER
K: 1 D: 0 PTS



TIME 44.2
40% RUNNER
K: 0 D: 1 PTS



Credit: Wesley Lo, Shiyu Wu, Haojun Yan for music compilation, playing, and editing



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Introduction

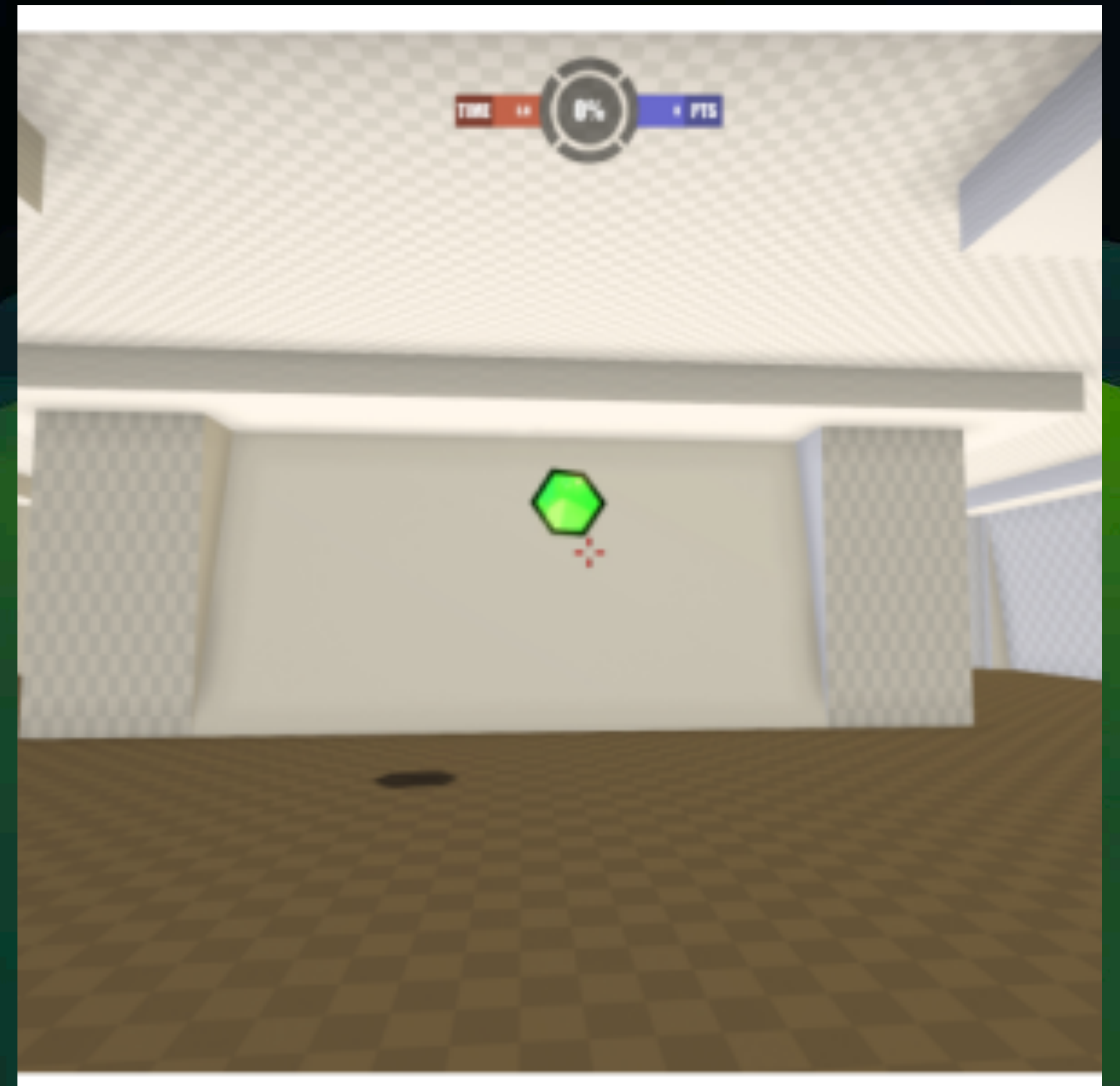
Motivation

- Latency affects user experience in networked games
- Delay between player's action and server feedback can cause unresponsiveness
- Mitigation techniques have been developed to compensate
- Limited public research and testing in this field
- Study focused on two compensation techniques: time warp and latency exposure

Introduction

First-Person Science (FPSci)

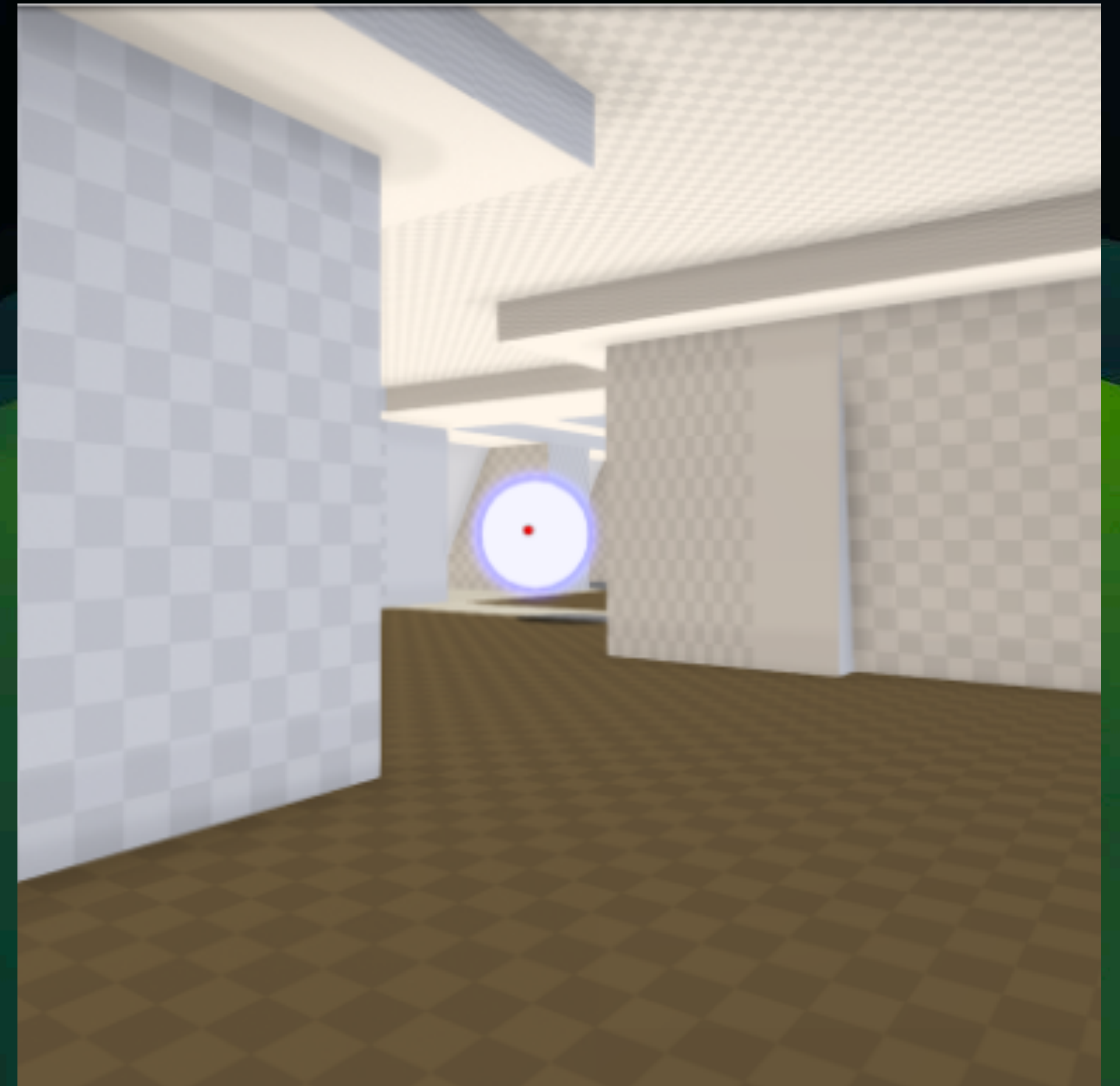
- Open-source, experiment-centric Single Player FPS game
- Developed by NVIDIA for research purposes
- Designed to study a broad set of user interactions at low local latency



