

# Tutorial: Traffic of Online Games

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IETF 87, Berlin, August 1<sup>st</sup>, 2013  
Transport Area Open Meeting

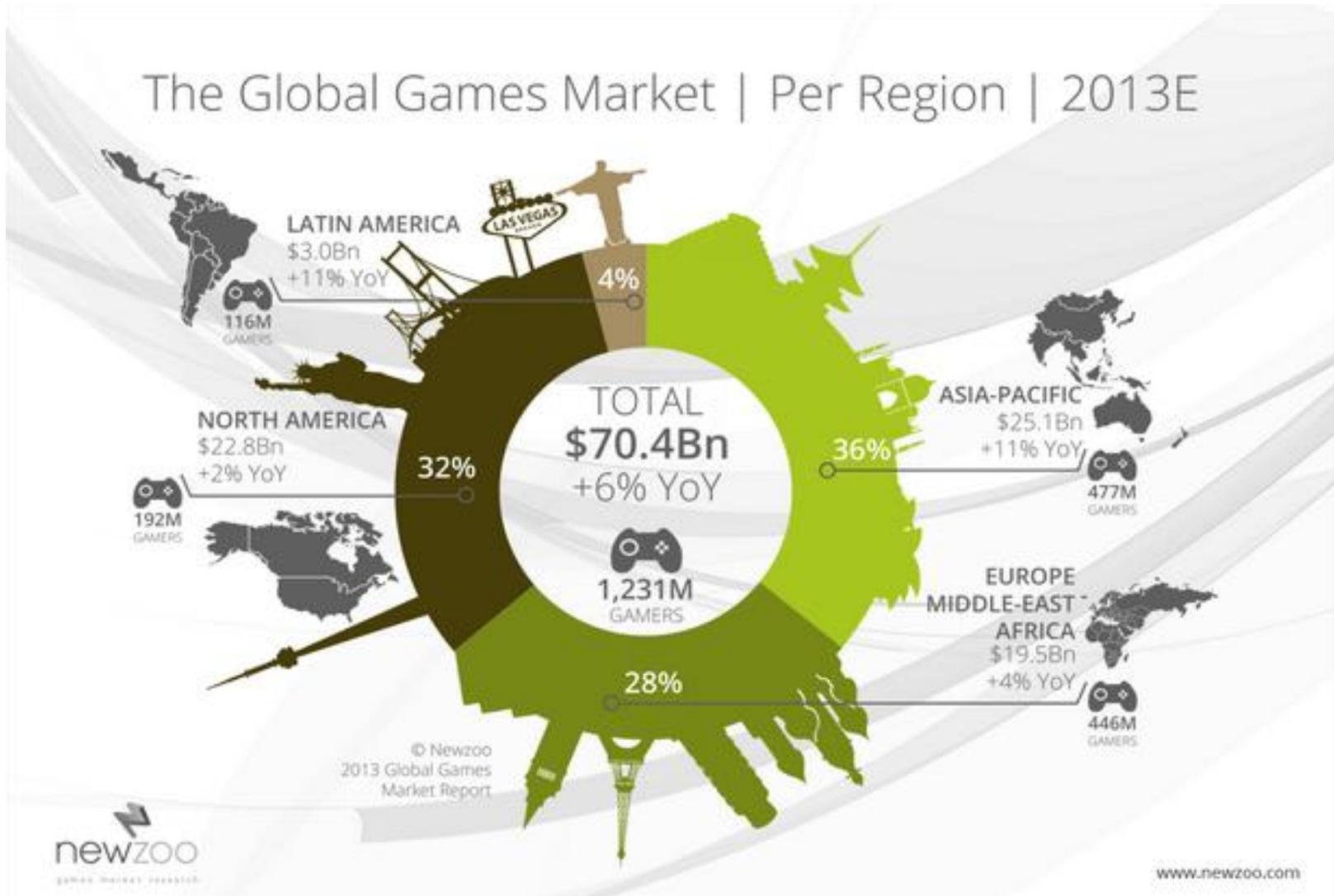
# Goals of this presentation

- Information about current practices in online games industry
- Traffic of online games – trends and characteristics
- Current network issues and QoE requirements

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- 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...

