Ch 13 Traffic Measurement and Player Analysis

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MMORPG

- Different from FPS games
  - No requirement for high precision - can tolerate some delay
  - Tracking accuracy lower
  - No explicit game rounds
  - No limit on number of players
  - Use TCP instead of UDP - timing/delay not such an issue
Trace Collection of Lineage II

Figure 1: Schematic of measurement setup.
### Table 2: Overview of Measurement Data

<table>
<thead>
<tr>
<th>Measurement Period</th>
<th>Thursday 2004.12.9 12:02 PM ~ 92 hours and</th>
<th>Monday 2004.12.13 8:24 AM 22 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captured log generated by <code>tcpdump</code></td>
<td>About 1 terabyte</td>
<td></td>
</tr>
<tr>
<td>Concurrent Users</td>
<td>2000 ~ 5140</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Packet Count</th>
<th>Total Packet Count</th>
<th>12,723,507,137</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>Total Packet Count</td>
<td>6,288,990,481</td>
</tr>
<tr>
<td>Data Packet Count</td>
<td>1,443,289,225</td>
<td></td>
</tr>
<tr>
<td>Downstream</td>
<td>Total Packet Count</td>
<td>6,434,516,656</td>
</tr>
<tr>
<td>Data Packet Count</td>
<td>6,280,005,461</td>
<td></td>
</tr>
</tbody>
</table>
No. of Users connected to server

Figure 2: Number of concurrent users connected to the server.

Network or Server Outage
Distribution of Client Packet Size

Figure 3: Distribution of client packet size.
CDF of Client Packet Size

Figure 4 Cumulative distribution of client packet size.
Client Packets

- 73% of client bytes are used for headers
- 38% of client packets are dedicated TCP ACKs
  - TCP uses delayed ACKS - 200ms
Figure 5: Distribution of server packet size
CDF of Client Packet Size

Fig. 6 Cumulative distribution of server packet size.
Most TCP ACKS are piggybacked
Bandwidth Usage

Figure. 10 Trace of bandwidth usage.
Figure 11: Correlation between the number of users and downstream bandwidth.
Figure 12: Correlation between the number of users and upstream bandwidth.
Packet Inter-arrival distr.

Exponential CDF with rate = 8 pkt/sec

Cumulative distribution function

Packet interarrival time (ms)

Client packets
exp(client packets)
Server packets

200msec update cycle
PSD of Packet Arrivals

6Hz is automated mouse click frequency

5Hz - 200msec cycle
Table 3: Asymmetry between upstream and downstream traffic.

<table>
<thead>
<tr>
<th></th>
<th>Upstream</th>
<th>Downstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Size of Payload</td>
<td>19.06 Bytes</td>
<td>318.39 Bytes</td>
</tr>
<tr>
<td>Ratio of data Bytes</td>
<td>22.9 %</td>
<td>97.6 %</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Up to 9 Mbps</td>
<td>Up to 140 Mbps</td>
</tr>
</tbody>
</table>
Paper

Studying Player Populations

- When they play
- How long they play
- How often they play
- Player loyalty
- Player retention over time
Questions of Interest to Providers

- How many players will there be next week?
  - Provision servers to support them

- What can I do to increase this number?
  - Impact of game updates and promotions

- What can I do to make sure players don’t quit?
  - Detecting disinterested players
Difficult questions to answer

- Requires player data from a successful game over a long time period - very difficult to obtain
Questions

- How many players will there be next week?
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  - Detecting disinterested players
## Games Studied

<table>
<thead>
<tr>
<th>GameSpy trace</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start time</strong></td>
<td>Fri Nov 1 2002</td>
</tr>
<tr>
<td><strong>End time</strong></td>
<td>Fri Dec 31 2004</td>
</tr>
<tr>
<td><strong>Total games</strong></td>
<td>550</td>
</tr>
<tr>
<td><strong>Total player time</strong></td>
<td>337,765 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Casual games trace</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start time</strong></td>
<td>Wed Jun 1 2005</td>
</tr>
<tr>
<td><strong>End time</strong></td>
<td>Wed Jun 28 2006</td>
</tr>
<tr>
<td><strong>Total games</strong></td>
<td>110</td>
</tr>
<tr>
<td><strong>Total player time</strong></td>
<td>128,331 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cs.mshmro.com trace</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start time</strong></td>
<td>Tue Apr 1 2003</td>
</tr>
<tr>
<td><strong>End time</strong></td>
<td>Mon May 31 2004</td>
</tr>
<tr>
<td><strong>Total connections</strong></td>
<td>2,886,992</td>
</tr>
<tr>
<td><strong>Total unique players</strong></td>
<td>493,889</td>
</tr>
<tr>
<td><strong>Median session time</strong></td>
<td>27 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EVE Online trace</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start time</strong></td>
<td>Tue May 6 2003</td>
</tr>
<tr>
<td><strong>End time</strong></td>
<td>Sun Mar 12 2006</td>
</tr>
<tr>
<td><strong>Total sessions</strong></td>
<td>67,060,901</td>
</tr>
<tr>
<td><strong>Total unique players</strong></td>
<td>925,928</td>
</tr>
<tr>
<td><strong>Total player time</strong></td>
<td>17,204 years</td>
</tr>
<tr>
<td><strong>Median session time</strong></td>
<td>64 minutes</td>
</tr>
</tbody>
</table>

