

Ch 13 Traffic Measurement and Player Analysis

Magda El Zarki

Prof. of CS

Univ. of CA, Irvine

Email: elzarki@uci.edu

<http://www.ics.uci.edu/~magda>

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

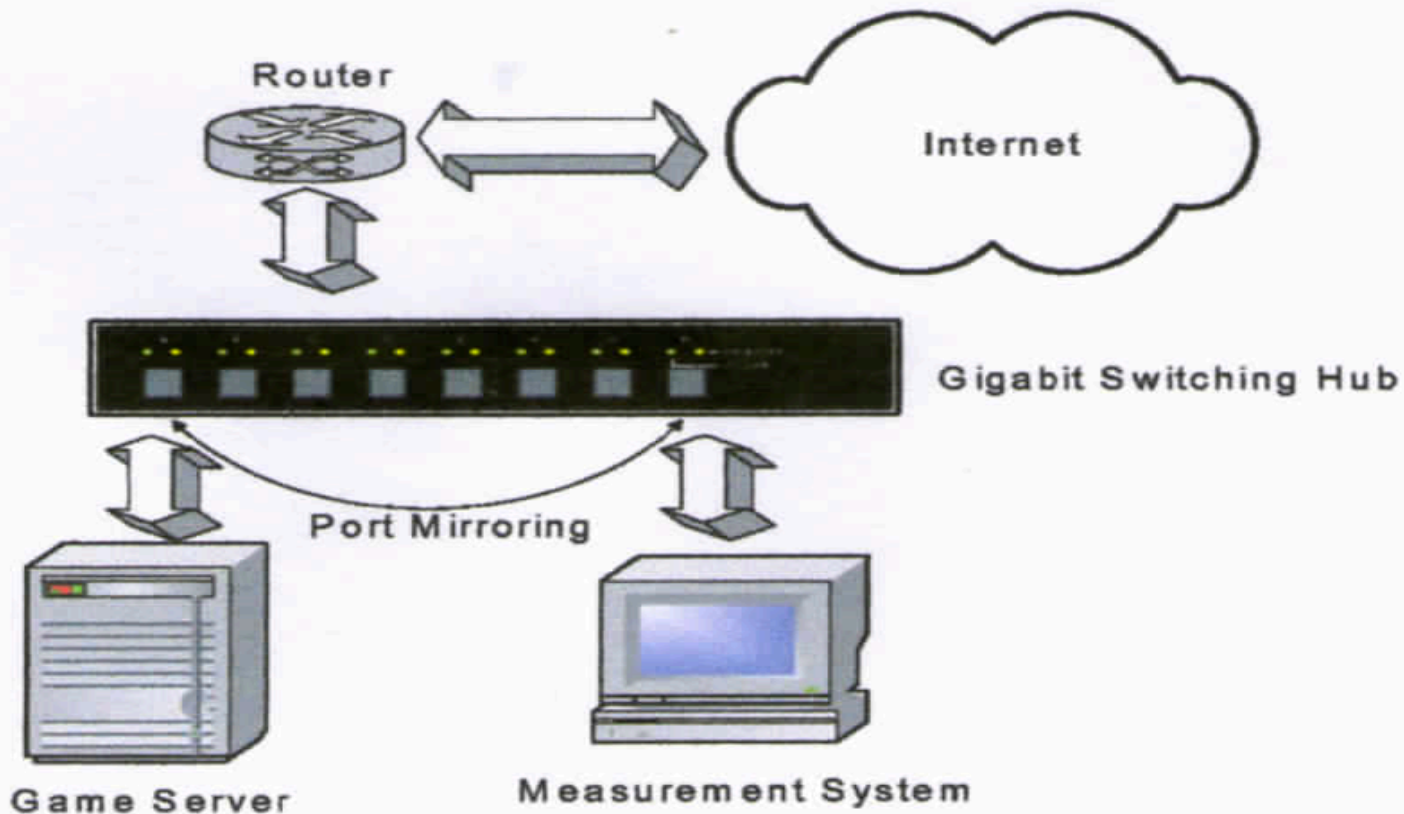


Figure. 1 Schematic of measurement setup.

Overview of Data Collection

Table. 2 Overview of measurement data.

Measurement Period	Thursday 2004.12.9 12:02 PM ~		92 hours and 22 minutes
	Monday 2004.12.13 8:24 AM		
Captured log generated by 'tcpdump'	About 1 tera bytes		
Concurrent Users	2000 ~ 5140		
Packet Count	Total Packet Count		12,723,507,137
	Upstream	Total Packet Count	6,288,990,481
		Data Packet Count	1,443,289,225
	Downstream	Total Packet Count	6,434,516,656
		Data Packet Count	6,280,005,461

No. of Users connected to server

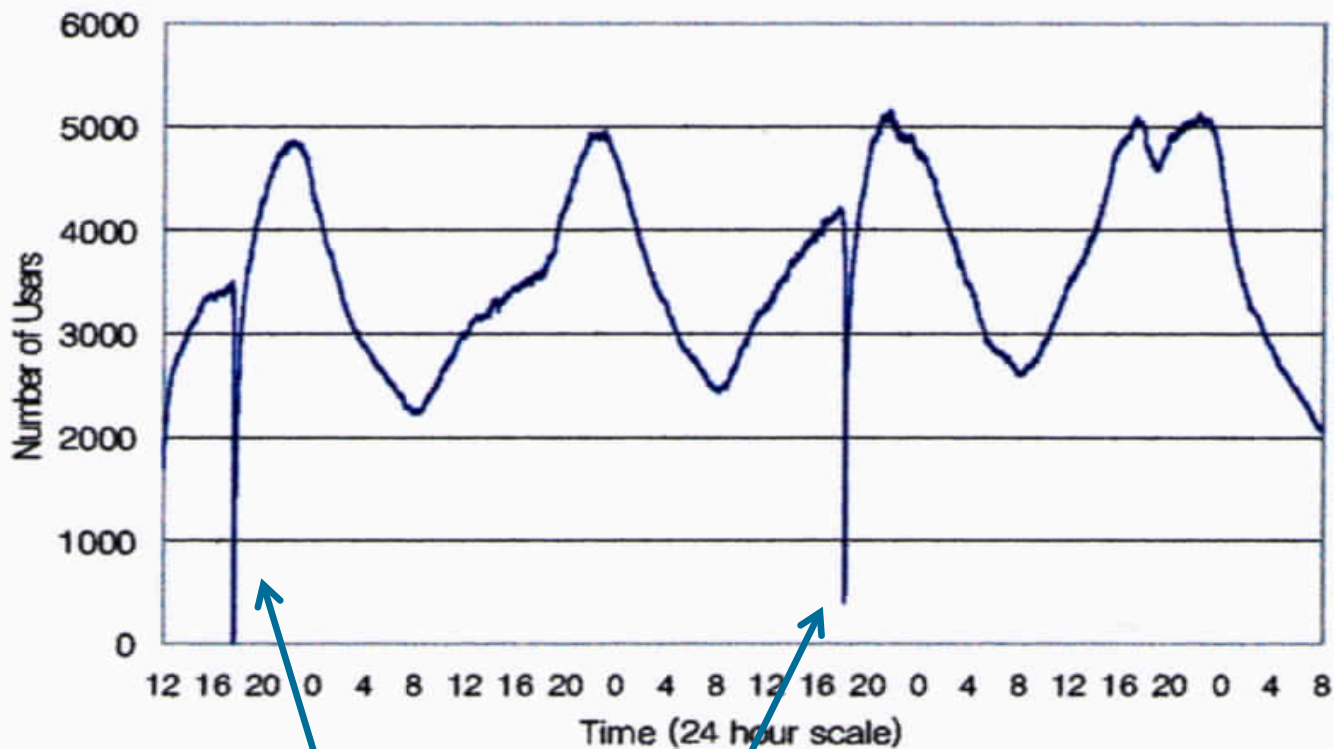


Figure. 2 Number of concurrent users connected to the server.

