Dissecting Server-Discovery Traffic Patterns Generated By Multiplayer First Person Shooter Games

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Outline
- Motivation
- Data Collection
- Server-Discovery Traffic Identification
- Analysis
- Improved Server Discovery
- Conclusions and Future Work
Motivation

- First Person Shooters usually based on client server model
- Players need to locate servers and retrieve server information to decide where to play
- Besides the actual game traffic (non-probe traffic) there is traffic to locate and query game servers (probe traffic)
  - How much probe traffic on typical server?
  - Demographics of probe traffic vs. non-probe traffic?

Motivation Cont’d

Step 1: Get Server List

Client ➝ GetServerList ➝ Master Server

Step 2: Probe Servers

Client ➝ GetInfo ➝ Game Server 1 ➝ ... ➝ Game Server N

Step 3: Join a Server

Client ➝ Connect ➝ Game Server

Probe Traffic

Non-Probe Traffic
Data Collection

- Game: Enemy Territory
  - First person shooter based on Quake 3 engine
  - Team-based with strategic objectives
- Two public (identically configured) game servers
  - CAIA server (Melbourne, Australia)
  - GrangeNet server (Canberra, Australia)
- Collected traffic flow information over 20 weeks
  - Bidirectional flows
  - Flow key: src IP, src port, dst IP, dst port
  - Flow timeout: 60 seconds
  - Volume (packets, bytes)
  - Packet length, inter-arrival times (min, mean, max, std dev)

Probe Traffic Identification

- Simple heuristic
  - Packets from server to client < 20
  - Mean inter-arrival time of server to client packets > 500ms
- Based on insights from looking at probe traffic characteristics
- When compared against game server log information there is some error (0.5% of the volume misclassified)
### Analysis – Overall Volume

<table>
<thead>
<tr>
<th></th>
<th>CAIA</th>
<th>GrangeNet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows</td>
<td>16.18e6</td>
<td>16.93e6</td>
</tr>
<tr>
<td></td>
<td>(99.95%)</td>
<td>(99.99%)</td>
</tr>
<tr>
<td>Non-Probe</td>
<td>7993</td>
<td>1757</td>
</tr>
<tr>
<td></td>
<td>(0.05%)</td>
<td>(0.01%)</td>
</tr>
<tr>
<td>Mpackets</td>
<td>36.46</td>
<td>36.94</td>
</tr>
<tr>
<td></td>
<td>(4.61%)</td>
<td>(25.01%)</td>
</tr>
<tr>
<td></td>
<td>755.13</td>
<td>110.74</td>
</tr>
<tr>
<td></td>
<td>(95.39%)</td>
<td>(74.99%)</td>
</tr>
<tr>
<td>GBytes</td>
<td>8.18</td>
<td>8.10</td>
</tr>
<tr>
<td></td>
<td>(6.56%)</td>
<td>(35.75%)</td>
</tr>
<tr>
<td></td>
<td>116.58</td>
<td>14.56</td>
</tr>
<tr>
<td></td>
<td>(93.44%)</td>
<td>(64.25%)</td>
</tr>
</tbody>
</table>

### Analysis – Flows over Time

- **Flow count (10e3)**
  - **Probe Traffic**
  - **Non-probe Traffic**

Data visualization showing flow counts over time for probe and non-probe traffic for CAIA and GrangeNet.
Analysis – Flows Weekly Pattern

Mean Flows (10e3)
Probe Traffic

Mean Flows
Non-probe Traffic

Day of the Week

Analysis – Flows Daily Pattern

Mean Flows (10e3)
Probe Traffic

Mean Flows
Non-probe Traffic

Hour of the Day
Analysis – Demographics

- Mapped IP addresses to countries using free GeoIP database (claimed 97% accuracy)
- Grouped countries (130+) into geographical regions
- Distribution is very similar for both servers

Traffic Analysis – Weekly Again

Mean Flows (10e3)

Probe Traffic

Non-probe Traffic
Traffic Analysis – Daily Again

Mean Flows (10e3)
Probe Traffic

Mean Flows
Non-probe Traffic

Analysis – Probe Traffic Characteristics

92% have no inter-arrivals (2-packet flows)

Client-to-server packets are usually 60 bytes
Server-to-client packets are ~330 or ~800 bytes
Improved Server Location

- Distribution of probe traffic depends on order of server list send by master server
- Our data (and some rather unscientific experiments with game client) suggest that the list is not order by location/distance
  - Unnecessary probe traffic send to servers that players are unlikely to join because of high latency
  - Players have to wait longer to find suitable (close) servers

Improved Server Location cont’d

- Do not distant servers to client; at least sort server list in order of increasing distance/latency
- Very accurate ordering not required, could just sort by countries or even regions
- How to determine distance?
  - Clients and servers are configured with their location during installation/configuration
  - Master server determines locations based on IP addresses
  - Master server estimates latency between client and servers
Conclusions

- Amount of probe traffic independent of server popularity → can be significant fraction (7% and 36% on our servers)
- Number of probe flows is very high (99.9% on our servers) → can have significant impact on devices/software that keeps per-flow state
- Geographic origins of probe and non-probe traffic differ greatly
  - Non-probe traffic reflects local player community
  - Probe traffic seems to reveal global player distribution; does not even require popular server!

Future Work

- Compare round-trip times and number of hops of probe and non-probe traffic
- More accurate probe traffic detection based on packet payload
- Study server list distribution and possible performance increase of distance-based ordering
- Study newer games e.g. Half-Life 2
- Real-time player map
Thanks for your attention!
Questions?

Analysis – Week vs. Weekend

Monday-Friday

Weekend