Game Traffic Analysis
http://caia.swin.edu.au/genius/

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Games

- Xbox
  - Halo
  - TimeSplitters2

- Half Life

- Quake 3
Experiment set-up

Server

Packet Sniffer

Client

Client

Client
Used Tools

- Tcpdump
  - Captures all packets on an Ethernet LAN
- Pkthisto
  - Processes packet flows
  - Each histogram consists of 2,000 packets
Observed Characteristics

- Packet lengths
- Packet inter-arrival times
- Individual flows
  - One client to server
  - Sever to one client
- Aggregate flows
  - All clients to server
  - Server to all Clients
Xbox Halo
Packet Lengths

- Server to Client

- Length dependent on the total number of players in the game (N)

\[ Pk\_length = 30*N + 100 \]
Packet Lengths

server packet lengths

bytes

number of players

Actual data
analytical model

09/07/2003
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Packet Lengths

- Client to server
- 74% of packet lengths dependent on the number of players attached to a client console (C)
- C can only be between 1 and 4

\[ Pk\_length = 30\times C + 80 \]

- 16% have fixed length of 72 bytes
Packet Lengths

client packet lengths

bytes

player per client

Actual data
analytical model

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Packet Inter-arrival times

- Server to client
- Burst of number of client (L) packets every 40 ms
- \((100 \times (L-1)/L)\%\) packets have inter-arrival times close to 0 ms
- \(100 - (100 \times (L-1)/L)\%\) packets are spaced 40 ms apart
Packet inter-arrival times (2 clients)

Interarrival Histogram

Relative Frequency (%)

Interarrival Time (ms)

IH 84
IH 76
IH 68
IH 60

0.25 4 7.75 11.5 15.25 19 22.75 26.5 30.25 34 37.75 41.5 45.25
Packet inter-arrival times (3 clients)
Packet inter-arrival times

- Client to server
- Did not vary for the different experiments (independent of all parameters)
- 74% packets transmitted every 40 ms (dependent on players on console)
- 16% packets transmitted every 201 ms (72 B packets)
Packet inter-arrival times

- 2 independent flows result in 30% of inter-arrival times uniformly distributed between 0 and 40 ms
- 70% of packets are spaced 40 ms apart
Packet inter-arrival times

Interarrival Histogram

Interarrival Time (ms)

Relative Frequency (%)
Packet inter-arrival times

Cumulative Interarrival Distribution Plot

Interarrival Time (ms)

Cumulative Relative Frequency (%)
Packet inter-arrival times

- Aggregate client to server flow
- Dependent on Xbox hardware
- 2 Xboxes transmit packets exactly every 40ms
- 3rd Xbox transmits packets every 40.001ms
- Results in a drift of inter-arrival times
Packet inter-arrival times

- 2 Xboxes with same packet transmission pattern
- 1st Xbox starts at 10 ms, 2nd at 40ms

<table>
<thead>
<tr>
<th>x1</th>
<th>x2</th>
<th>x1-x2</th>
<th>x2 – x1</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>40</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>50</td>
<td>80</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>90</td>
<td>120</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>
Packet inter-arrival times

Interarrival Histogram

Relative Frequency (%)

Interarrival Time (ms)

IH 61
IH 58
IH 55
Packet inter-arrival times

- 1 client transmits every 40ms, the 2nd every 40.001ms
- x1 starts at 10ms and x2 at 40ms
- But the inter-arrival times have a slight drift against on another
- Result in a diamond shaped inter-arrival plot
Packet inter-arrival times

![Packet inter-arrival times graph]

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Packet inter-arrival times

Interarrival Histogram

Interarrival Time (ms)

Relative Frequency (%)
Status

- Finished Halo traffic analyses
- Developed simulation model based on Halo traffic characteristics
Xbox
TimeSplitters2
Games played

- Only games with 2 Xboxes
  - No aggregate flow measurements
- 2-4 players
  - 2 or 1 on each Xbox
- Very preliminary results
Packet lengths

- Almost the same for client to server and server to client
- Only difference are 100 B packets sent from server to client
- Dependent of number of players connected to consol
  - Seems independent from total number of players in the game
Packet lengths

Length Histogram (client2server)
Packet lengths

Length Histogram (server2client)
Packet inter.arrival times

- Client transmits packets in 120 ms intervals
- Server to client packet transmission possibly dependent on the number of players in the game
- Always peaks at 0, 20, 100 and 120 ms
- For 3 players: additional peaks at 60 ms
- For 4 players: 3 player peaks plus peaks at 40 ms and 80 ms
Packet inter-arrival times

Interarrival Histogram (server2client; 4 players)
Status

- Just started to collect data
- Run more experiments
- Up to 4 players per client
- 3 & 4 Xboxes
  - Aggregate flows
Half Life
Packet lengths

- Server to Client
- Independent of all game parameter (number of players, map)
- Heavy tailed
- Starts about 60 B, main body ends at about 300 B, tail goes up to 800 B
Packet lengths

Length Histogram

![Packet Length Distribution Graph]

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Packet lengths

- Client to Server
- Independent of all game parameters (number of players, map)
- M-shaped graph
- Start around 60 B, end around 100 B, no tail
- Often peak at 47 B
Packet inter-arrival times

- Server to client
  - Most packets transmitted in 60 ms intervals
- Client to Server
- Dependent on computer set-up
- Most regular one: peaks at 33, 50, 66 ms
Packet inter-arrival times

Interarrival Histogram

Interarrival Time (ms)

Relative Frequency (%)
Packet inter-arrival times

Interarrival Histogram

Interarrival Time (ms)
Status

- Enough data traces available
- Finished characterisation of traffic pattern
- Started to develop statistical models for packet length and inter-arrival times
  - Problem client to server inter-arrival times
Quake 3
Status

- Many data traces available
- Preliminary report written in December 2002
- Started to compare recent data with observations in report
User perception trials
Aim & experiments

- To get insight on which network condition are acceptable for real-time games
- Play the same game while varying the delay or packet loss between the server and the clients
- Collect player feed-back
  - Objective: kills/deaths
  - Subjected: how enjoyable was the game
- Will run during 2nd semester