Network or Server Outage

Distribution of Client Packet Size

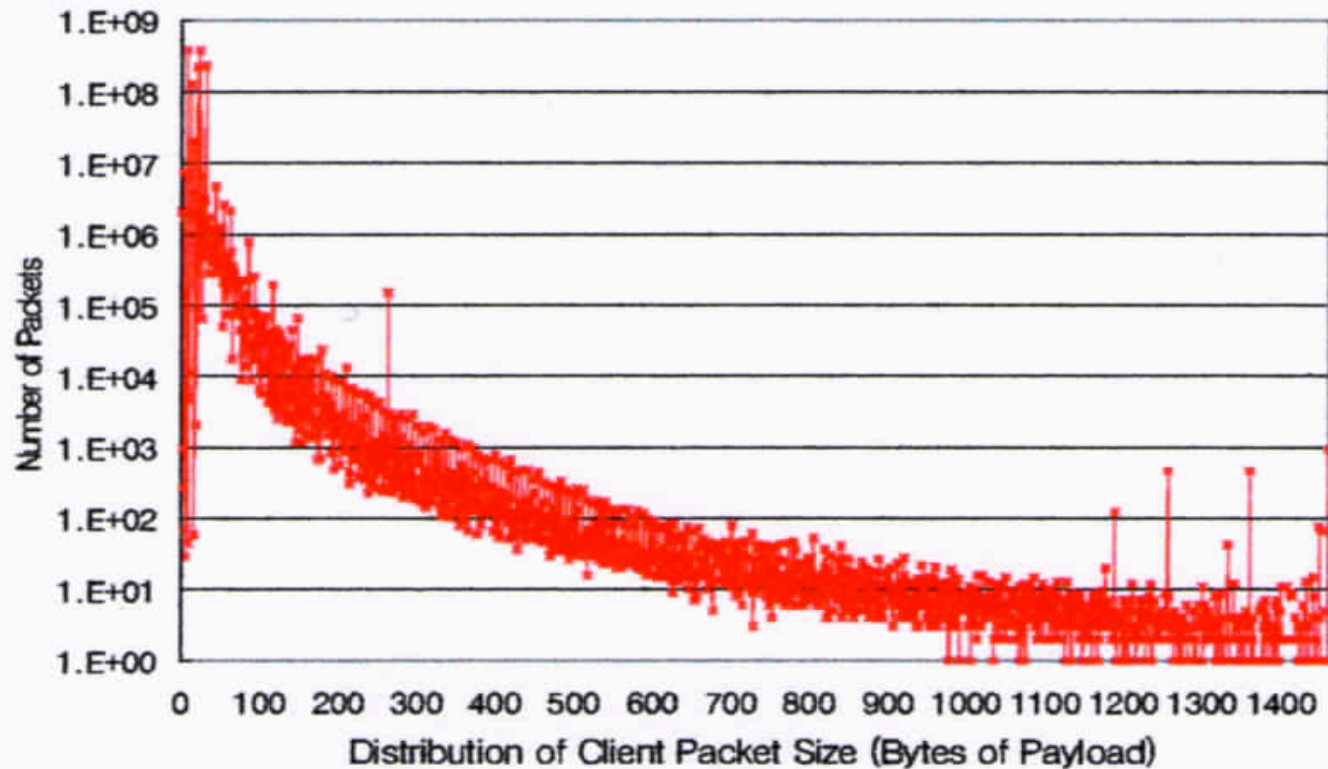


Figure. 3 Distribution of client packet size.

CDF of Client Packet Size

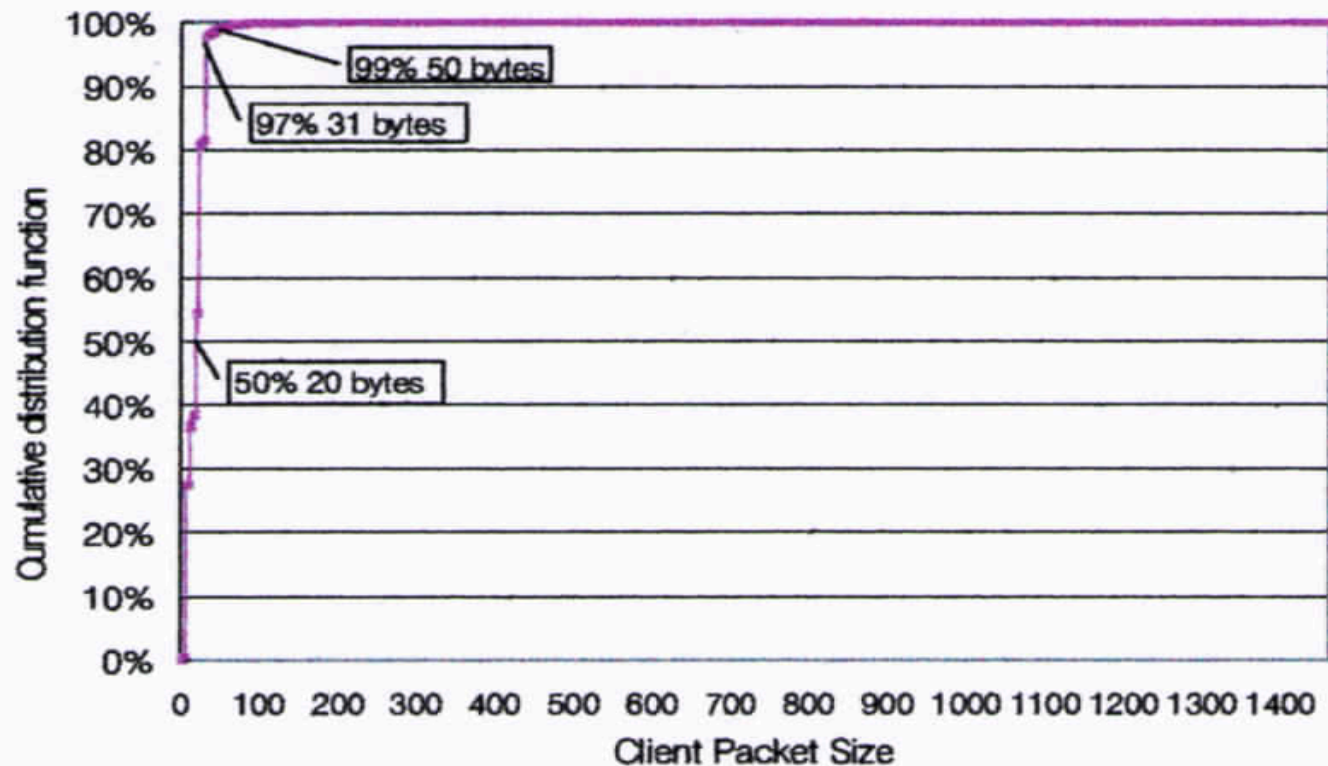


Figure. 4 Cumulative distribution of client packet size.

Client Packets

- 73% of client bytes are used for headers
- 38% of client packets are dedicated TCP ACKs
 - TCP uses delayed ACKS - 200ms

