Tutorial:
Traffic of Online Games

Jose Saldana & Mirko Suznjevic

IETF 87, Berlin, August 1st, 2013
Transport Area Open Meeting
Goals of this presentation

• Information about current practices in online games industry

• Traffic of online games – trends and characteristics

• Current network issues and QoE requirements
Goals of this presentation

• Information about current practices in online games industry

• Traffic of online games – trends and characteristics

• Current network issues and QoE requirements

• A perfect excuse to play for a while...
Size of the gaming industry

The Global Games Market | Per Region | 2013E

- **Latin America**: $3.0Bn, 4% growth YoY, 116M gamers
- **North America**: $22.8Bn, 32%, 192M gamers
- **Asia-Pacific**: $25.1Bn, 36%, 477M gamers
- **Europe**: $19.5Bn, 28%, 446M gamers
- **Middle-East & Africa**: $13.6Bn, 28%, 1,231M gamers

Total: $70.4Bn, +6% YoY

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www.newzoo.com
Shift towards online

- Multiplayer games
- Social games
- Content distribution
- DRM

Recent Digital* and Physical Sales Information

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Digital Format</th>
<th>Total Physical Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>2010</td>
<td>72%</td>
<td>28%</td>
</tr>
<tr>
<td>2011</td>
<td>69%</td>
<td>31%</td>
</tr>
</tbody>
</table>

Source: The NPD Group/Games Market Dynamics: U.S

facebook®
GAMES
> 250 million monthly players

PEAK CONCURRENT PLAYERS

- 650,000: Top 100 Games on Steam on Friday 10/5/12
- 1.4 Million: Call of Duty Modern Warfare 3 on Xbox Live
- 3 Million: League of Legends

1.8.2013.
Shift towards online

Recent Digital* and Physical Sales Information

- Multiplayer games
- Social games
- Content distribution
- DRM

Xbox One is predicted to be supported by 500,000 servers, compared to 30,000 of Xbox Live (current one)

facebook®
GAMES
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PEAK CONCURRENT PLAYERS

650,000
TOP 100 GAMES ON STEAM
on Friday 10/5/12

1.4 MILLION
CALL OF DUTY MODERN WARFARE 3 ON XBOX LIVE

3 MILLION
LEAGUE OF LEGENDS
AVERAGE NUMBER OF PLAYERS ONLINE SIMULTANEOUSLY ON A TYPICAL GAMES MONTH OF JUNE

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Who are the consumers?

The average game player age is:

30

32% under 18 years
31% 18-35 years
37% 36+ years

Are video games only for kids?

Source: Entertainment Software Association (ESA)
Architecture

• Increasing dominance of client – server
  – Cheating avoidance
  – Easier synchronization
  – Billing

• Server organization
  – Server included in the game and one client acts as the server (e.g., *Warcraft 3*)
  – Dedicated server application released and players create their own servers (e.g., *Call of Duty*)
  – *Server fully controlled by the developer/publisher* (e.g., *World of Warcraft*)
Client versions

- Specific application per game (hybrid clients)
- Clients encompassing multiple games
  - Browser-based games
  - Cloud based games (thin clients)

- Client version highly affects traffic characteristics
Business models

• Pay to play
  – Game client/account
  – Subscription
  – Additions to existing games

• Free to play (F2P)
  – Micro transactions
  – Additional content
  – Cosmetic/usability improvements

• F2P demands full server control!!!
Bottlenecks

- Three potential bottlenecks:
  - uplink: gamers send their actions
  - server: calculation of the next state
  - downlink: send the state to players
Information transferred

• What information does the traffic comprise?
  – Player commands/inputs
  – Virtual world state refreshes
  – Chat
  – Audio flows for player communication
    • Some games have in-built VoIP systems
    • Many players use stand alone applications (Teamspeak, Ventrilo, Skype...)
  – 3D data describing virtual world (Second Life)
  – Video
    • Send by cloud based games
    • Streaming of gaming sessions
Traffic characterization

• Game flows:
  – Long lived
  – High packet rate
  – Small payload sizes
  – Low bandwidth usage
  – Using both UDP and TCP
  – *Dependant on the game genre*

• Identified issues:
  – Delay sensitivity
  – Low but very inefficient bandwidth usage
  – Variable delivery requirements

• Thin client games are an exception
Why so small?