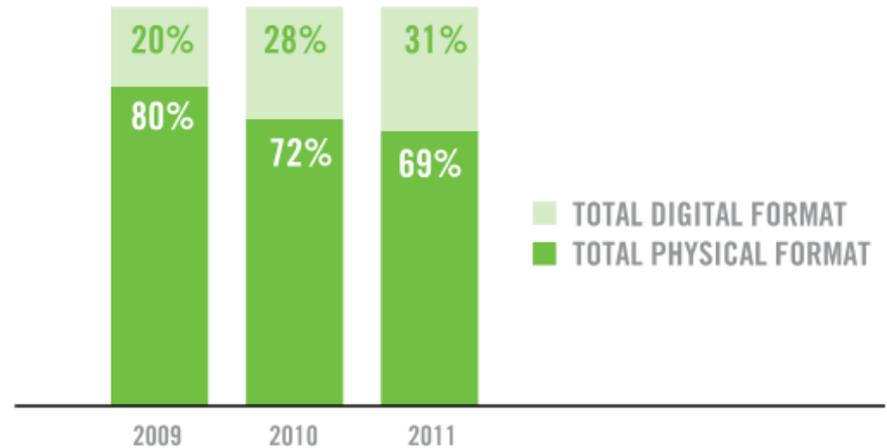
# Size of the gaming industry



# Shift towards online

## Recent Digital\* and Physical Sales Information

- Multiplayer games
- Social games
- Content distribution
- DRM



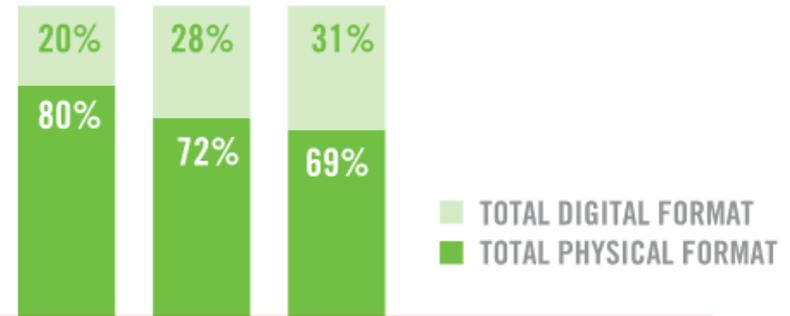
Source: The NPD Group/Games Market Dynamics: U.S



# Shift towards online

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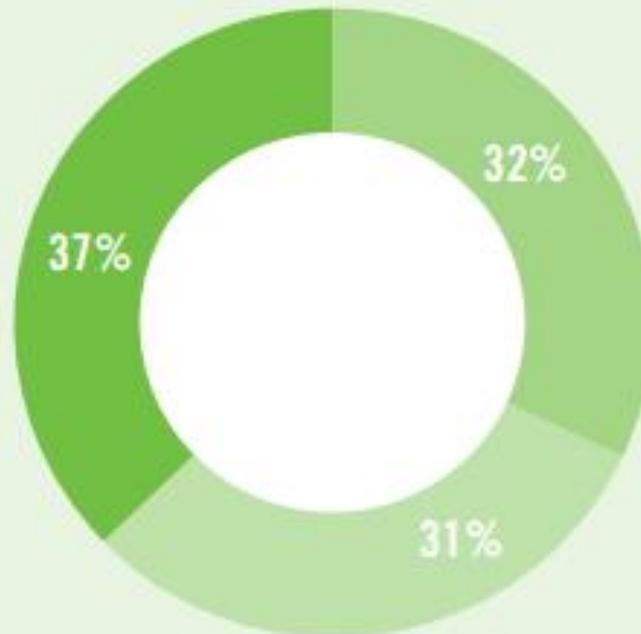
Xbox one is predicted to be supported by 500 000 servers, compared to 30 000 of Xbox live (current one)



# Who are the consumers?

The average game player age is:

30



**AGE**  
of Game Players

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

# Are video games only for kids?

## Did You KNOW?

According to ESA's 2012 Essential Facts, 49 percent of American households own a game console.