Distribution of Server Packet Size

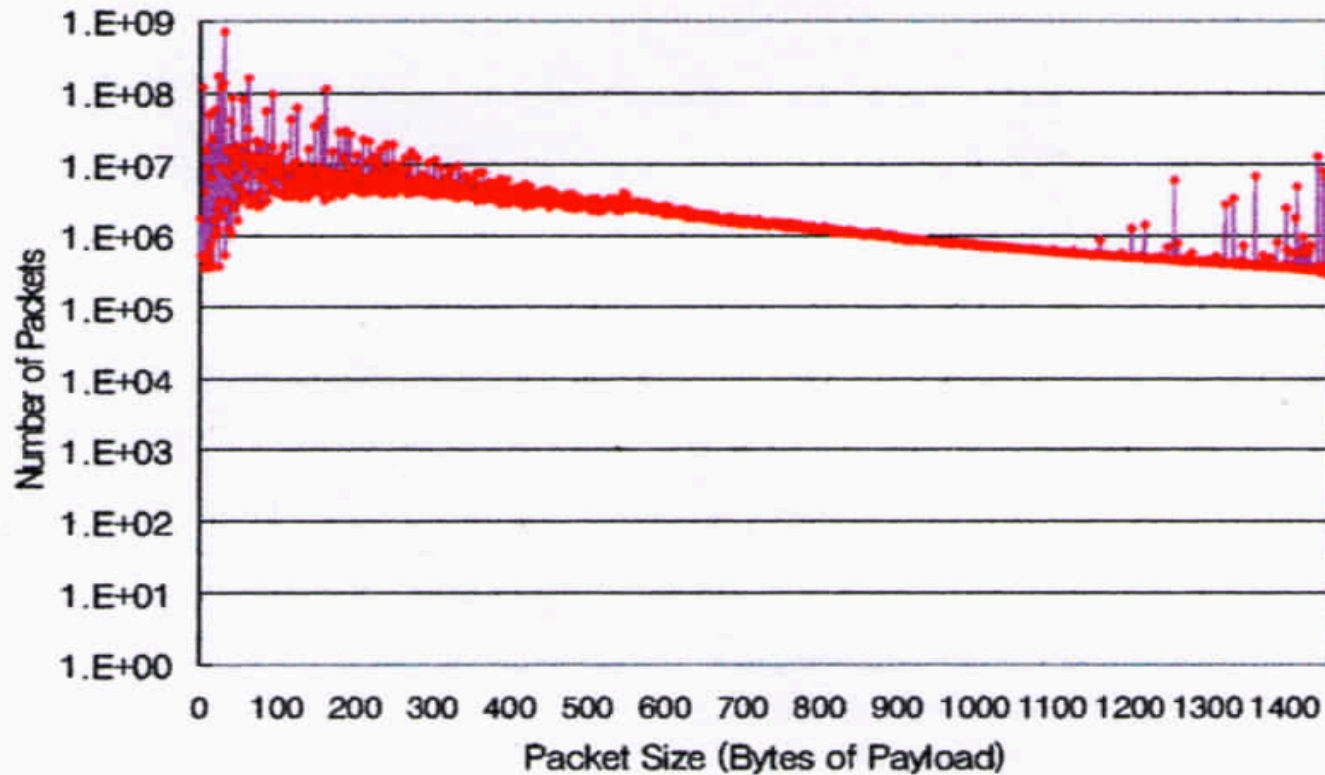


Figure. 5 Distribution of server packet size

CDF of Client Packet Size

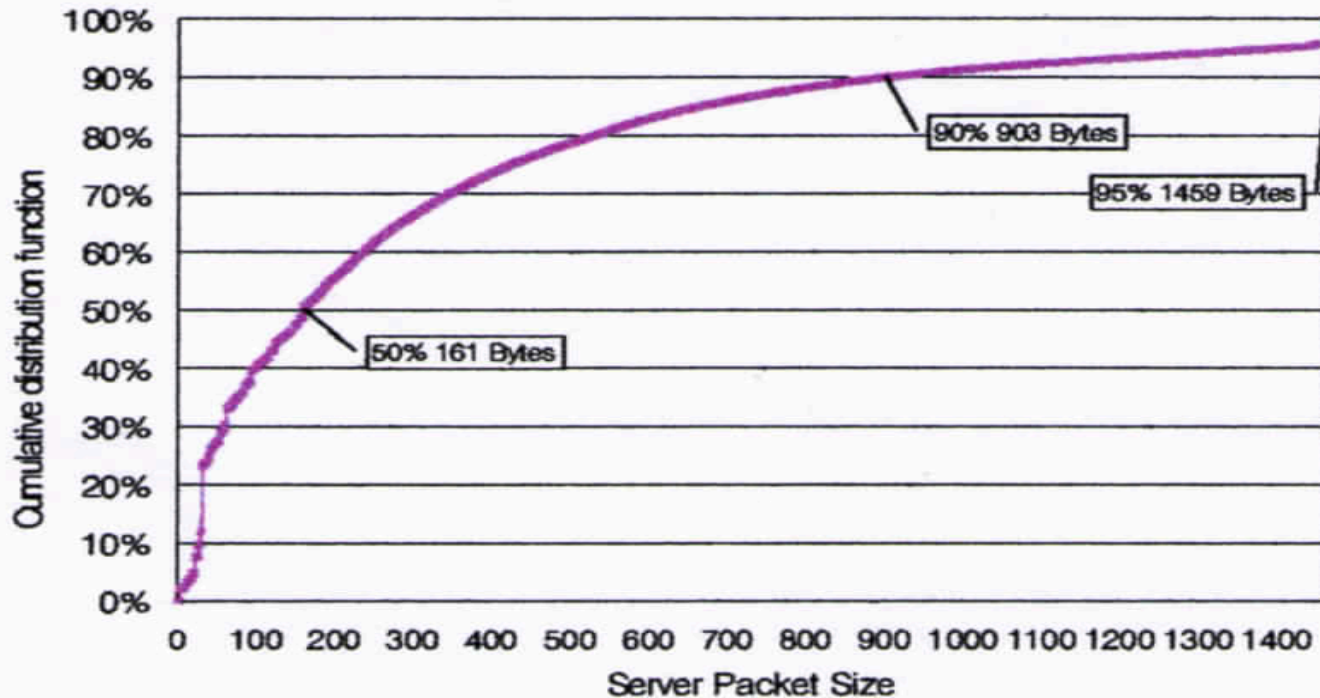


Figure. 6 Cumulative distribution of server packet size.

Most TCP ACKS are piggybacked

Bandwidth Usage

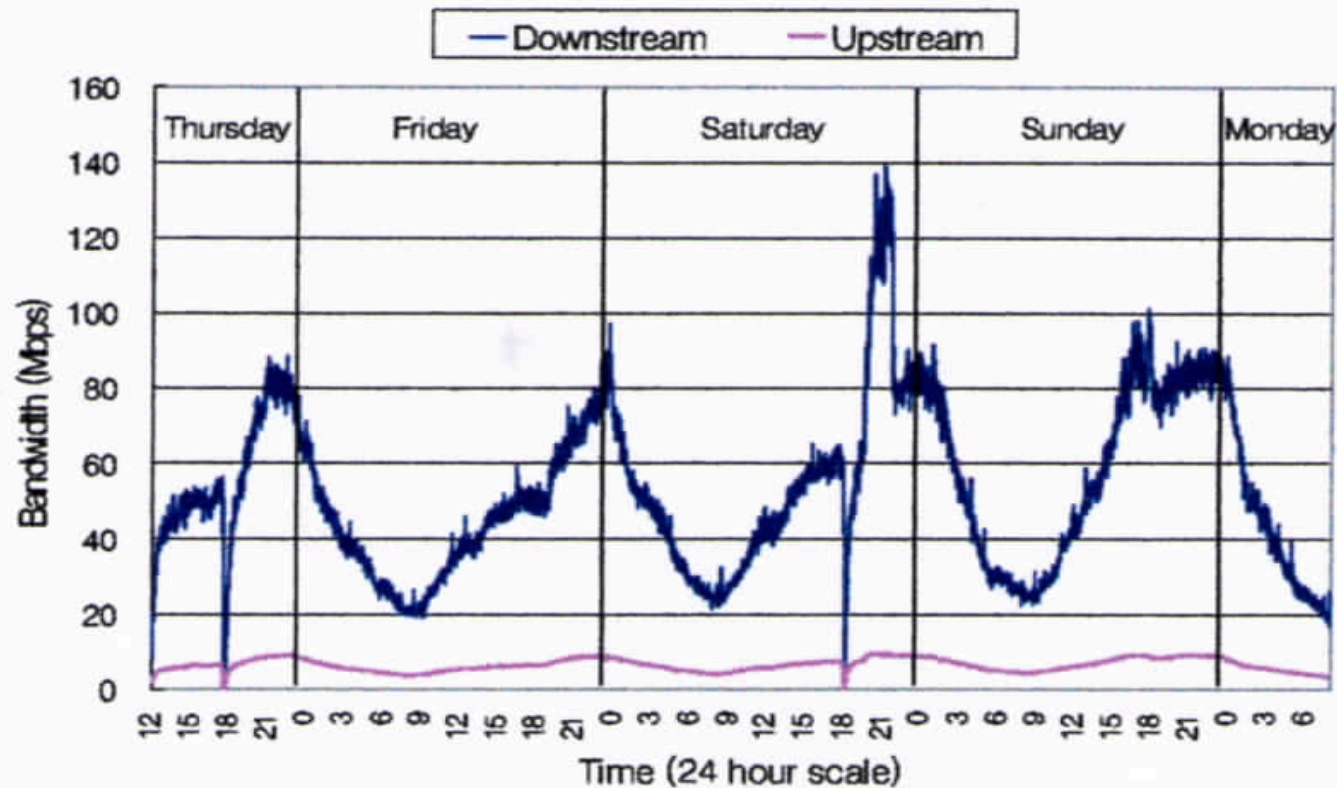


Figure. 10 Trace of bandwidth usage.

Bandwidth and No. of Players S->C

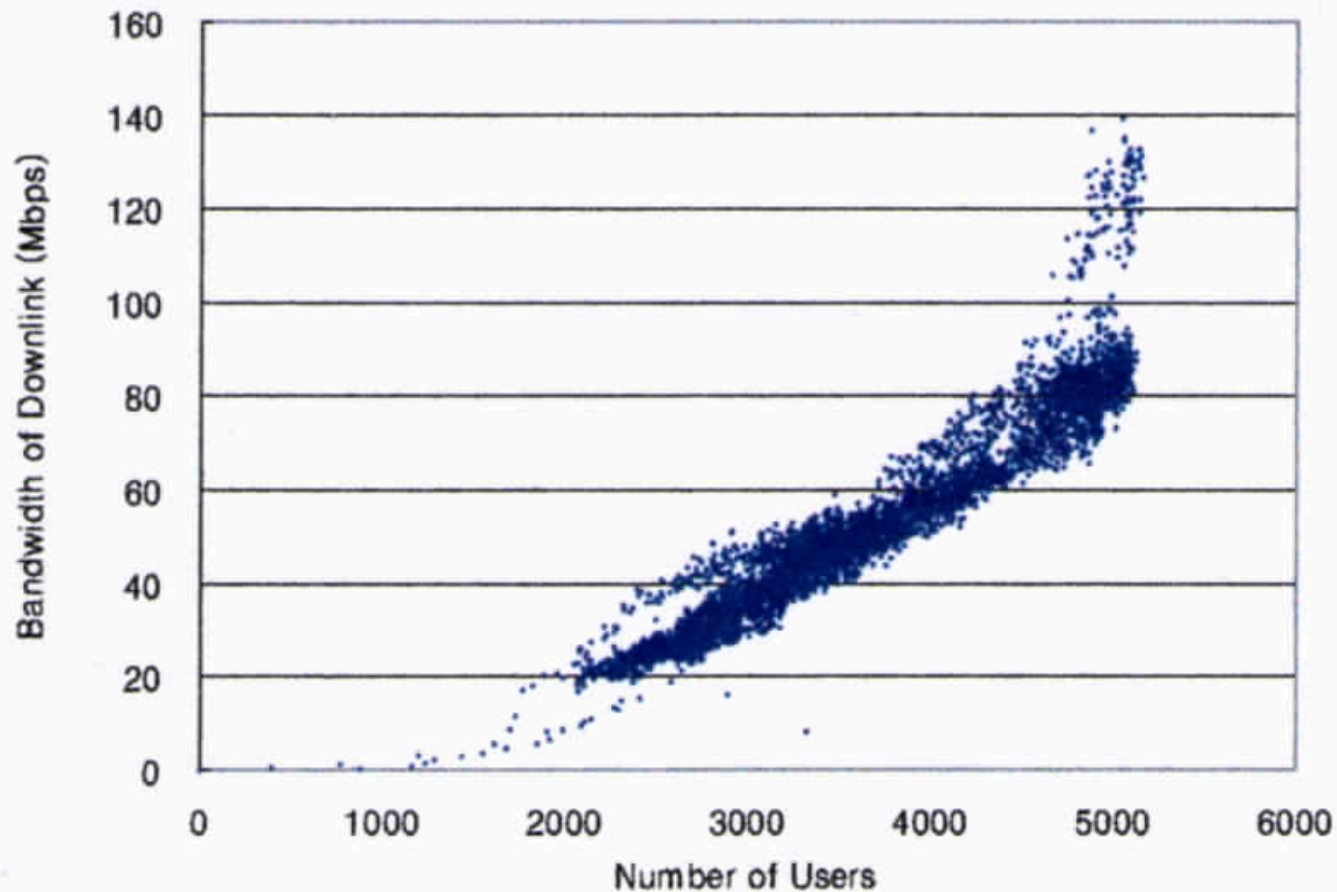


Figure. 11 Correlation between the number of users and downstream bandwidth.