• Market penetration!
• *World of Warcraft* was released in 2004 – in order to reach as much users as possible it needed to work on 33,6k modem
• *Unreal Tournament* on 14,4k 😊
• High broadband penetration – will games use more and more bandwidth?
  – No (and yes)
Game traffic evolution? – Not really

StarCraft I (1998-2010)
1-5kbps
(2-8 players)

StarCraft II (2010-present)
2-3 kbps
(independent of number of players)


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Game traffic revolution? Yes*

- Cloud gaming traffic
  - Very high bandwidth usage
  - High quality video
  - Very delay sensitive (no client side optimization)
  - * no high market penetration

RTP/UDP flows of the OnLive Streaming Protocol

<table>
<thead>
<tr>
<th>Direction</th>
<th>RTP SSRC</th>
<th>RTP Payload Type</th>
<th>Flow description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downstream</td>
<td>0x0000000000</td>
<td>100</td>
<td>QoS monitoring flow</td>
</tr>
<tr>
<td>Downstream</td>
<td>0x00010000</td>
<td>100</td>
<td>OnLive Control</td>
</tr>
<tr>
<td>Downstream</td>
<td>0x00030000</td>
<td>100</td>
<td>Audio stream (CBR Codec)</td>
</tr>
<tr>
<td>Downstream</td>
<td>0x00040000</td>
<td>100</td>
<td>Cursor position</td>
</tr>
<tr>
<td>Downstream</td>
<td>0x00050000</td>
<td>101</td>
<td>Audio stream (VBR Codec)</td>
</tr>
<tr>
<td>Downstream</td>
<td>0x00060000</td>
<td>96</td>
<td>Video stream</td>
</tr>
<tr>
<td>Downstream</td>
<td>0x00080000</td>
<td>100</td>
<td>Voice Chat (Sound from other players)</td>
</tr>
<tr>
<td>Upstream</td>
<td>0x0000XXXX</td>
<td>100</td>
<td>User input (keyboard and mouse buttons)</td>
</tr>
<tr>
<td>Upstream</td>
<td>0x0001XXXX</td>
<td>100</td>
<td>Cursor movement</td>
</tr>
<tr>
<td>Upstream</td>
<td>0x0004XXXX</td>
<td>100</td>
<td>OnLive Control ACK</td>
</tr>
<tr>
<td>Upstream</td>
<td>0x0008XXXX</td>
<td>100</td>
<td>Voice Chat (Microphone from the user)</td>
</tr>
</tbody>
</table>
Global trends

- Global game traffic
  - Very small share of the global volume
  - 22% CAGR (Compounded Annual Growth Rate)

<table>
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</thead>
<tbody>
<tr>
<td>By Subsegment (PB per Month)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet video</td>
<td>14,818</td>
<td>19,855</td>
<td>25,800</td>
<td>32,962</td>
<td>41,916</td>
<td>52,752</td>
<td>29%</td>
</tr>
<tr>
<td>Web, email, and data</td>
<td>5,173</td>
<td>6,336</td>
<td>7,781</td>
<td>9,542</td>
<td>11,828</td>
<td>14,494</td>
<td>23%</td>
</tr>
<tr>
<td>File sharing</td>
<td>6,201</td>
<td>7,119</td>
<td>7,816</td>
<td>8,266</td>
<td>8,478</td>
<td>8,667</td>
<td>7%</td>
</tr>
<tr>
<td>Online gaming</td>
<td>22</td>
<td>26</td>
<td>32</td>
<td>39</td>
<td>48</td>
<td>59</td>
<td>22%</td>
</tr>
</tbody>
</table>
Game genres

