Network Game Design:

Hints and Implications of Player Interaction

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User behavior is a key factor of how well a network system performs (and how should a system be designed)

Example: Virtual World Partitioning Problem

If game players tend to be clustered in the game world
⇒ dynamic and adaptive partitioning of the game world would be required.
Motivation

Drawing Design Implications from Players’ Interaction for Designing More Responsive & Scalable Online Games
What We’ve Done

1. **Collecting** game traces (packet-level)

2. **Inferring** user interaction from game traces
   - Who are interacting?
   - Where are the players?
   - How do they interact? (stay together or team up)

3. Studying the **implications** of user interaction on game design
Talk Outline

- The question

  
  - Trace collection
    - Deriving user interaction
    - Analysis of user interaction (and its implications)
    - Conclusion
Game Studied -- ShenZhou Online
Game Trace Collection

<table>
<thead>
<tr>
<th>trace</th>
<th>conn. #</th>
<th>packets (in/out/both)</th>
<th>bytes (in/out/both)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>57,945</td>
<td>342M / 353M / 695M</td>
<td>4.7TB / 27.3TB / 32.0TB</td>
</tr>
<tr>
<td>N2</td>
<td>54,424</td>
<td>325M / 336M / 661M</td>
<td>4.7TB / 21.7TB / 26.5TB</td>
</tr>
</tbody>
</table>
Why We Use Packet-Level Traces?

Packet-level traces are *much easier* to obtain

- no modification to game servers is required
- recording packet traces does not increase the workload of game servers

Player behavior inferred naturally connects to *network-level factors*, e.g., IP addresses and network latency
Extraction of Player Interaction

We would like to know …
- whether any two players are at the same place
- whether any two players are teammates

For each player (game session), we have …
- a client packet arrival process
- a server packet arrival process

We’ve proposed an algorithm
- based on the correlations between the packet arrival processes
Example: Four Neighbors

- Server packet rates imply the degree of PC/NPC activities around the avatar
Example: Four Teammates

- Client packet rates imply the **degree of game play activities** of the avatar
Talk Progress

- The question
- Trace collection
- Deriving user interaction

→ Analysis of user interaction (and its implications)
  - player dispersion
  - network proximity
  - social interaction

- Conclusion
Dispersion of Players

The dispersion of players in the game world:
- well modeled by Zipf distributions
- 30% of players gather in the top 1% of places

Implications:
- static and fixed-size partitioning of the game world might be insufficient
- dynamic and adaptive partitioning algorithms should be used
Peer-to-Peer Games

- Reducing server load $\Rightarrow$ more scalable
- Faster response time
- Audio/video communications

![Diagram showing client-server and peer-to-peer architectures](image-url)
Overlay Construction

How to construct overlay networks?

Goal: to optimize the overall transmission latency

i.e., how to pass information between the peer nodes?
Overlay Construction Alternatives

Design 1:
by network distance

(optimize network latency)

Design 2:
by virtual world distance

(connect frequently contact nodes)

Which design leads to more efficient overlays for online games?
Similarity between The Two Approaches?

Network Topology View

Game World View

two approaches lead to different overlays

two approaches lead to similar overlays

either approach is OK
Correspondence between Network Distance and Virtual World Distance

Observation:
- Players who are neighbors or teammates tend to be closer to each other in network topology.

Evidence 1: Players who have interaction tend to have closer IP addresses.
Evidence 2: Players who have interaction tend to have shorter network latencies (between them).
Implications of Network Proximity

For client-server architecture
- improves the fairness of game playing, as interacting players tend to have similar latencies to their servers

For peer-to-peer architecture
- message delivery between the hosts of interacting players is faster
- opportunities for optimizing network latency between interacting players
Effect of Network/Physical Distance

Observation (for a group of players):
- network distance $\downarrow$ team play time $\uparrow$

Explanation and implications:
- real-life relationship carries over into the game;
- real-life interaction plays a key role in game play;
  - enriching in-game communication encourages players to be more involved in team play.
Effect of Social Interaction

Observation:
- degree of social interaction \( \uparrow \) game play time \( \uparrow \)
- team size \( \uparrow \) team play time \( \uparrow \)

Explanations and implications:
- due to the enjoyment derived from interaction and social bonds, a game could be made stickier by encouraging the formation of large groups.
Conclusion

Packet-level traces
- easier to obtain
- feasible to extract user interaction

Findings summarized
- partitioning of the virtual world should be dynamic
- network proximity of interacting game players
- games could be made more sticky by supporting in-game communication and encouraging team playing
Thank You!

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