Bandwidth and No. of Players C->S

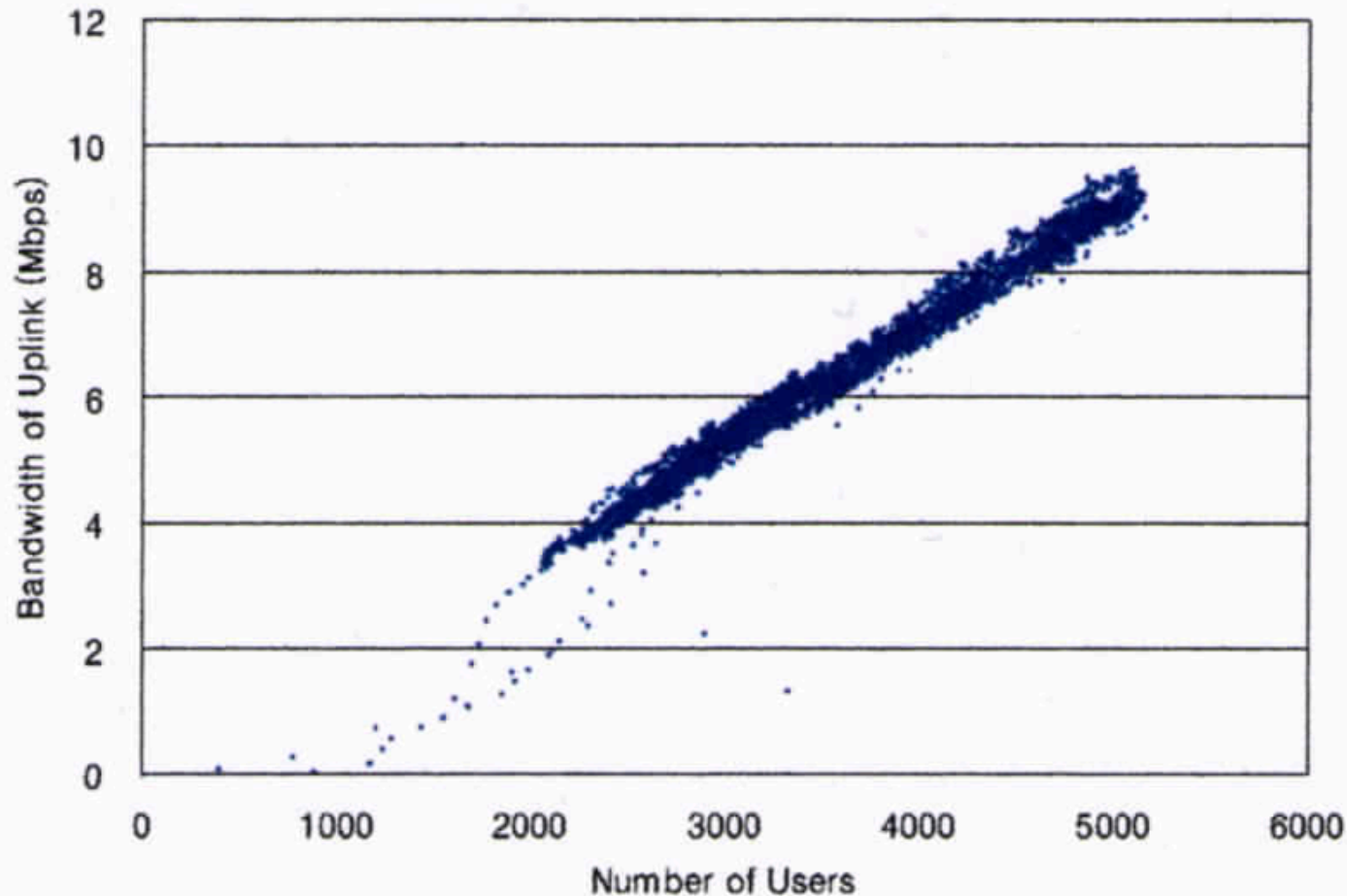
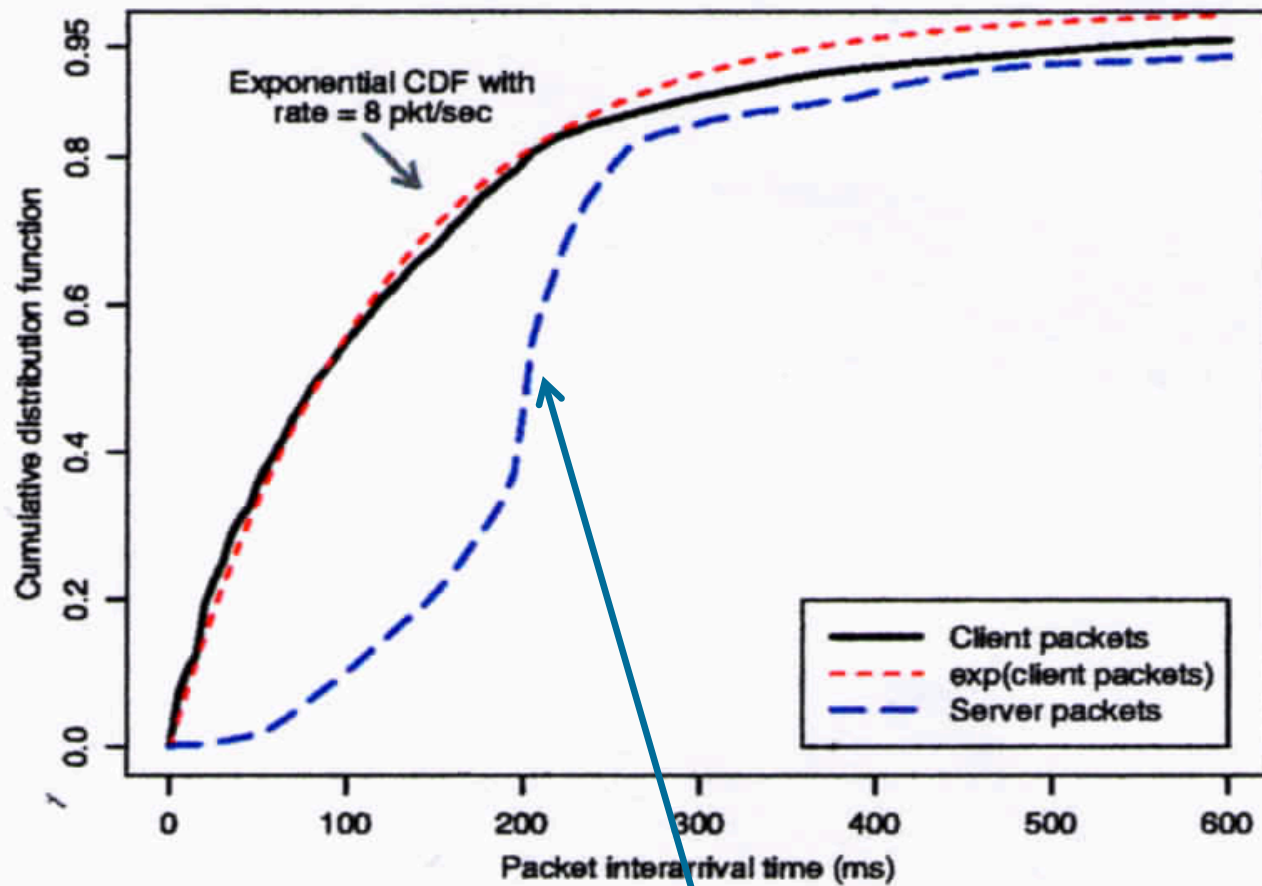


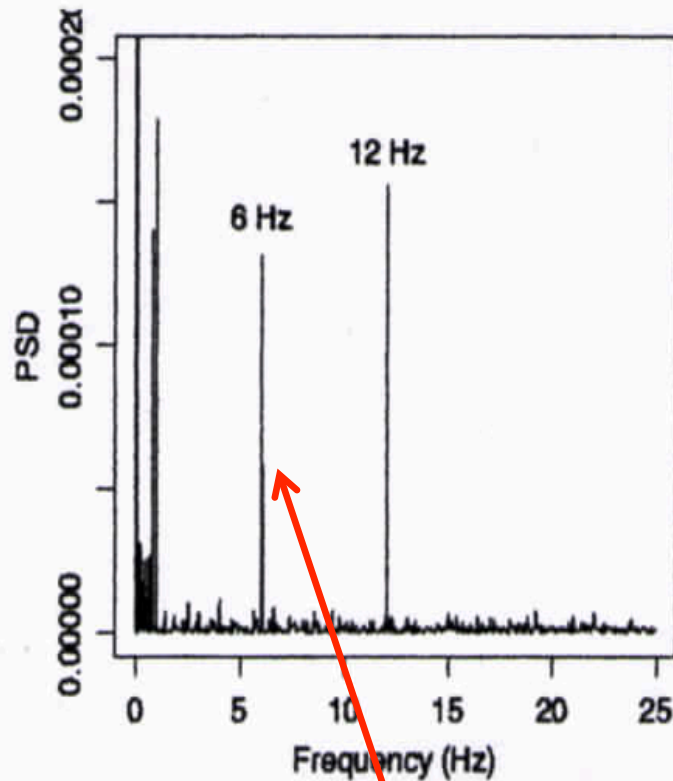
Figure. 12 Correlation between the number of users and upstream bandwidth.