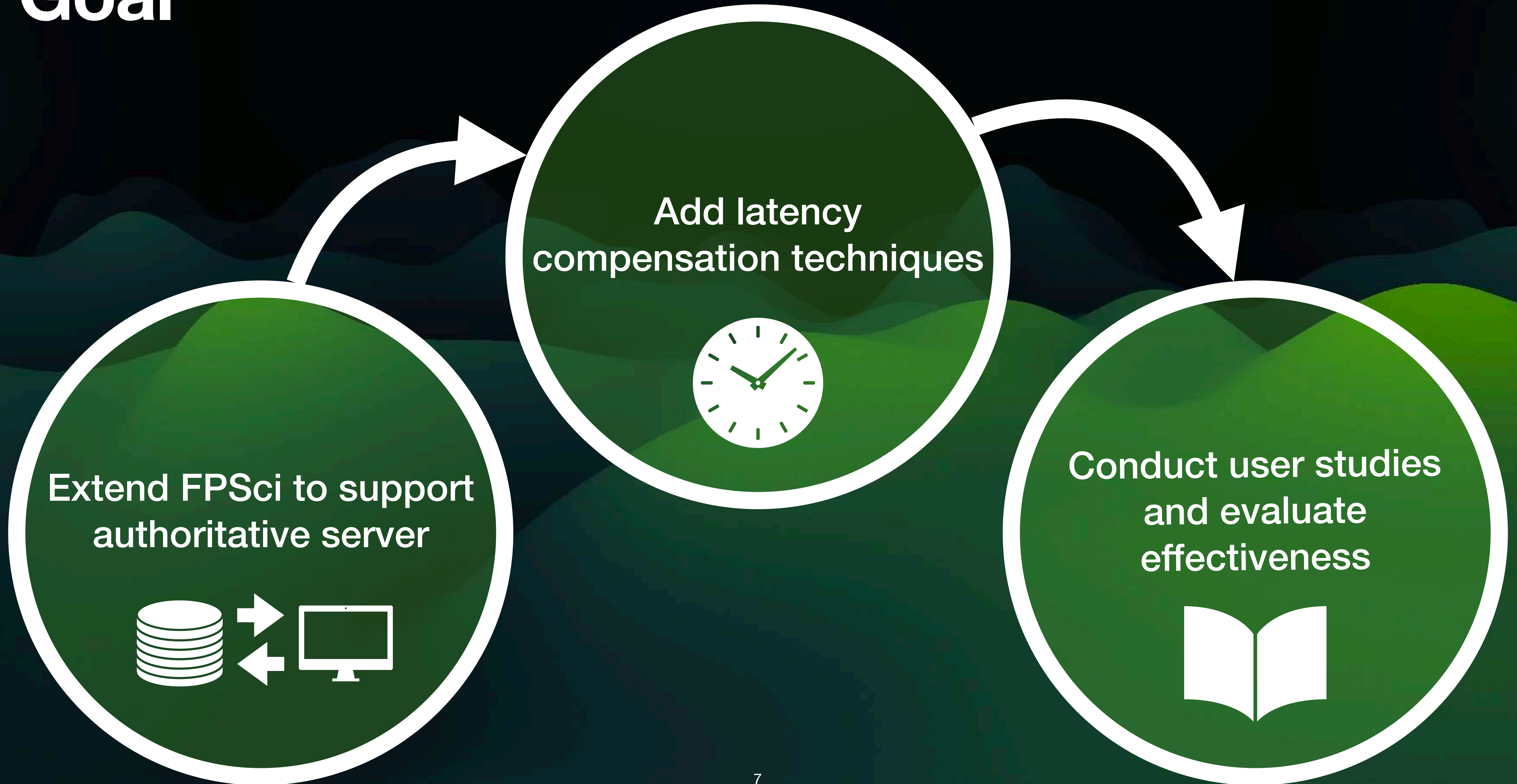
Introduction

Previous MQP

- Converted FPSci to a multiplayer game
- Broadcasting Server
- Client authoritative movement and shooting
- Networking and packet infrastructure