▣ About the ESA

▣ Become a Member

▣ Industry Facts

- Economic Data
- Sales & Genre Data
- Game Player Data
- Games & Violence
- Video Game Research

▣ Public Policy

▣ Games: Improving What Matters

▣ News Room

## Game Player Data

Video games are now a mass medium, widely enjoyed on a variety of platforms by a diverse audience. The ESA's *2012 Essential Facts About the Computer and Video Game Industry* reveals interesting demographic facts about today's gamers and the games they play, including:

- The average gamer is 30 years old and has been playing for 12 years. Sixty-eight percent of gamers are 18 years of age or older.
- Forty-seven percent of all players are women, and women over 18 years of age are one of the industry's fastest growing demographics.
- Today, adult women represent a greater portion of the game-playing population (30 percent) than boys age 17 or younger (18 percent).
- Sixty-two percent of gamers play games with others, either in person or online. Seventy-eight percent of these gamers play with others at least one hour per week.
- Thirty-three percent of gamers play social games.
- Gamers play on-the-go: device.

Source: Entertainment Software Association (ESA)

<http://www.theesa.com/facts/gameplayer.asp>

1.8.2013.



# 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

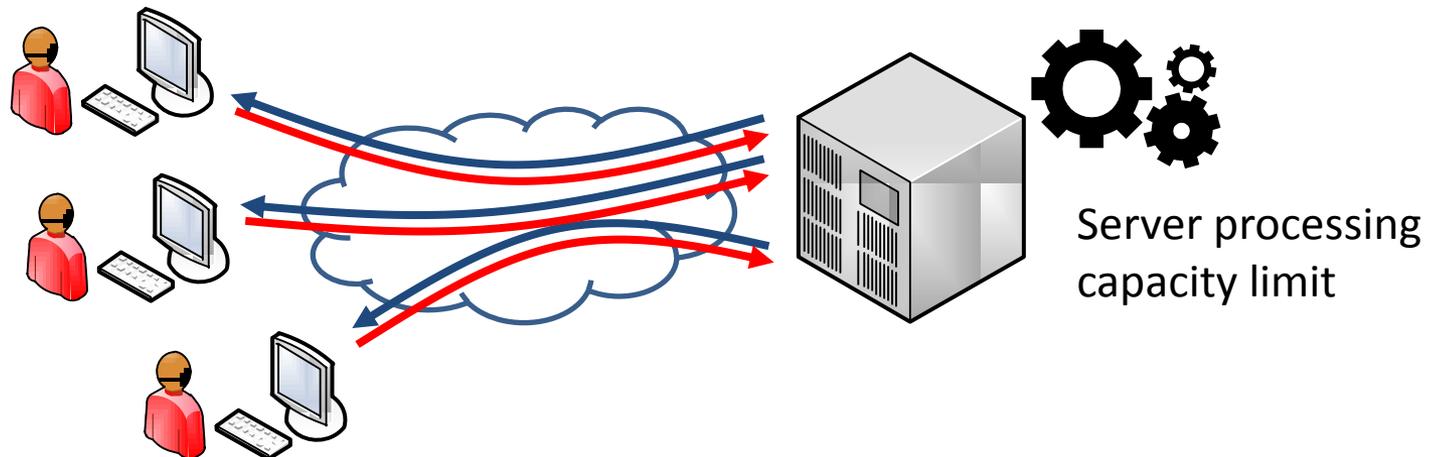
- Specific application per game (hybrid clients)
- Clients encompassing multiple games
  - Browser-based games
  - Cloud based games (thin clients)
- Client version highly affects traffic characteristics

# 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

*120 hours of World of Warcraft*

by Elizabeth Harper 📅 Jul 24th 2007 at 8:10PM

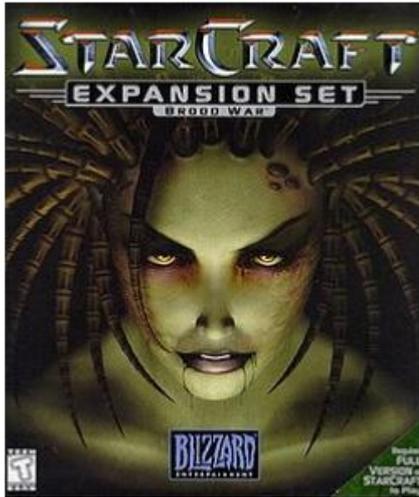


# Why so small?

- 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)

