

The Effects of Latency on Player Performance in Cloud- based Games

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Introduction

- Latency is the dominant factor that can affect user's experience of playing cloud-based games
- This paper presents two user studies that measure the impacts of latency on cloud-based games with two different experiments
- They compared the result to the tradition network game result with the same latency involved

Experiment Design

- They conducted two separate user studies with different platforms, different games and different measurement mechanisms
- DummyNet was used to control the latency, the participants were blind to the amount of added latency
- After each session, they collected both subjective opinions and objective results

Study 1

OnLive

- A commercial cloud-based game system with a lightweight client (or with their OnLive console) connects to the OnLive cloud, where provides several gaming choices
- The game chosen was *Crazy Taxi*, the goal was to earn as many points as possible in a given time, which took about 1 minute
- The points player earned in the trials are the objective measure of performance



Study 1

Dummynet Setting

- The baseline latency connected to the OnLive server was about 50 ms
- Based on pilot study, 7 different added latencies were chosen: 0, 25, 50, ..., 150 ms with 25 ms a step
- The induced latencies were manually shuffled in each session to each user

Study 2

GamingAnywhere

- An academic cloud gaming system with a server and a client hooked up to play different provided games
- The game for experiment called Neverball, the goal is to tilt the game world to roll a marble to the marked place
- The time to finish the stage was the objective measure of performance



Study 2

Dummynet Setting

- They connected the server and the client in LAN, thus the baseline latency was less than 1 ms
- Based on pilot study, they chose 5 different added latencies: 33, 66, 100, 150, and 200 ms
- The latencies were split in 3 groups:
 - 33 & 66 ms,
 - 100 ms and
 - 150 & 200 ms.
- They were permuted differently in each trial

Design Summary

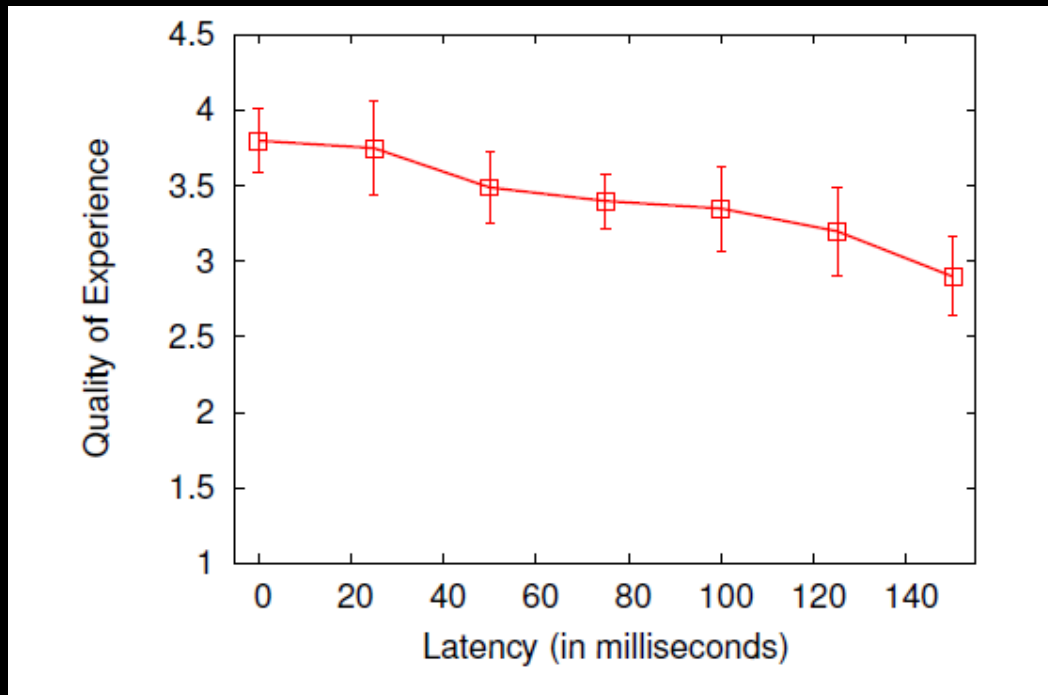
- One study used OnLive with a console connected to the server cloud
- The other one used GamingAnywhere with a client and server on private LAN
- Both studies induced latency via Dummynet with latencies ranging from 0 to 200 ms