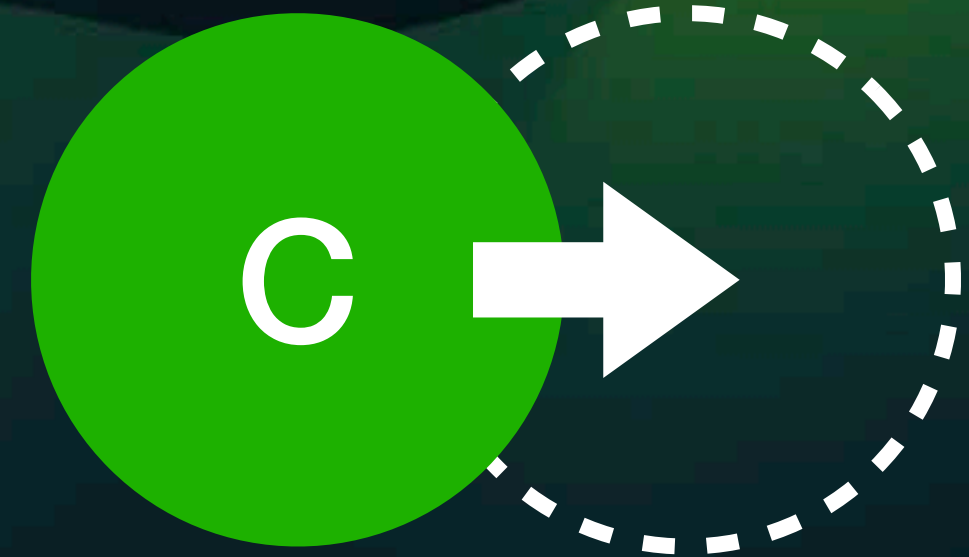


Goal

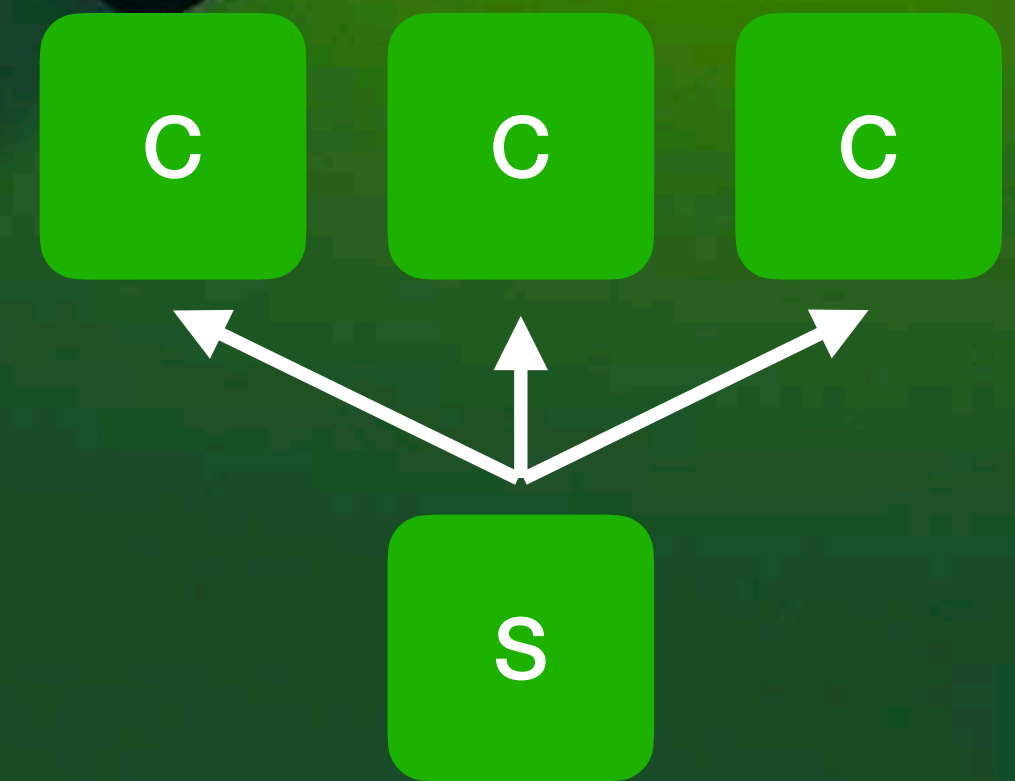


Implementation

Authoritative Server Structure

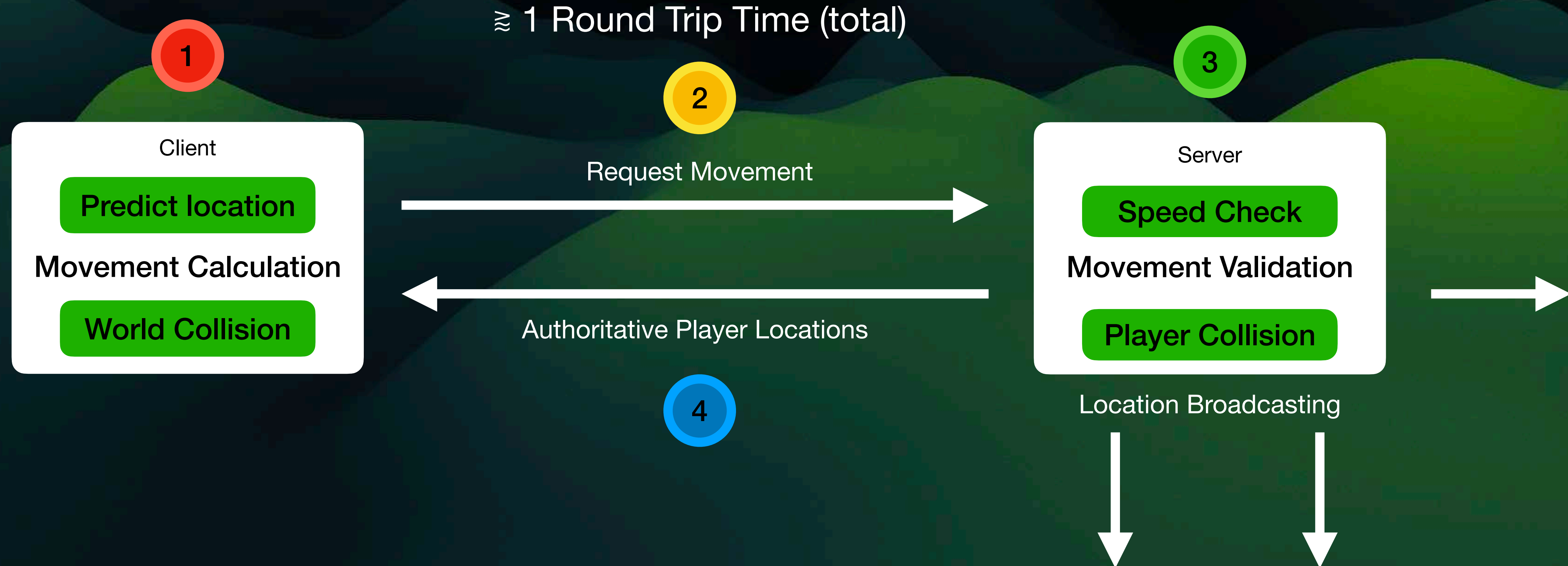


Functionality		Authority
Position	Movement	Client
	Location	Server
Shooting		Server