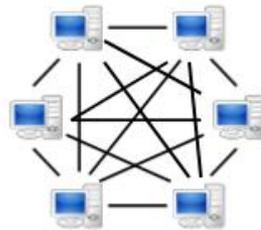


# Game traffic evolution? – Not really

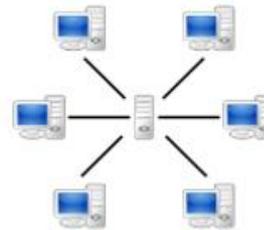
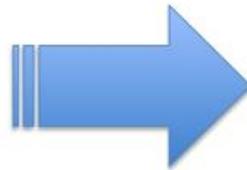


**StarCraft I (1998-2010)**

1-5kbps  
(2-8 players)



Peer-to-peer  
Architecture



Server-client  
Architecture



**StarCraft II (2010-present)**

2-3 kbps  
(independent of  
number of players)

M. Claypool, D. LaPoint, and J. Winslow, "Network Analysis of Counter-strike and Starcraft," in Proceedings of the 22nd IEEE International Performance, Computing, and Communications Conference (IPCCC), USA, April 2003.

C-S. Lee, "The Revolution of StarCraft Network Traffic" in Proceedings of the 11th Annual Workshop on Network and Systems Support for Games NetGames 2012

# 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

Direction	RTP SSRC	RTP Payload Type	Flow description
Downstream	0x00000000	100	QoS monitoring flow
Downstream	0x00010000	100	OnLive Control
Downstream	0x00030000	100	Audio stream (CBR Codec)
Downstream	0x00040000	100	Cursor position
Downstream	0x00050000	101	Audio stream (VBR Codec)
Downstream	0x00060000	96	Video stream
Downstream	0x00080000	100	Voice Chat (Sound from other players)
Upstream	0x0000XXXX	100	User input (keyboard and mouse buttons)
Upstream	0x0001XXXX	100	Cursor movement
Upstream	0x0004XXXX	100	OnLive Control ACK
Upstream	0x0008XXXX	100	Voice Chat (Microphone from the user)

# Global trends

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

Consumer Internet Traffic, 2012–2017							
	2012	2013	2014	2015	2016	2017	CAGR 2012–2017
<b>By Subsegment (PB per Month)</b>							
Internet video	14,818	19,855	25,800	32,962	41,916	52,752	29%
Web, email, and data	5,173	6,336	7,781	9,542	11,828	14,494	23%
File sharing	6,201	7,119	7,816	8,266	8,478	8,667	7%
Online gaming	22	26	32	39	48	59	22%