TABLE I. SUMMARY OF SETUP FOR USER STUDIES

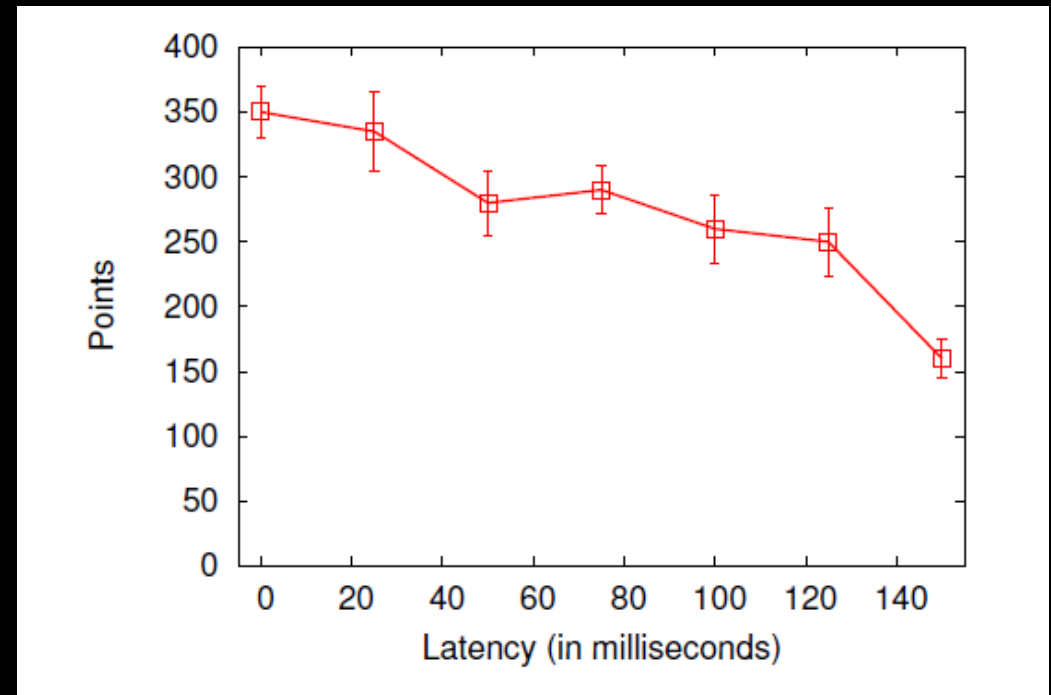
Cloud System	OnLive	GamingAnywhere
Game Used	Crazy Taxi	Neverball
Hardware	Console, TV, laptop	PCs
Latency Control	Dummynet	Dummynet
Latencies (msec)	0, 25, 75, 100, 125, 150	0, 33, 66, 100, 150, 200
Number of Users	49	34