- Game categorization:
  - Action (e.g., Grand Theft Auto)
  - Adventure (e.g., Broken Sword)
  - Arcade (e.g., Pinball)
  - Children’s Entertainment (e.g., Bob the Builder)
  - Family Entertainment (e.g., Mahjongg)
  - Fighting (e.g., Mortal Combat)
  - Flight (e.g., Wing Commander)
  - Racing (e.g., Need For Speed)
  - Role Playing (e.g., World of Warcraft)
  - Shooter (e.g., Quake)
  - Strategy (e.g., Starcraft)
  - Other Games


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Bandwidth usage across genres

Bandwidth [kbit/s]

- Warcraft III (RTS)
- World of Warcraft (MMORPG)
- Madden NFL (Sports)
- Unreal Tournament (FPS)
- Second Life (CVE)
- Crazy Taxi (Cloud)

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First Person Shooters (FPS)

• Gameplay characteristics:
  – Very fast paced
  – Very delay sensitive
  – Several tens of players in one virtual world

• Traffic characteristics
  – Use UDP
  – Loss tolerant
  – Latency very important (usually displayed on server lists, or score lists)
  – Very high packet rate
  – Fairly regular packet sizes
  – Fairly regular packet inter-arrival times
CDF’s of different FPS games

Massively Multiplayer Role-Playing Games (MMORPGs)

• Gameplay characteristics
  – Wide range of possible activities
  – Very large virtual worlds
  – Virtual economies
  – Large number of players in same virtual world (up to tens of thousands)

• Traffic characteristics
  – Much more variable traffic characteristics
  – Less fault tolerance
  – TCP and UDP
  – Looser latency constraints
  – Lower packet rate
  – Lower bandwidth usage
MMORPGs and TCP

- TCP not designed for a real time interactive application!!! (yet it works)
- Application limited not network limited flows
- Multiple thin TCP flows behave unlike one fat TCP flow
- Mechanisms in TCP directly deteriorate the experience of the players (delayed ACK, Nagle algorithm)
- Mechanisms of TCP do not work efficiently for MMORPG (cwnd reduced due to application not having something to send)
- High signaling overhead due to small packets
- High number of “pure” ACKS
Specific game transport protocol?

• Game transport protocol
  – Suggested in 2002 for MMORPGs
  – Not really accepted

• Prerequisites of MMORPG Transport Protocol
  – Must be transmitted in order and reliably (chat)
  – Reliable but not in order (attack)
  – Not reliable or in order (move)

• Transport options
  – Multi-streaming
  – Optional ordering
  – Optional reliability

CDF’s of different MMORPGs

MMORPG action diversity
Summary of problems

- Delay sensitivity
- Very low (and inefficient) bandwidth usage of “regular” games
- Very high bandwidth requirements of cloud based games
- Fairness
- Scalability problems
- Adapting to player behavior
- Protocol related issues
TCM-TF advertisement

- In need of some flexibility (game release, rush hour, certain places):
  - What if we can multiplex traffic flows when required?
  - What if we save bandwidth in bottlenecks?
First Person Shooter game:

Four IPv4/UDP client-to-server packets of Counter Strike
η=61/89=68%

One IPv4/TCM packet multiplexing four client-to-server Counter Strike packets
η=244/293=83%

MMORPG:

Seven IPv4/TCP client-to-server packets of World of Warcraft. E[P]=20bytes
η=20/60=33%

One IPv4/TCM packet multiplexing seven client-to-server W. of Warcraft packets
η=120/187=64%

VoIP (exactly like RFC4170):

Five IPv4/UDP/RTP VoIP packets with two samples of 10 bytes
η=20/60=33%

One IPv4 TCMTF Packet multiplexing five two sample packets
η=100/161=62%

1.8.2013.
TCM-TF BOF

Tunneling Compressed Multiplexed Traffic Flows BOF
Thursday (today) Afternoon Session II
15:20-16:50 CEST
Postdam 3

Hope to see you there 😊