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

Network and Systems Support for Games, 2014 13th Annual Workshop, IEEE
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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.
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 Dummymnet with latencies ranging from 0 to 200 ms.

<table>
<thead>
<tr>
<th>Cloud System</th>
<th>Game Used</th>
<th>Latency Control</th>
<th>Latencies (msec)</th>
<th>Number of Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>OnLive</td>
<td>Crazy Taxi</td>
<td>Dummymnet</td>
<td>0, 25, 75, 100, 125, 150</td>
<td>49</td>
</tr>
<tr>
<td>GamingAnywhere</td>
<td>Neverball</td>
<td>Dummymnet</td>
<td>0, 33, 66, 100, 150, 200</td>
<td>34</td>
</tr>
</tbody>
</table>
Study 1
Results

- 49 participants

- $R^2 = 0.92$

- $R^2 = 0.87$
Study 2

Results

- 34 participants

\[ R^2 = 0.86 \]

\[ R^2 = 0.70 \]
Both subjective and objective results showed that both QoE and user performance degrade linearly with an increase in latency.
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.
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.
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!