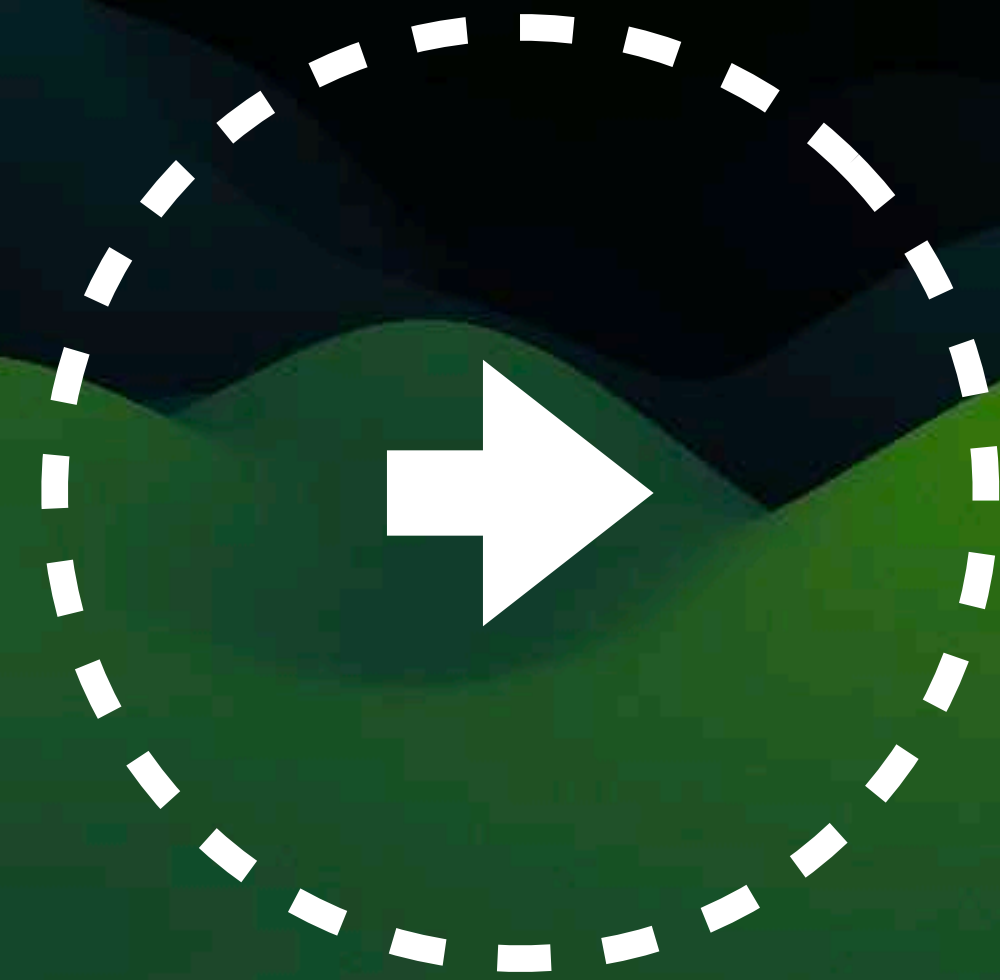


Authoritative Server

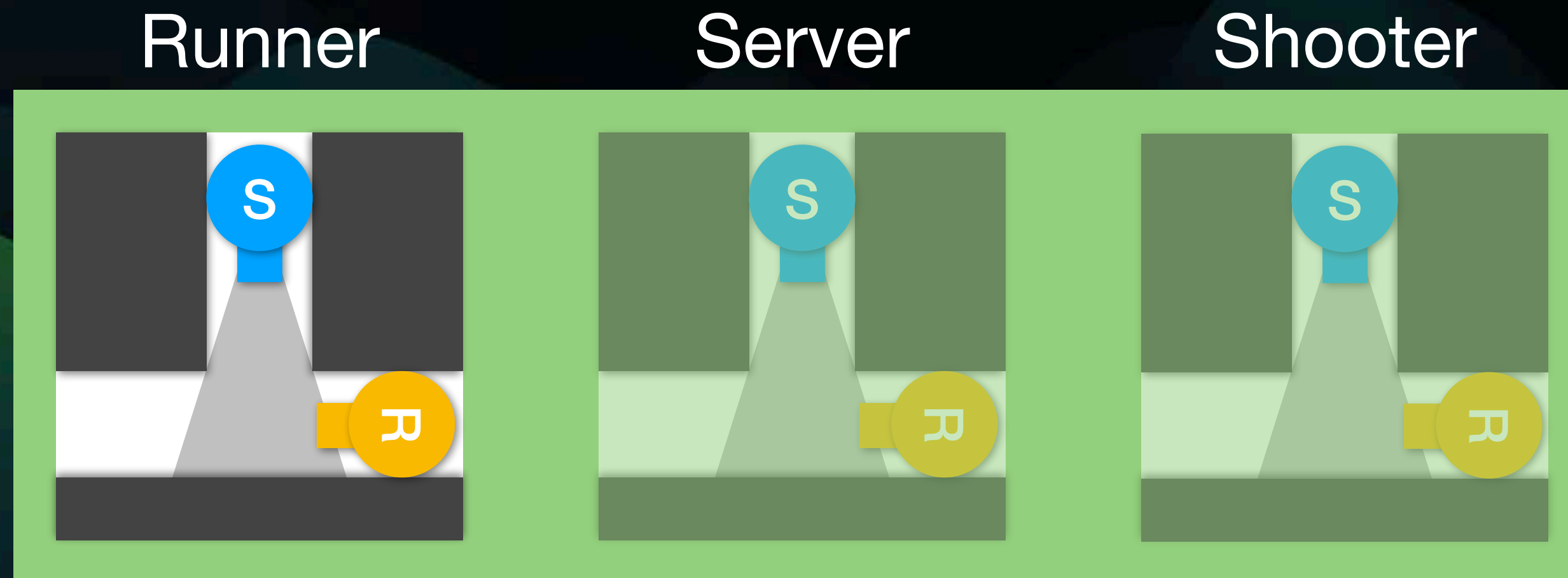
Location and Movement



Authoritative Shooting and Time Warp

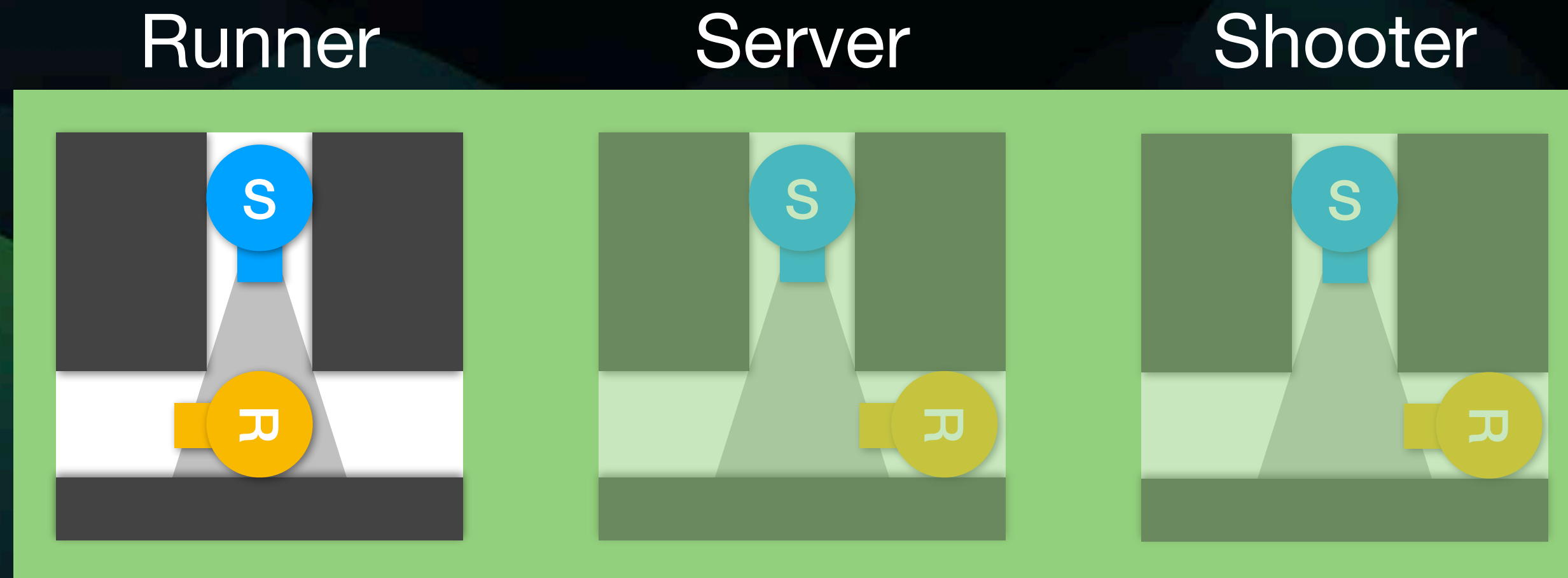


Authoritative Shooting and Time Warp



Frame 70

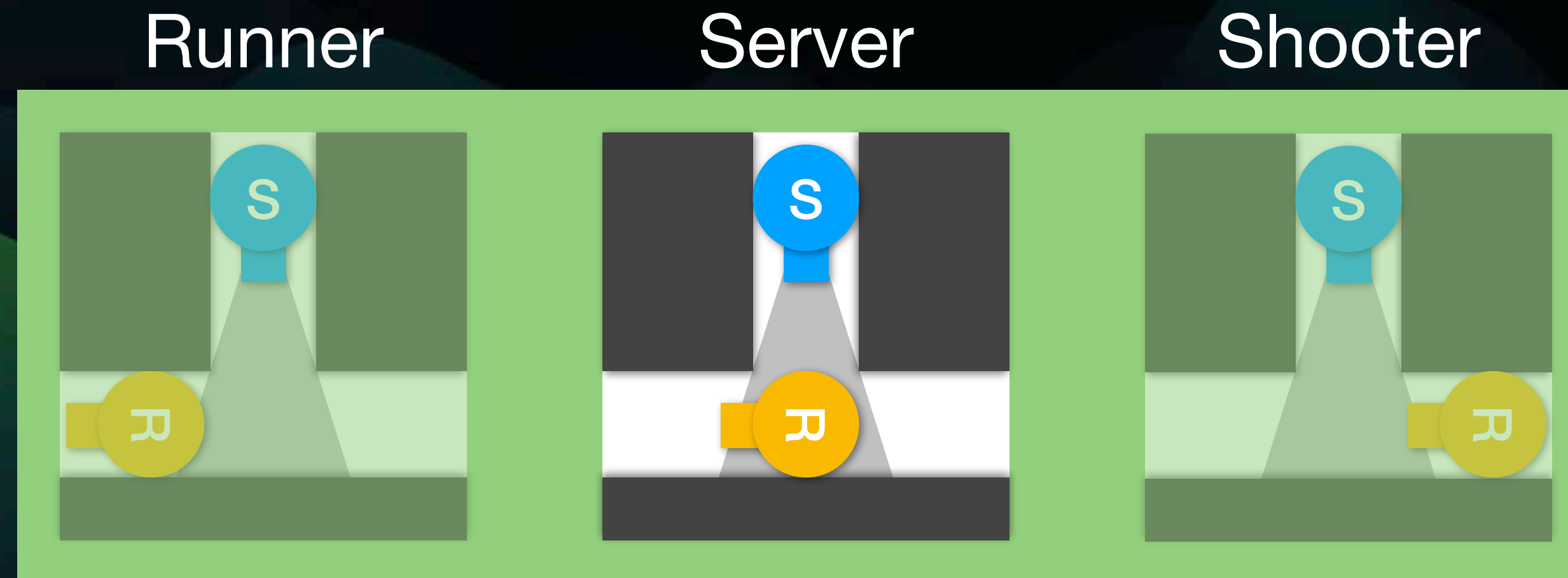
Authoritative Shooting and Time Warp