Packet Inter-arrival distr.

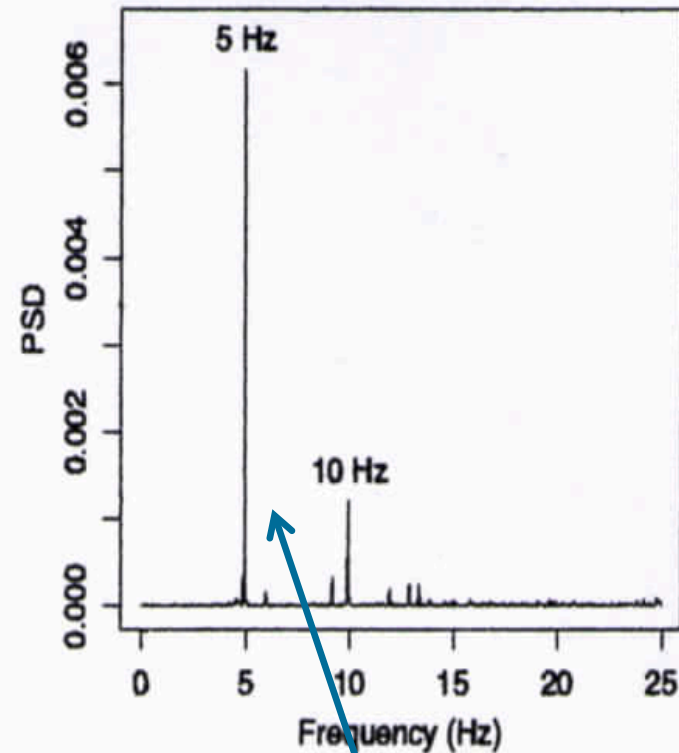


200msec update cycle

PSD of Packet Arrivals



(a) PSD of client packet arrival



(b) PSD of server packet arrival

6Hz is automated mouse click frequency

5Hz - 200msec cycle

Summary

Table. 3 Asymmetry between upstream and downstream traffic.

	Upstream	Downstream
Average <input type="text"/> Size of Payload	19.06 Bytes	318.39 Bytes
Ratio of data <input type="text"/> Bytes	22.9 %	97.6 %
Bandwidth	Up to 9 Mbps	Up to 140 Mbps

Paper

- Traffic Characteristics of a Massively Multi-player Online Role Playing Game, J. Kim, et al., NetGames'05, October 10-11, 2005, Hawthorne, New York, USA.

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

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Games Studied

GameSpy trace	
Start time	Fri Nov 1 2002
End time	Fri Dec 31 2004
Total games	550
Total player time	337,765 years

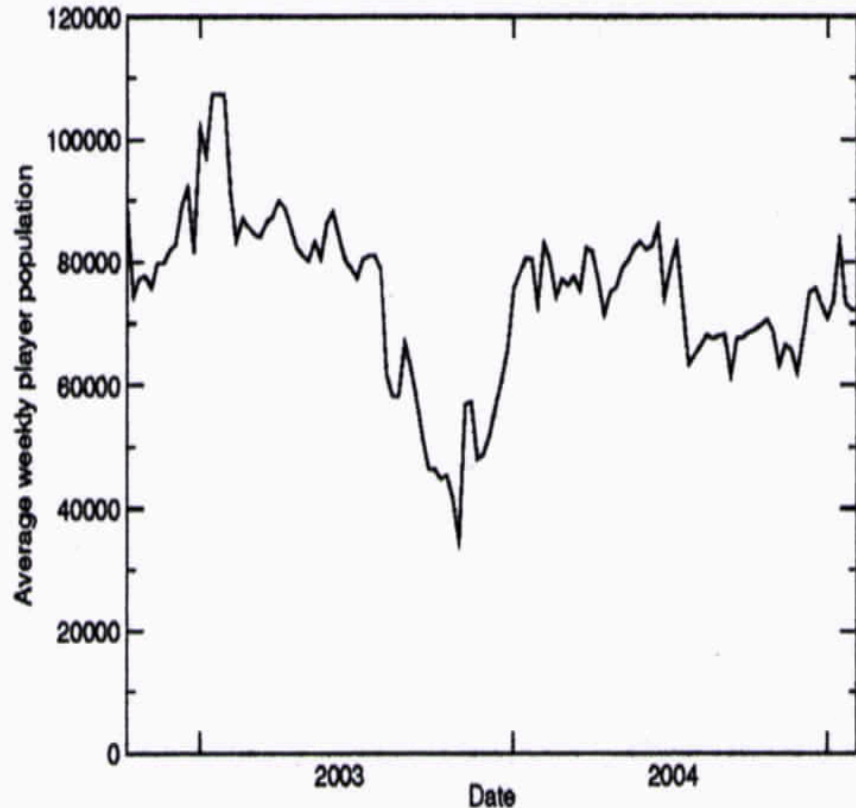
Casual games trace	
Start time	Wed Jun 1 2005
End time	Wed Jun 28 2006
Total games	110
Total player time	128,331 years

cs.mshmro.com trace	
Start time	Tue Apr 1 2003
End time	Mon May 31 2004
Total connections	2,886,992
Total unique players	493,889
Median session time	27 minutes

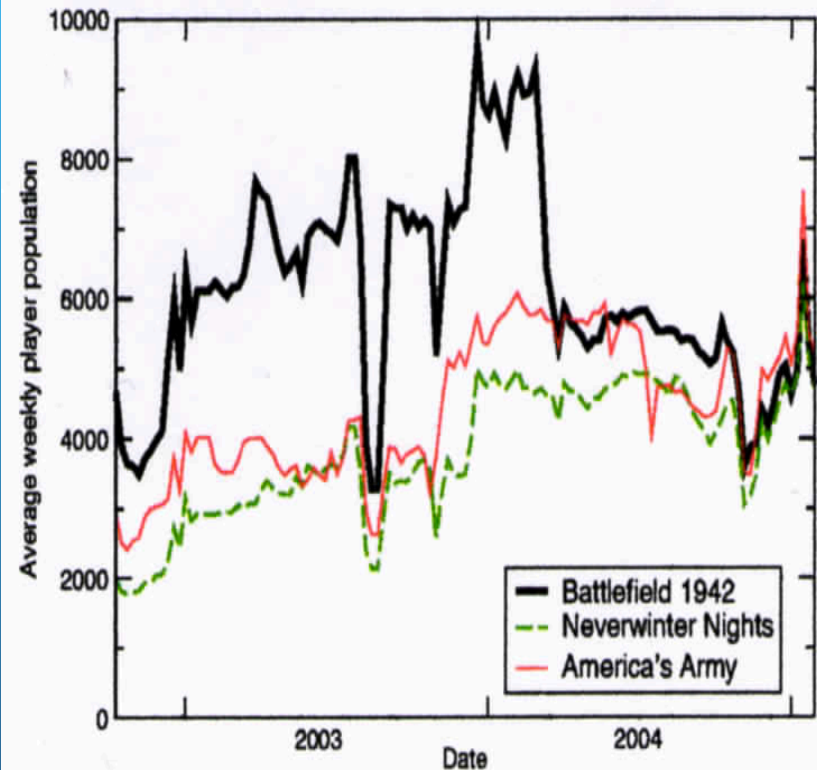
EVE Online trace	
Start time	Tue May 6 2003
End time	Sun Mar 12 2006
Total sessions	67,060,901
Total unique players	925,928
Total player time	17,204 years
Median session time	64 minutes

TABLE I
DATA SETS

Game Popularity over time (FPS)