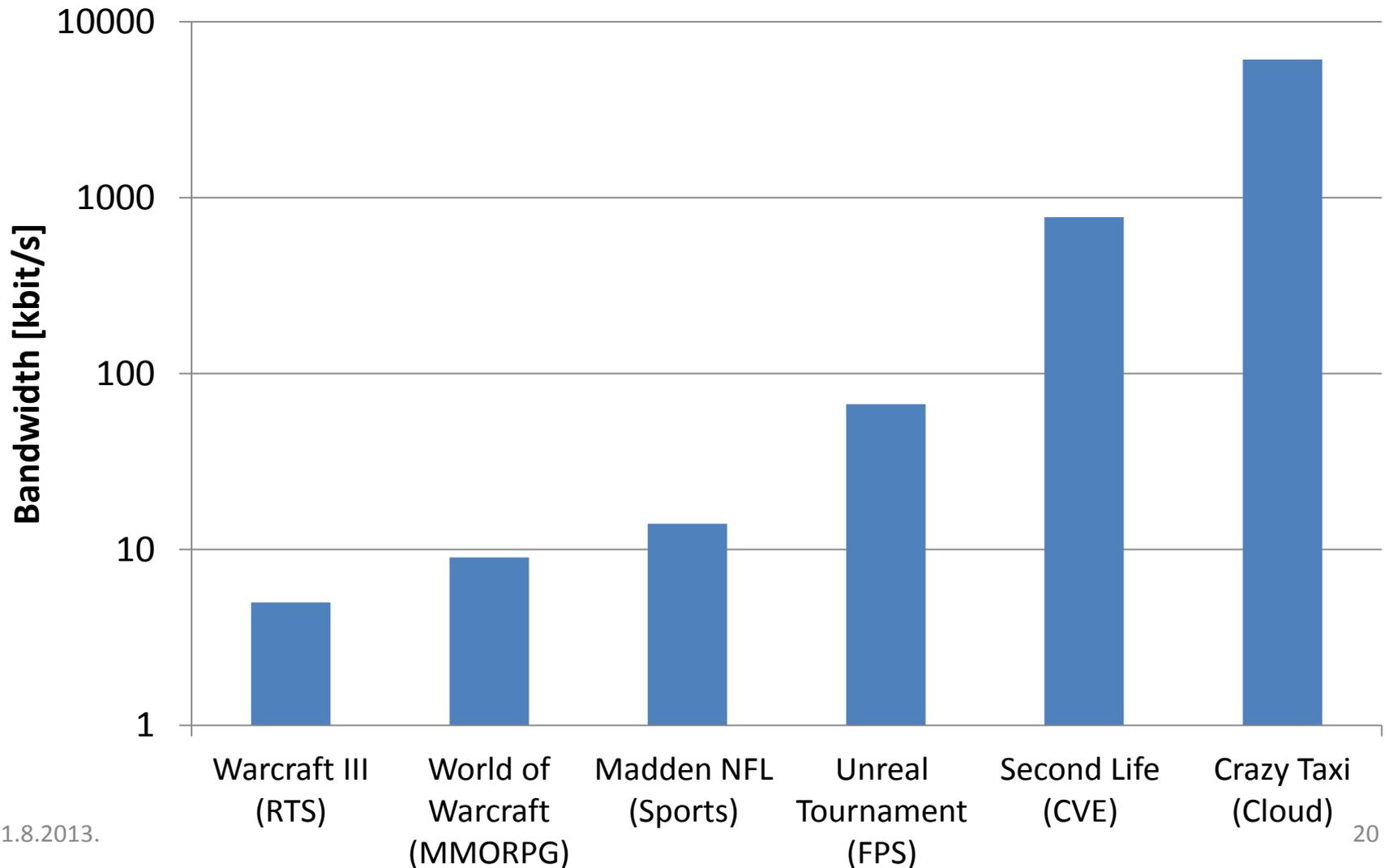
# Game genres

- 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



NPD Group Inc., NDP Software Category Definitions, 2008,  
<https://www5.npd.com/tech/pdf/swcategories.pdf>.