Runner move into view

Frame 70

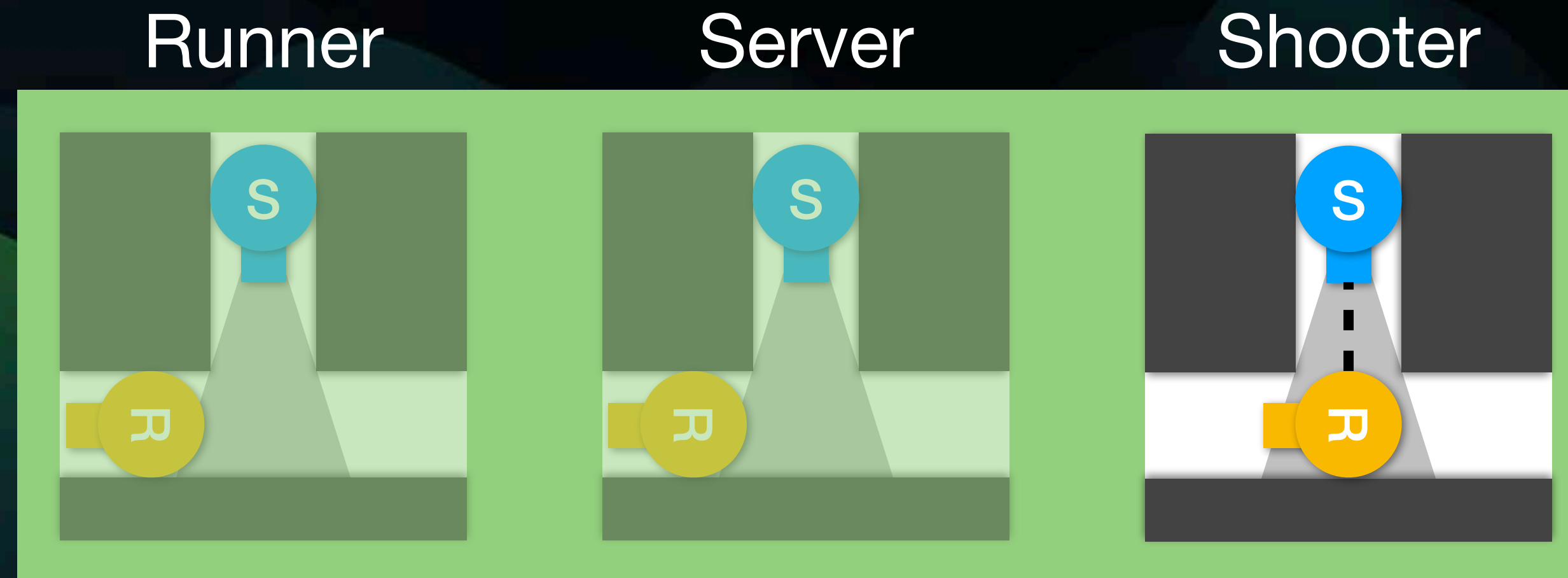
Authoritative Shooting and Time Warp



Server receives movement, notifies shooter

Frame 75

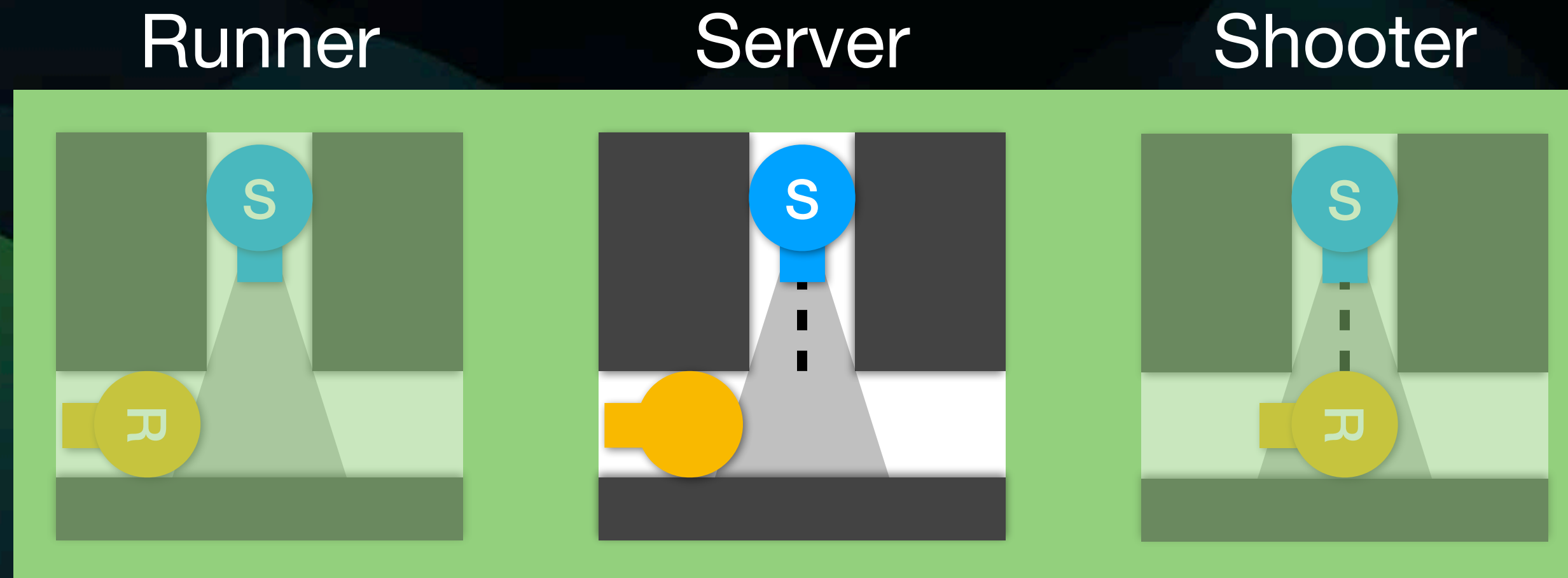
Authoritative Shooting and Time Warp



Shooter receives movement, shoots Runner

Frame 80

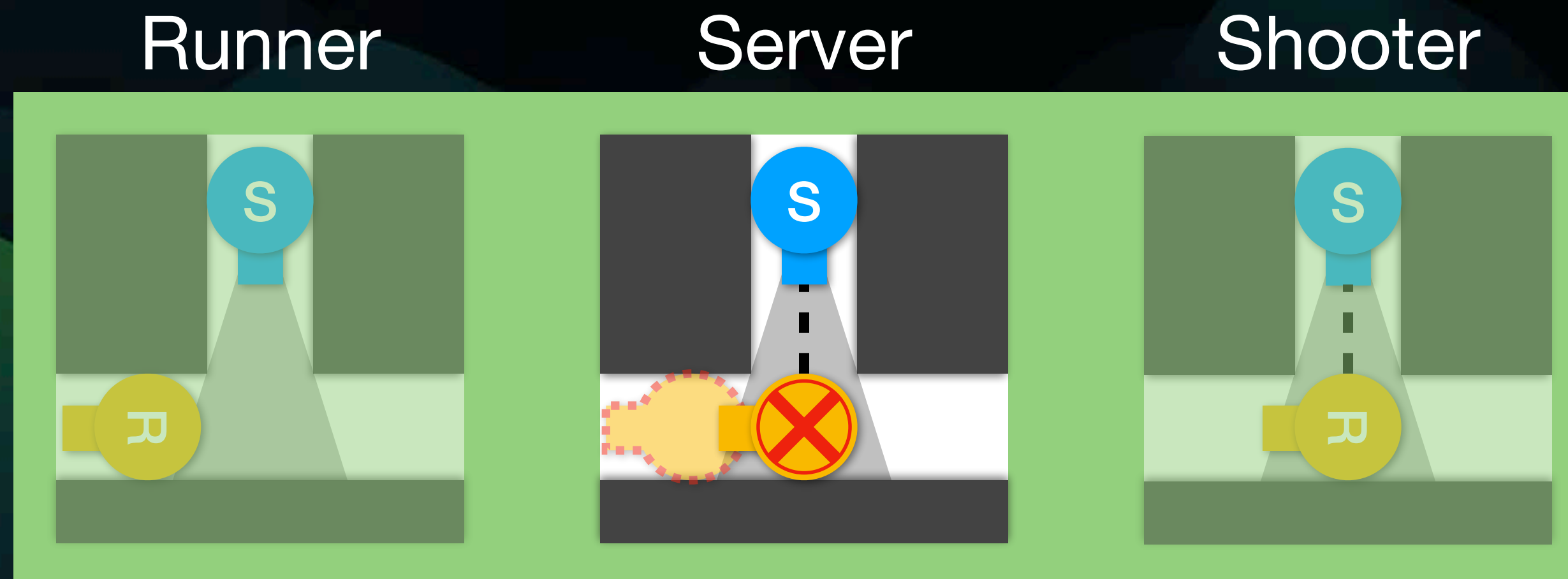