Study 1 Results

○ 49 participants



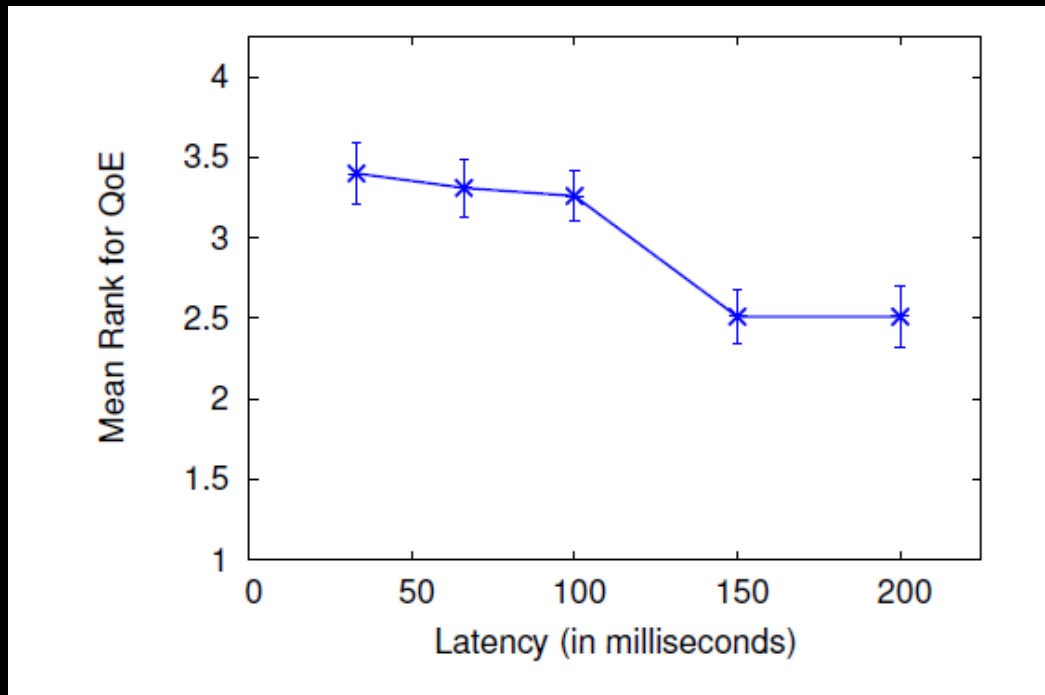
$$R^2 = 0.92$$



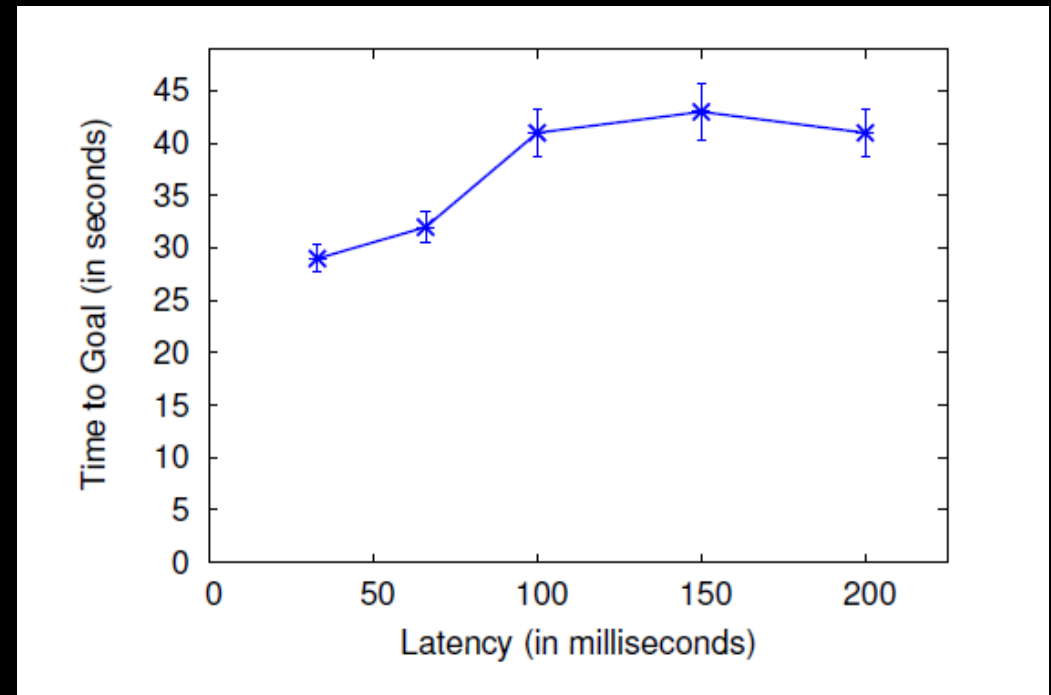
$$R^2 = 0.87$$

Study 2 Results

○ 34 participants



$$R^2 = 0.86$$



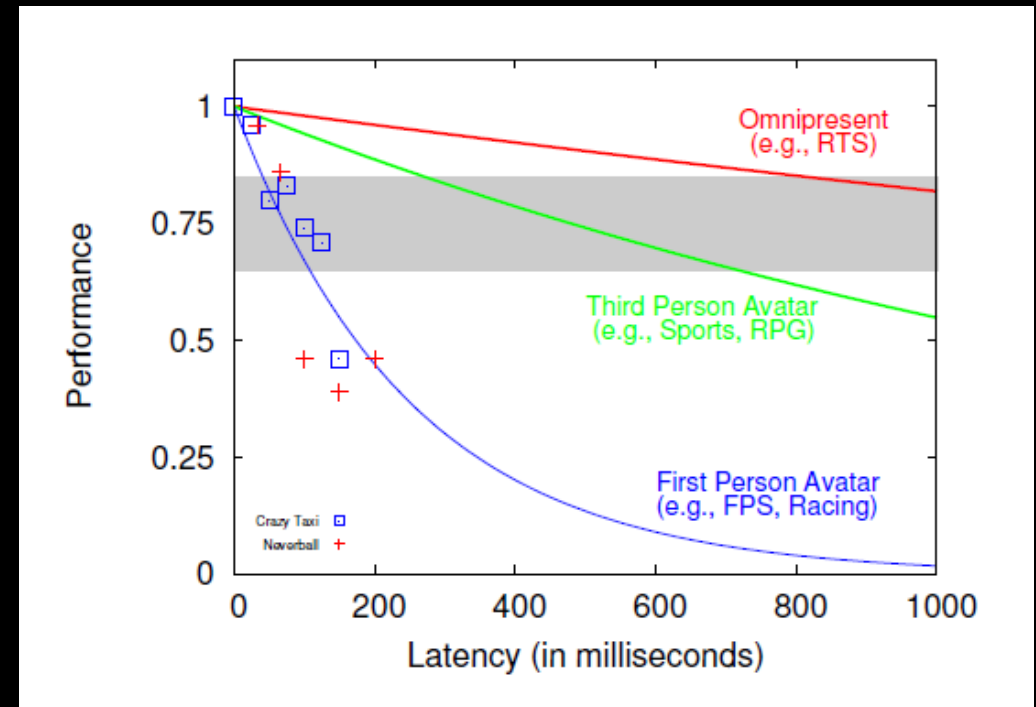
$$R^2 = 0.70$$

Analysis

- Both subjective and objective results showed that both QoE and user performance degrade linearly with an increase in latency

Cloud-based vs traditional network Comparison

- From some previous works, they found the effect of latency depend on user in-game perspective
- First person > Third person > Omnipresent
- The three curves are induced from the traditional network games, each indicates the impact of latency in different types of games
- The gray rectangle shows the user tolerance of latency

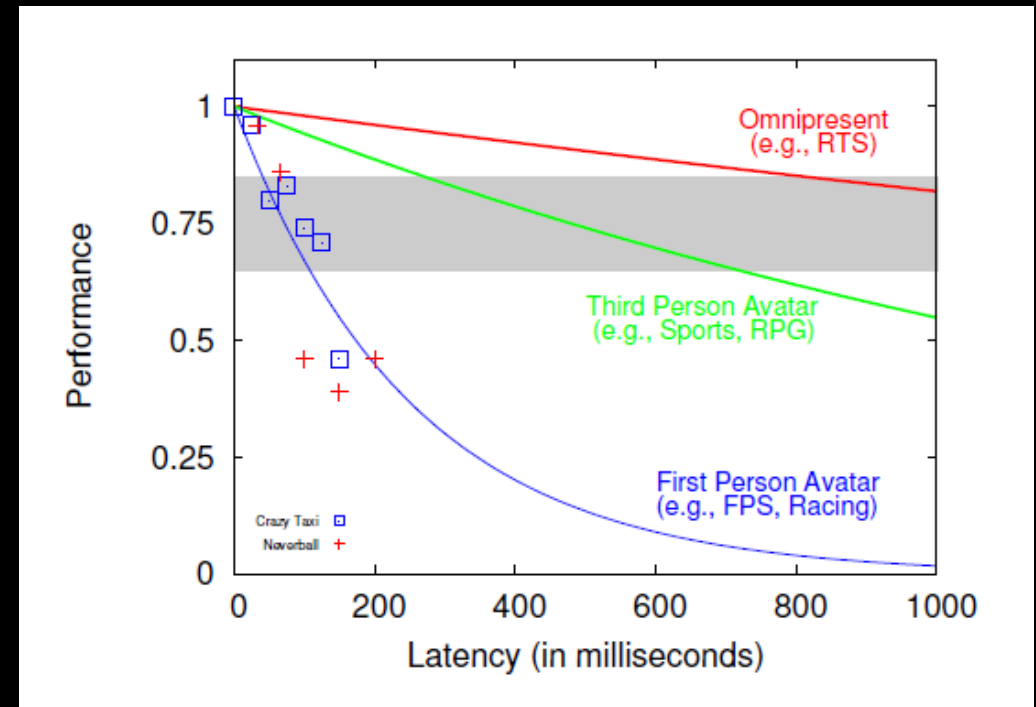


Crazy Taxi 

Neverball 

Cloud-based vs traditional network Comparison

- The data points are the normalized objective performance from this experiment
- Both cloud-based game results closely follow the curve of traditional first person games, despite they are both third person game
- The reason speculated was the difference of responsiveness, since in cloud-based game the actions cannot be shown until all the transmission and rendering are done, which would be impacted by even small amount of latency



Crazy Taxi 

Neverball 

Conclusion

- The cloud-based games are sensitive to even slight amount of latency, with user performance degrading by up to 25% with each 100 ms of latency
- The comparison shows that cloud-based games are more sensitive to latency than traditional network games due to the transmission of actions

Thanks for Listening!