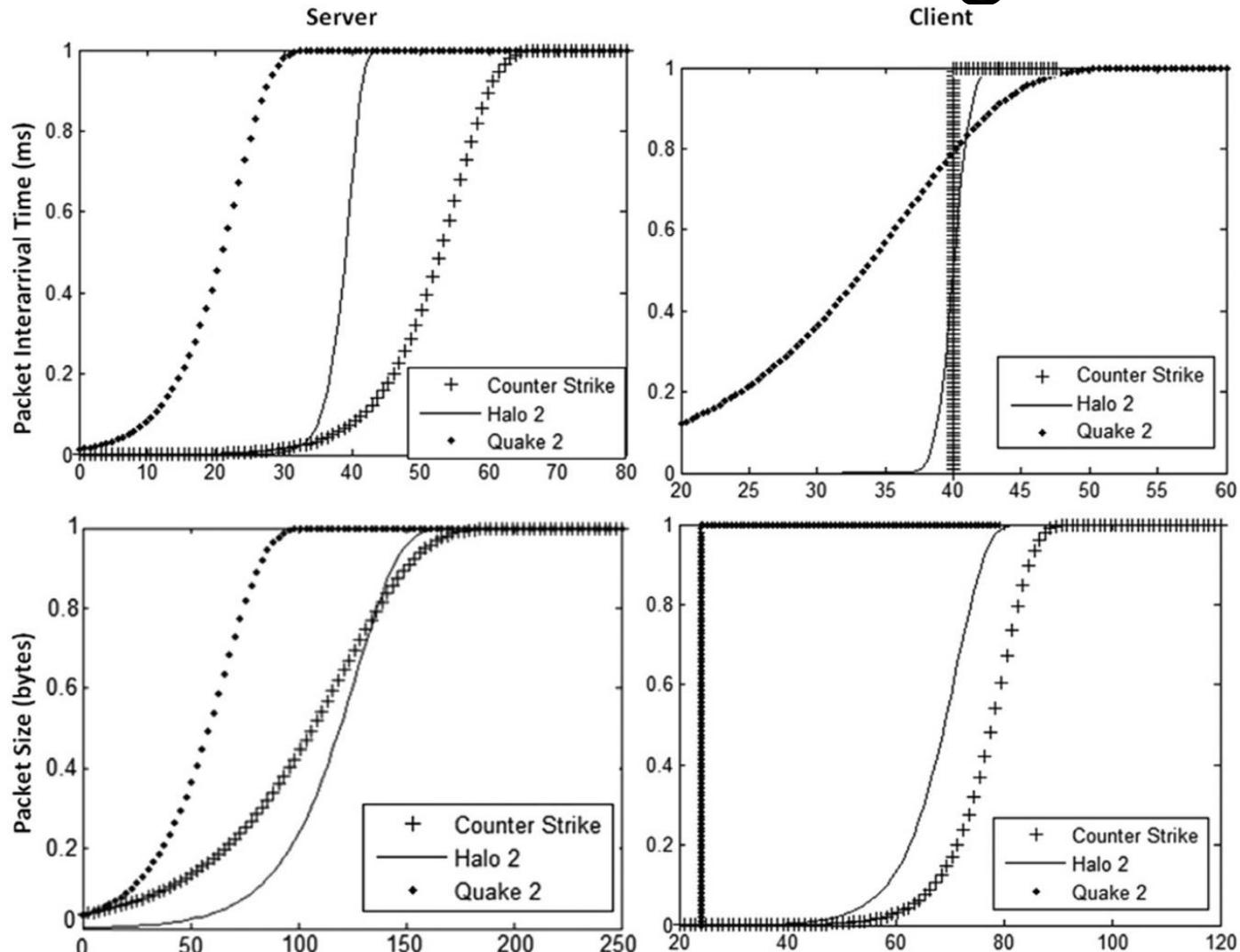
# Bandwidth usage across genres



# 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



X. Che and B. Ip, "Review: Packet-level traffic analysis of online games from the genre characteristics perspective", Journal of Network Computing Appl. 35, 240–252 (2012)