**TABLE I**

**DATA SETS**
Game Popularity over time (FPS)

(a) Half-Life

(b) GameSpy games
Game Popularity over time contd.

(c) Casual games

(d) EVE Online

MMORPG
Game workloads

- Periodic
- Strong daily peaks with weaker weekend peaks

Gamespy FPS

EVE Online MMORPG
Game Workloads contd.

(c) Spades
Comparing Across games

Fig. 6. Normalized load of four popular games over a representative week
FFT of Weekly Usage

Daily Usage is similar

Weekend Usage is similar

Fig. 4. FFT of player load across four games.
Game workloads

- Predictable over short-term
- Workload fluctuations small from week-to-week
Where are the players?

Fig. 8. Aggregate normalized load per-continent for cs.mshmro.com
Questions

- How many players will there be next week?
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EVE Online

- Single world sci-fi MMORPG
EVE Online statistics

- Launched in
  - UK and USA on May 6, 2003
  - Europe on May 23, 2003
  - China on June 12, 2006

- As of August 3, 2007
  - 190,000 active subscriptions
  - 35,000+ peak concurrent on-line players

- How does it stack up against other MMOs?
Decent Player Populations

MMOG Subscriptions Market Share - June 2006

- World of Warcraft: 52.5%
- Lineage II: 19.4%
- Lineage: 12.0%
- RuneScape: 6.3%
- Final Fantasy XI: 4.0%
- EverQuest: 1.6%
- EverQuest II: 1.4%
- Star Wars Galaxies: 1.4%
- City of Heroes / Villains: 1.3%
- Ultima Online: 1.1%
- Eve Online: 1.0%
- Dark Age of Camelot: 1.0%
- Toontown Online: 0.9%
- Dungeons & Dragons Online: 0.7%
- All Others: 3.3%
- Dofus: 0.6%
EVE Online trace

- Anonymized authentication log of EVE Online throughout its existence
- All session-related events for each player

<table>
<thead>
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<th>Duration</th>
<th>May 6, 2003 – March 12, 2006</th>
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EVE Online growth

- Active player population throughout trace
Mechanisms for increasing population

- New game content and updates
- Promotions and marketing
- Price reduction
Impact of game updates

- Gain in players after each game update in trace
  - Large gains after initial release
  - Modest gains after subsequent game updates (2+3 below)

- Castor spikes
  - Competing sci-fi MMORPG shuttered
  - Marketing blitz during game conference (free accounts)
Impact of game updates on player time

**Fig. 15.** Weekly minutes played per player after EVE Online updates.
Questions

• How many players will there be next week?
  • Provision servers to support them

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• What can I do to make sure players don’t quit?
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Player churn

- A fact of MMORPG life
  - MMORPGs notorious for low acquisition rates
  - EVE Online player acquisition rate drops over time

- Potential reasons
  - New players at a disadvantage
  - Hard-core player population "tapped" out

70% playing 1 month later

Only 25% still playing one month later
Can we measure disinterest?

- Examining play history to detect waning interest
  - Minutes played per week
  - Session length statistics
  - Inter-session time statistics
Metric #1: Minutes played per week

- Minutes played per week throughout play history
- Players play less over time
Metric #2: Session times

- Session time distribution
- Session length of “final” session shorter than normal
Metric #3: Intersession times

- Intersession time distribution
- “Final” intersession time significantly longer than normal
Catching a disinterested player

- Aggregate not individual statistics
  - Addicts thrown in with casual gamers
  - Normalize per-player

- What percentile does final session and final intersession times fall into versus player’s prior times?
  - “Final” intersession time a very good predictor!
Paper

- Characterizing On-line Games, Chris Chambers, Wuchang Feng, Sambit Sahu, Debanjan Saha, David Brandt, IEEE/ACM Transactions on Networking, vol. 18, no. 3, June 2010