Authoritative Shooting and Time Warp



Server receives shot

Frame 85

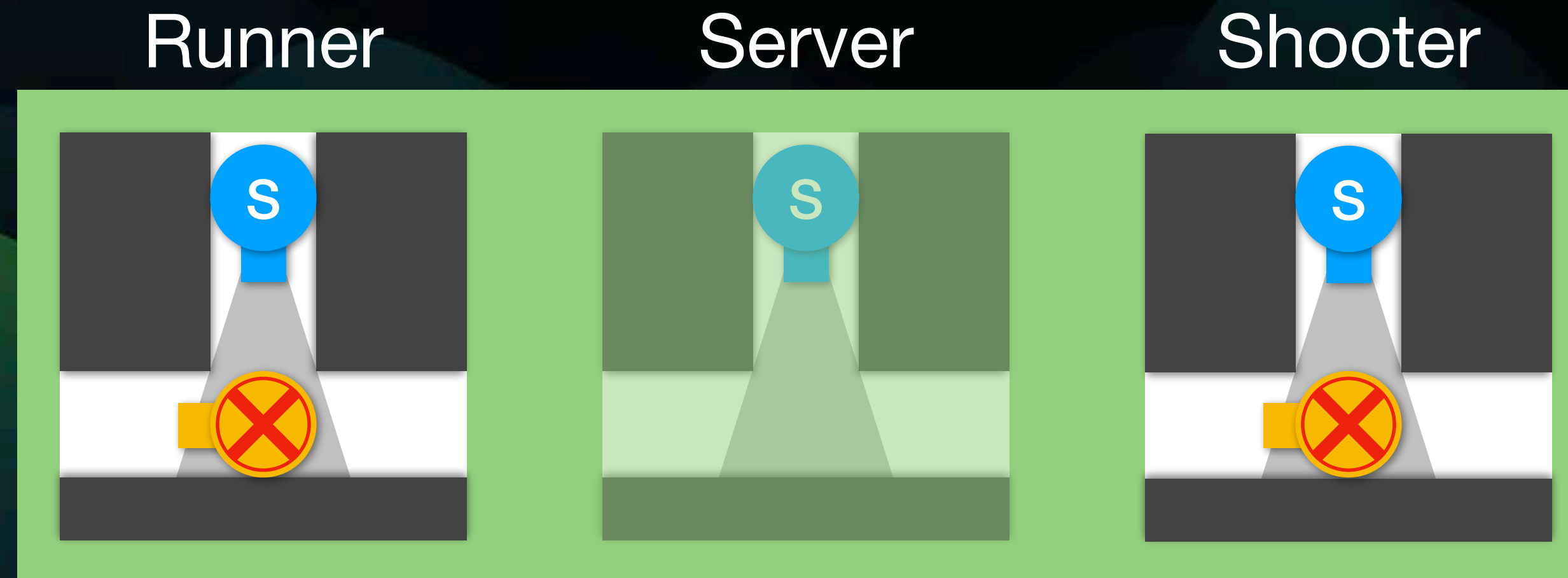
Authoritative Shooting and Time Warp



Server receives shot
Server rollback, confirms hit, broadcasts shot

Frame 85

Authoritative Shooting and Time Warp

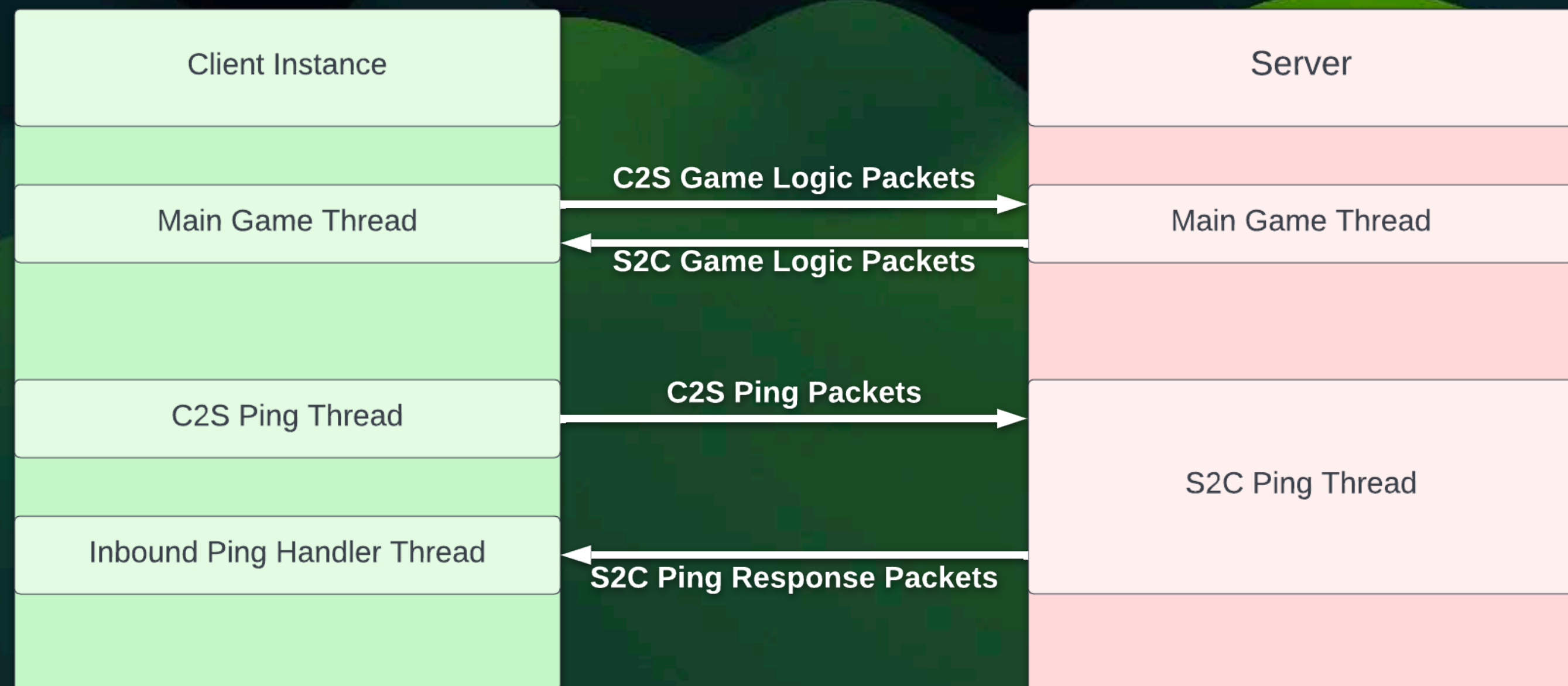


Frame 90

Latency Exposure

- Also known as: ping display
- Multi-threaded: not bounded to the game's tick rate
- Multiple different latency statistics besides latest ping
- Lots of configuration options:
 - Toggle-ability of feature as a whole
 - Other numeric parameters
- Statistics are logged to database file (both client-side and server-side)