# 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

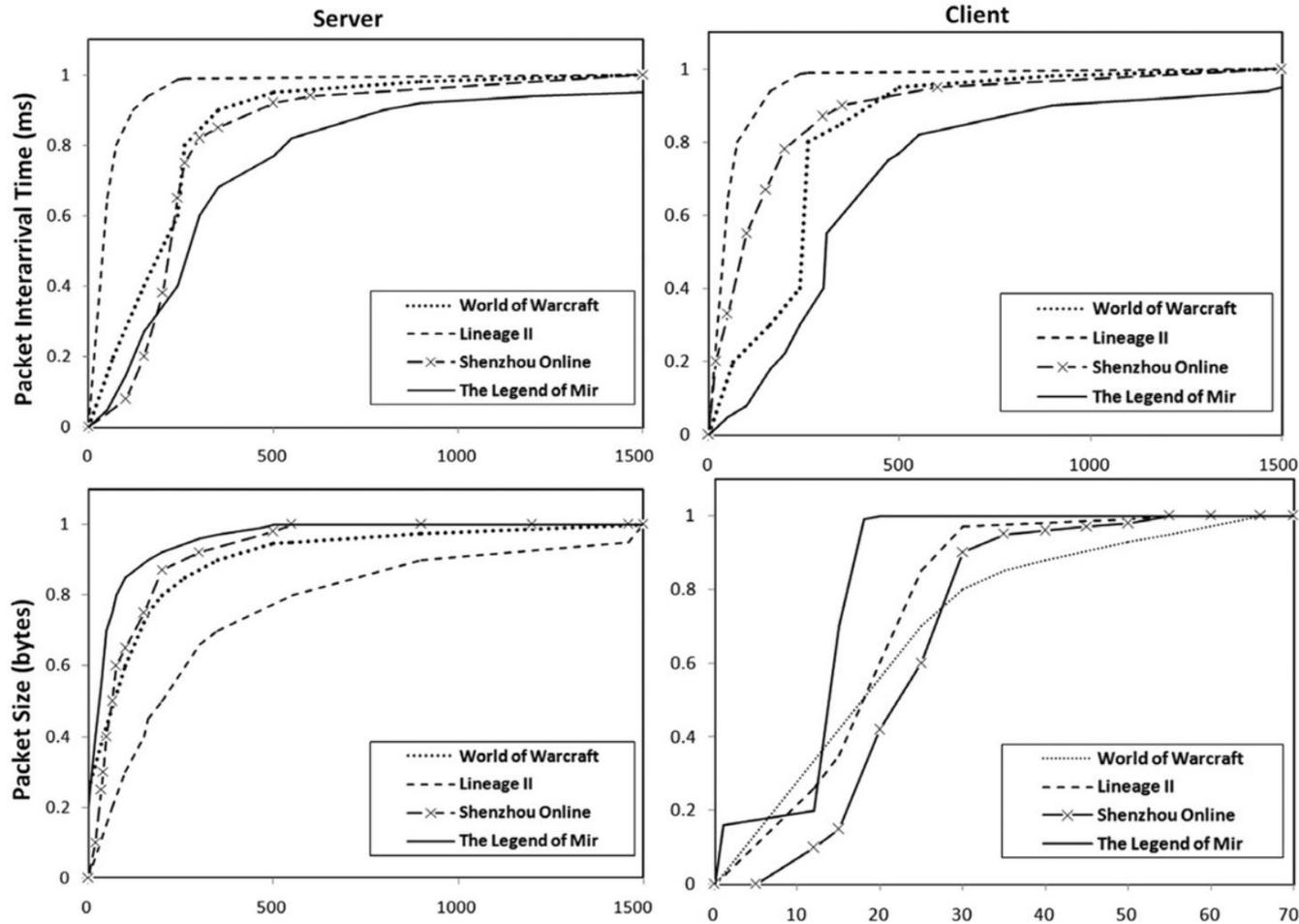
- TCP not designed for a real time interactive application!!! (yet it works)
- Application limited not network limited flows
- Multiple thin TCP flows behave unlike one fat TCP flow
- Mechanisms in TCP directly deteriorate the experience of the players (delayed ACK, Nagle algorithm)
- Mechanisms of TCP 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

S. Pack, E.Hong, Y. Choi, I.Park, J-S. Kim, and D. Ko, "Game Transport Protocol: A Reliable Lightweight Transport Protocol for Massively Multiplayer On-line Games (MMPOGs)", Multimedia Systems and Applications, Vol. 486 pp. 83-94, Oct, 2002)  
C-C. Wu, K-T. Chen, C-M. Chen, P.Huang, and C-L. Lei , "On the Challenge and Design of Transport Protocols for MMORPGs ", Multimedia Tools and Applications Vol. 45, No. 1, pp. 7--32, Oct, 2009.