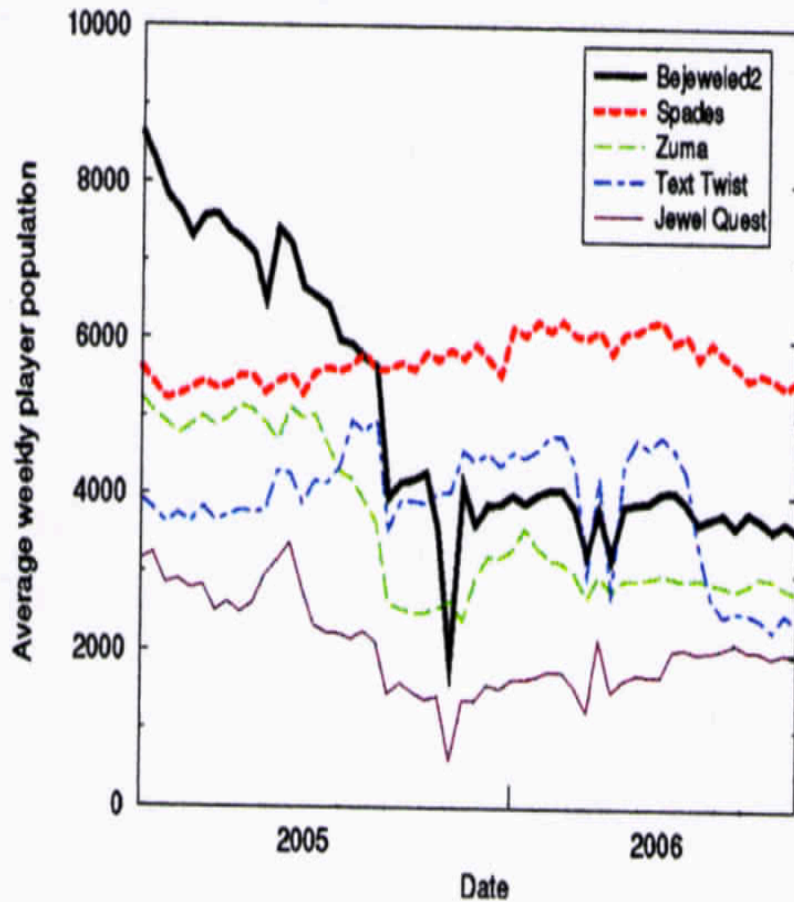


(a) Half-Life

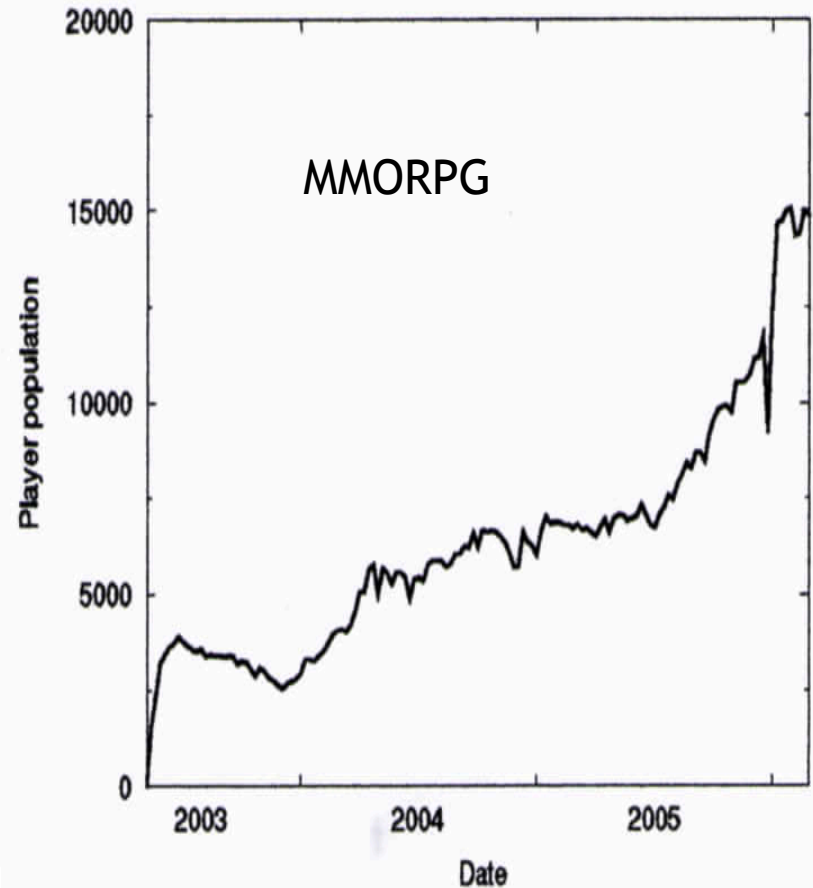


(b) GameSpy games

Game Popularity over time contd.