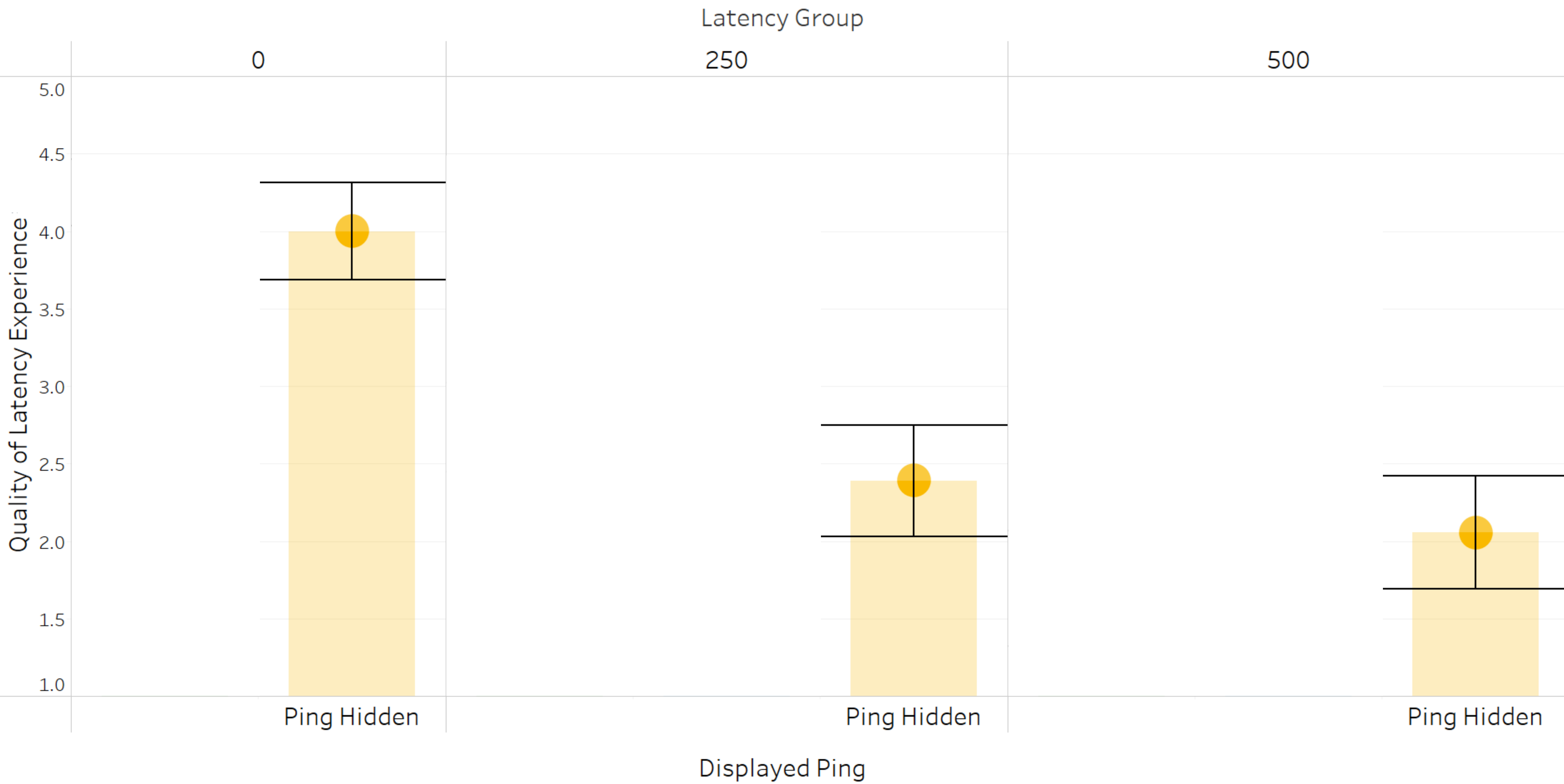
[Ping]
Latest: 251 ms
SMA: 100 ms
Min: 251 ms
Max: 251 ms



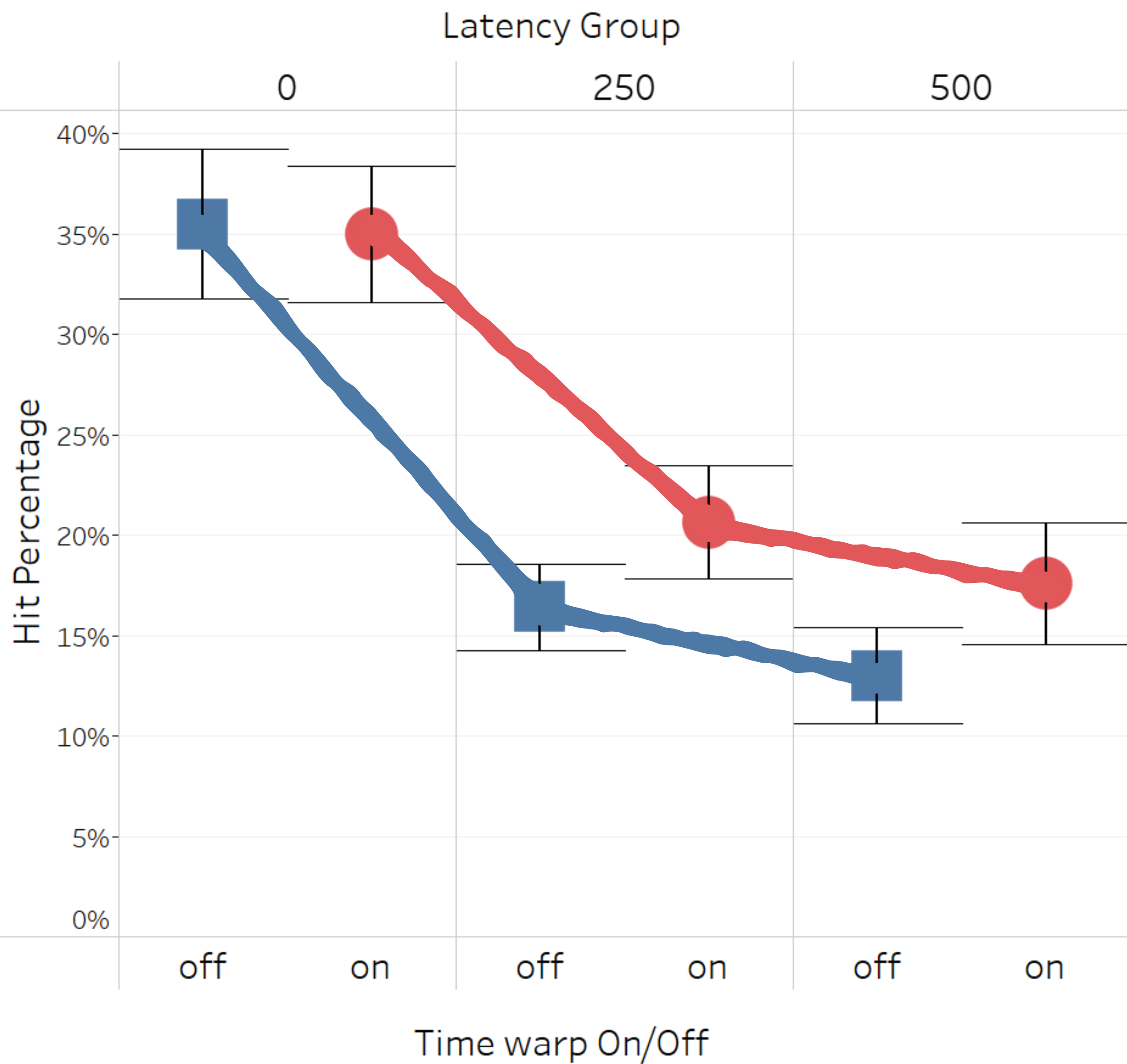
User Study

- 3 weeks; 42 participants
- Player-versus-player 1v1
- 20 rounds (2 groups of 10 rounds)
 - Groups' Time Warp settings vary (on/off)
 - First round in each group is discarded

How ping display affects quality of experience



Accuracy with time warp on/off close-combat



Achievements

- **Latency Compensation**

- Time Warp
- Latency Exposure (Ping Display)
- Latency Concealment
- Extrapolation

- **Authoritative Server Structure**

- Movement
- Shooting
- Authoritative Validations
- **Data Logging**
- **User Testing**
- **Data Analysis**



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Questions?

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