# CDF's of different MMORPGs



# MMORPG action diversity

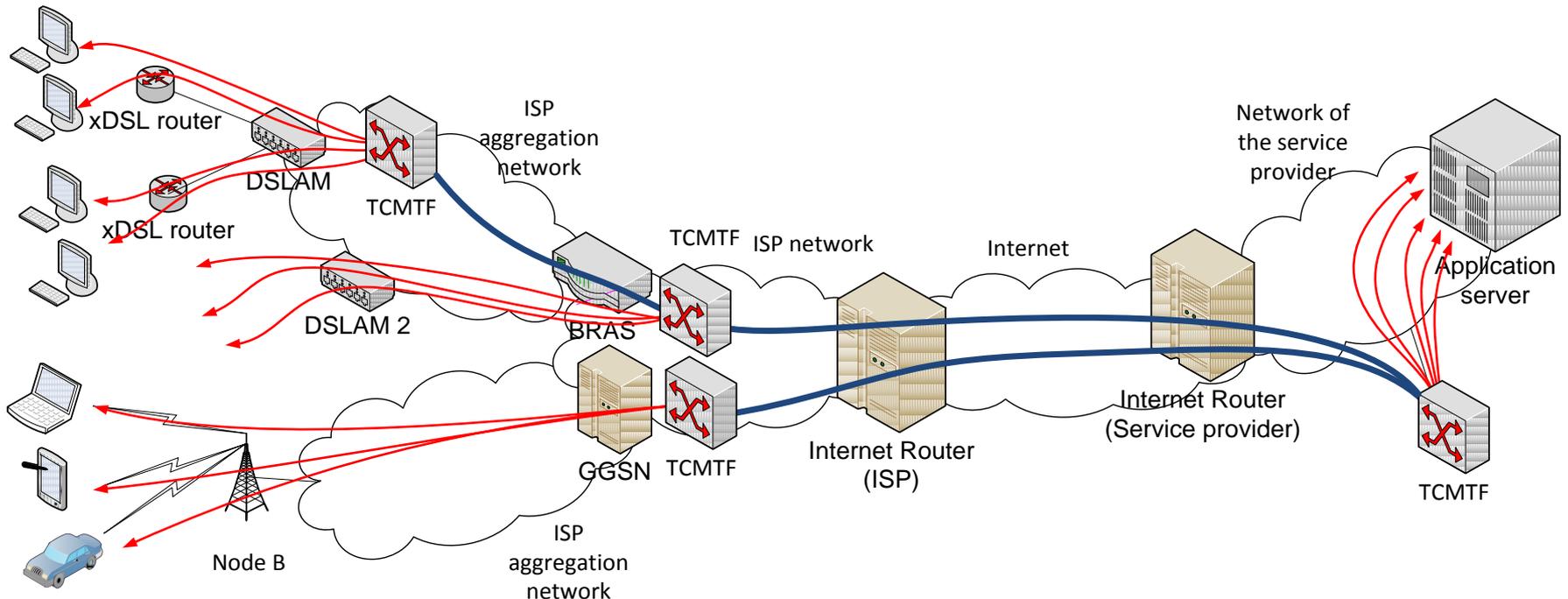


# Summary of problems

- 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?



# TCM-TF advertisement

## First Person Shooter game:

Four IPv4/UDP client-to-server packets of Counter Strike

$$\eta = 61/89 = 68\%$$



One IPv4/TCM packet multiplexing four client-to-server Counter Strike packets

$$\eta = 244/293 = 83\%$$



## MMORPG:

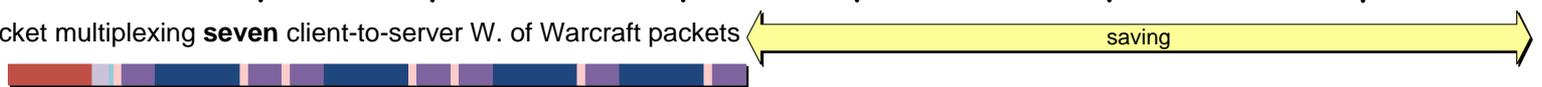
Seven IPv4/TCP client-to-server packets of World of Warcraft. E[P]=20bytes

$$\eta = 20/60 = 33\%$$



One IPv4/TCM packet multiplexing seven client-to-server W. of Warcraft packets

$$\eta = 120/187 = 64\%$$



## VoIP (exactly like RFC4170):

Five IPv4/UDP/RTP VoIP packets with two samples of 10 bytes

$$\eta = 20/60 = 33\%$$



One IPv4 TCMTF Packet multiplexing five two sample packets

$$\eta = 100/161 = 62\%$$



# 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 😊