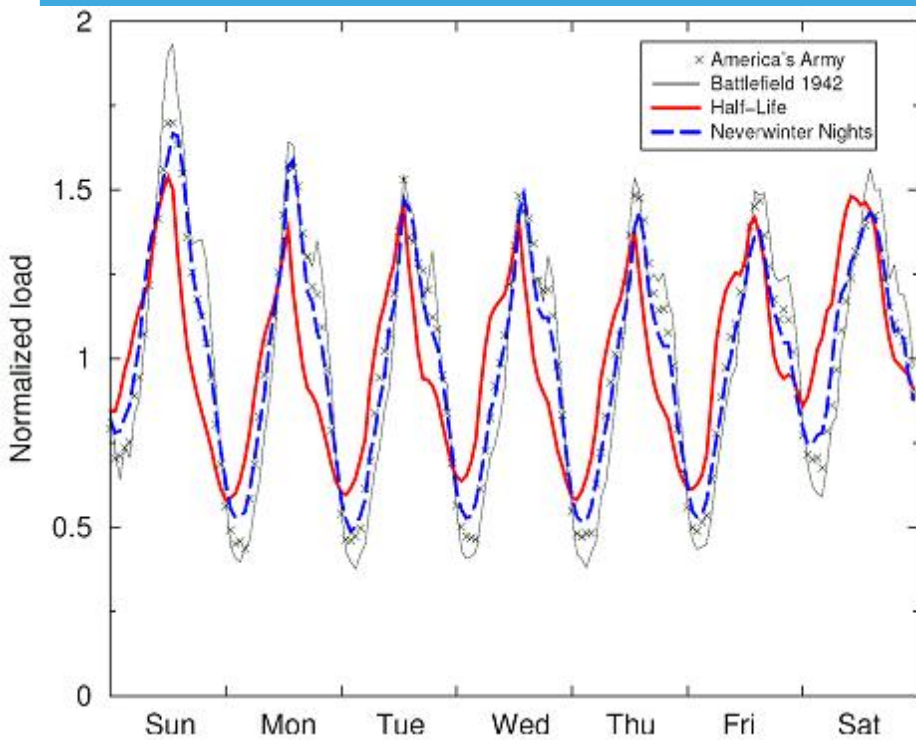
(c) Casual games



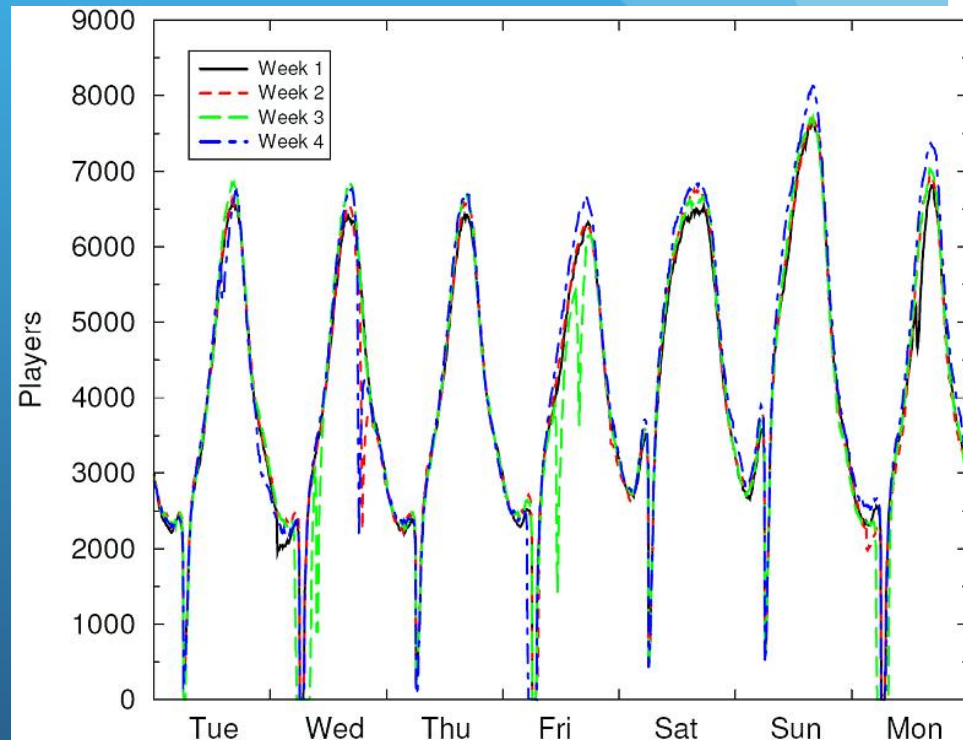
(d) EVE Online

Game workloads

- Periodic
 - Strong daily peaks with weaker weekend peaks

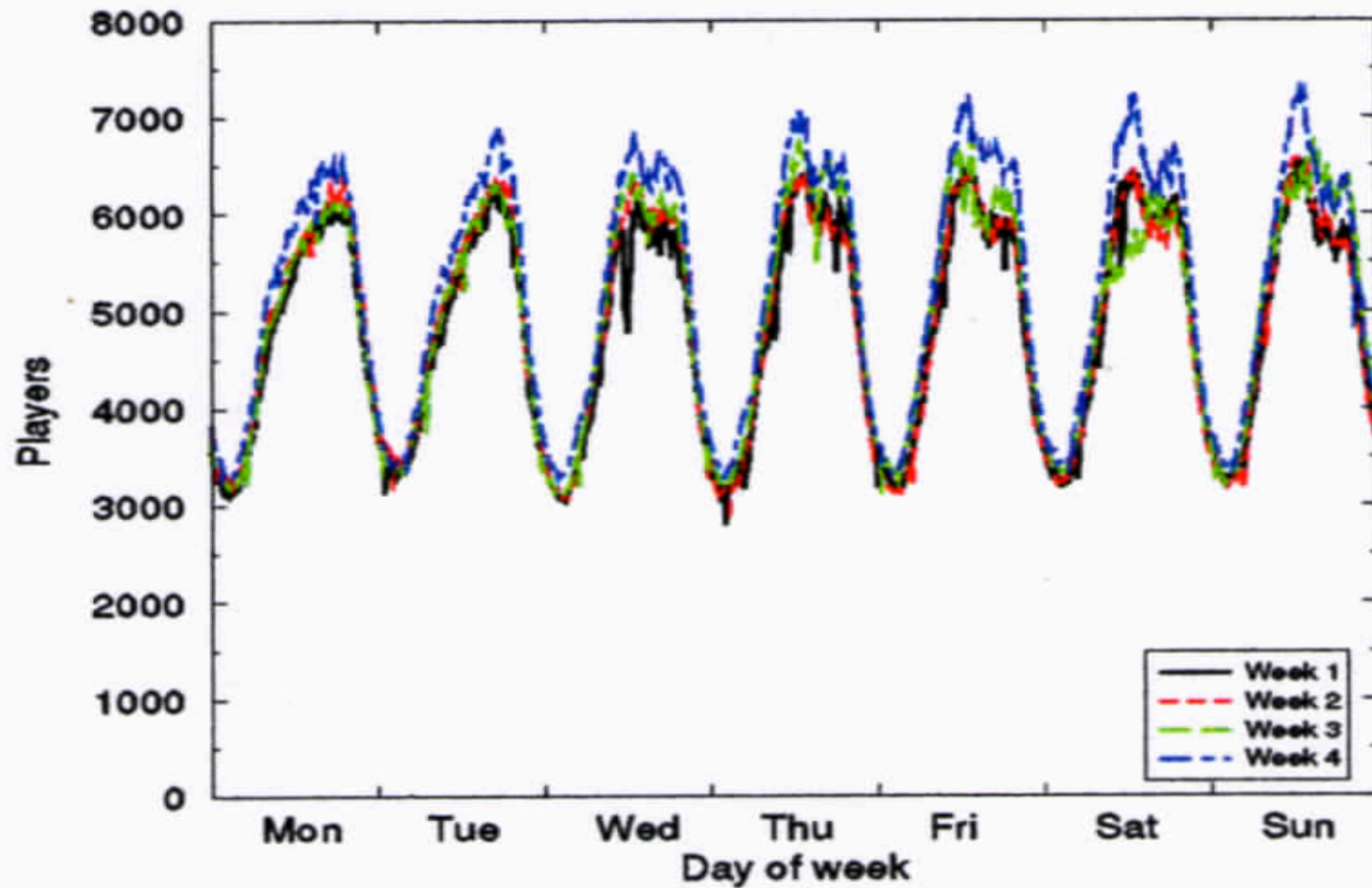


Gamespy FPS



EVE Online MMORPG

Game Workloads contd.



(c) Spades

Comparing Across games

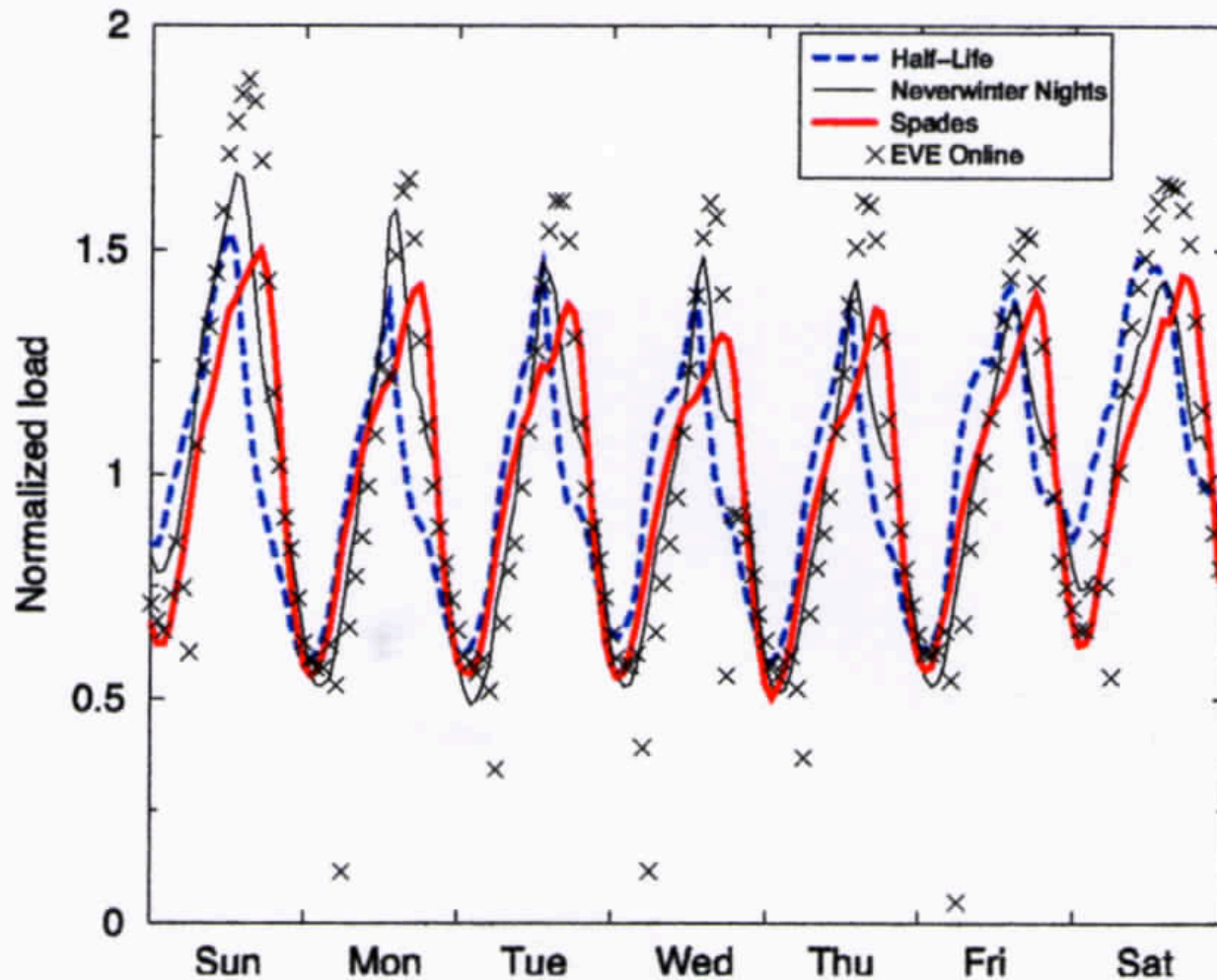


Fig. 6. Normalized load of four popular games over a representative week

FFT of Weekly Usage

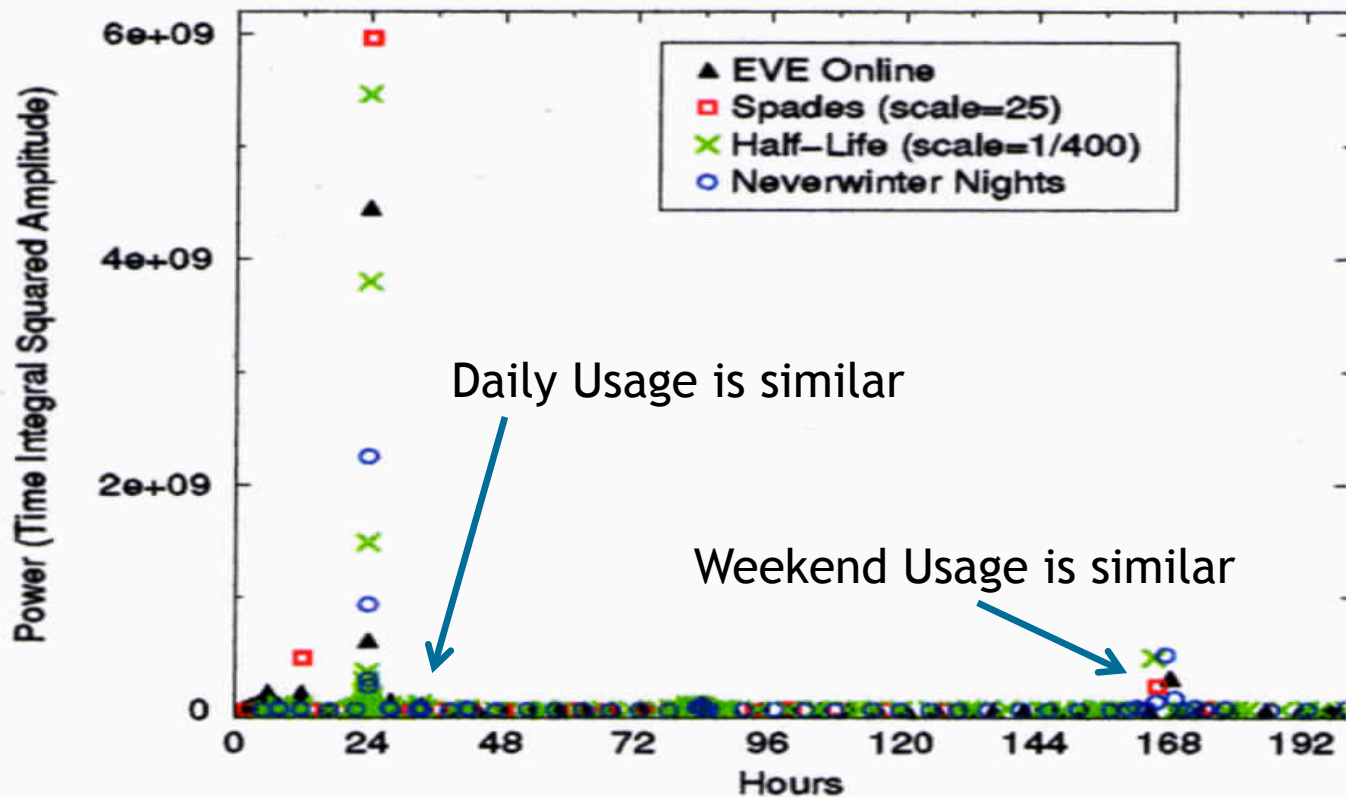
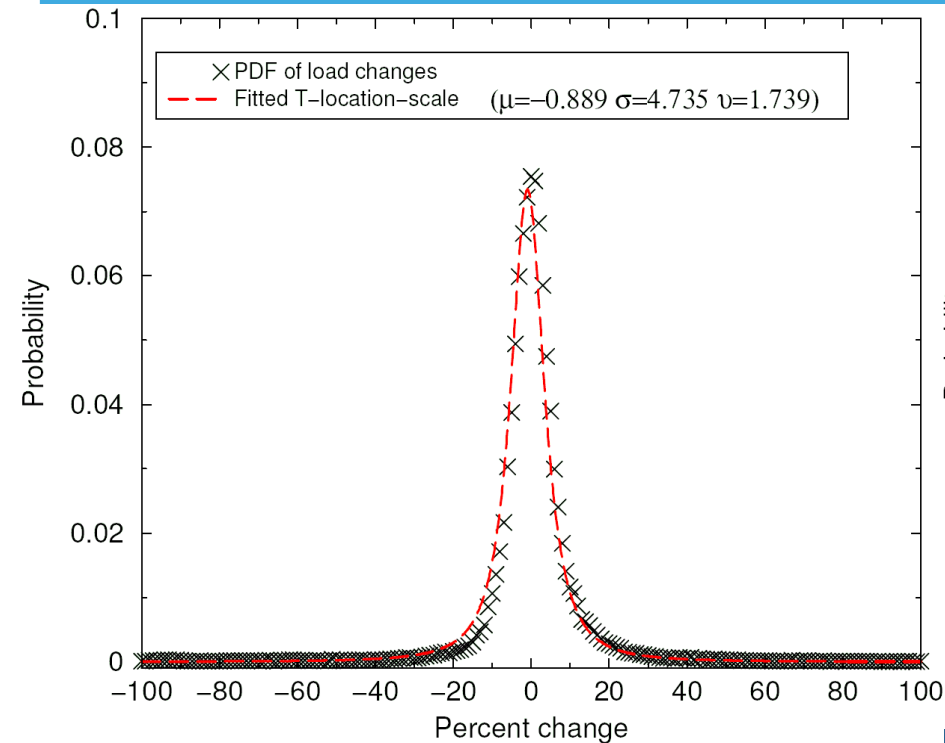


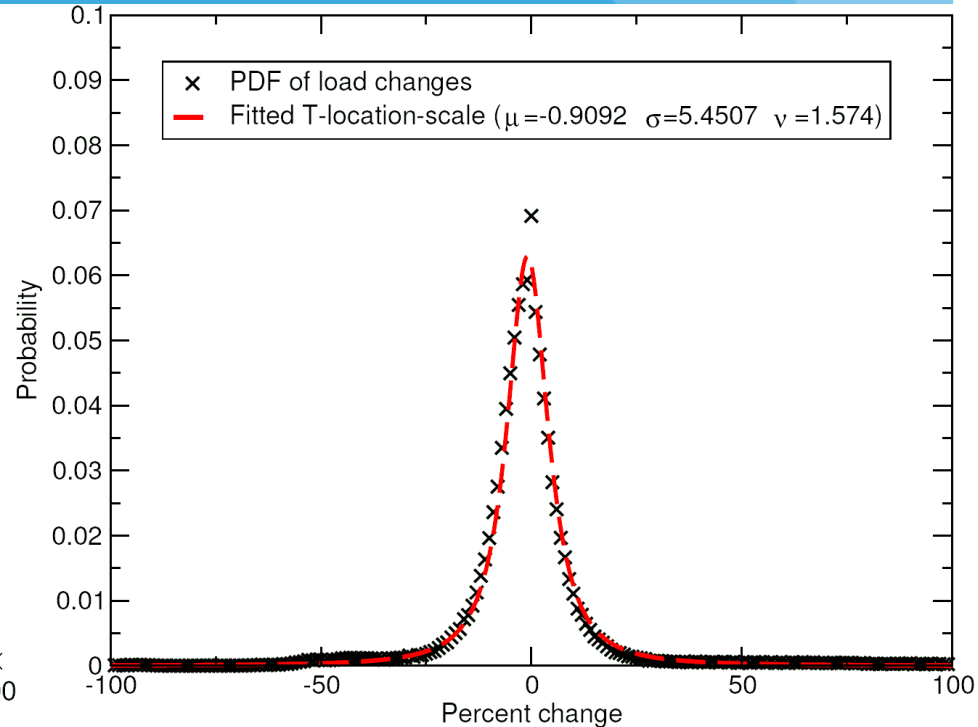
Fig. 4. FFT of player load across four games.

Game workloads

- Predictable over short-term
 - Workload fluctuations small from week-to-week



Gamespy



EVE Online

Where are the players?

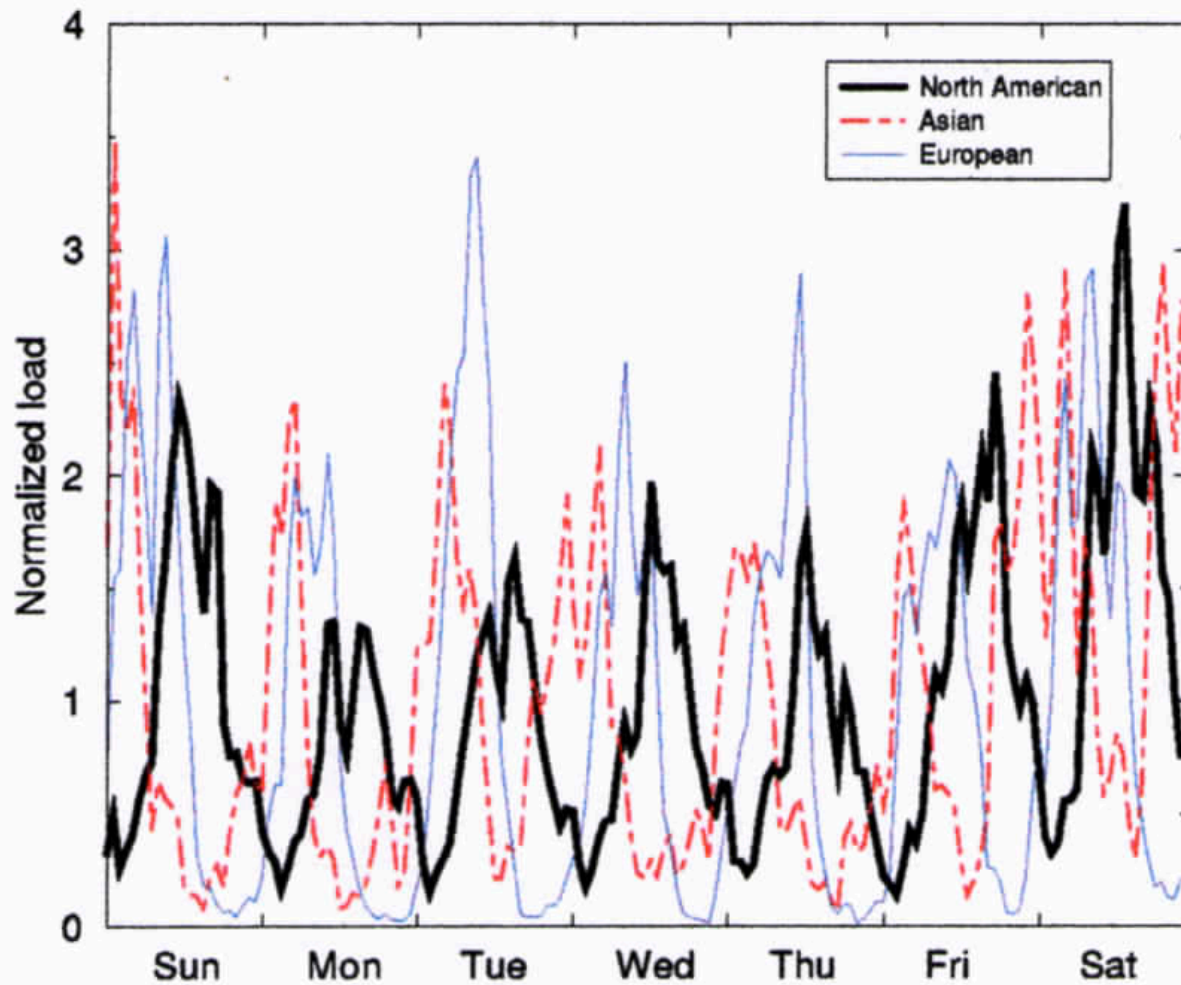


Fig. 8. Aggregate normalized load per-continent for `cs.mshmo.com`

Questions

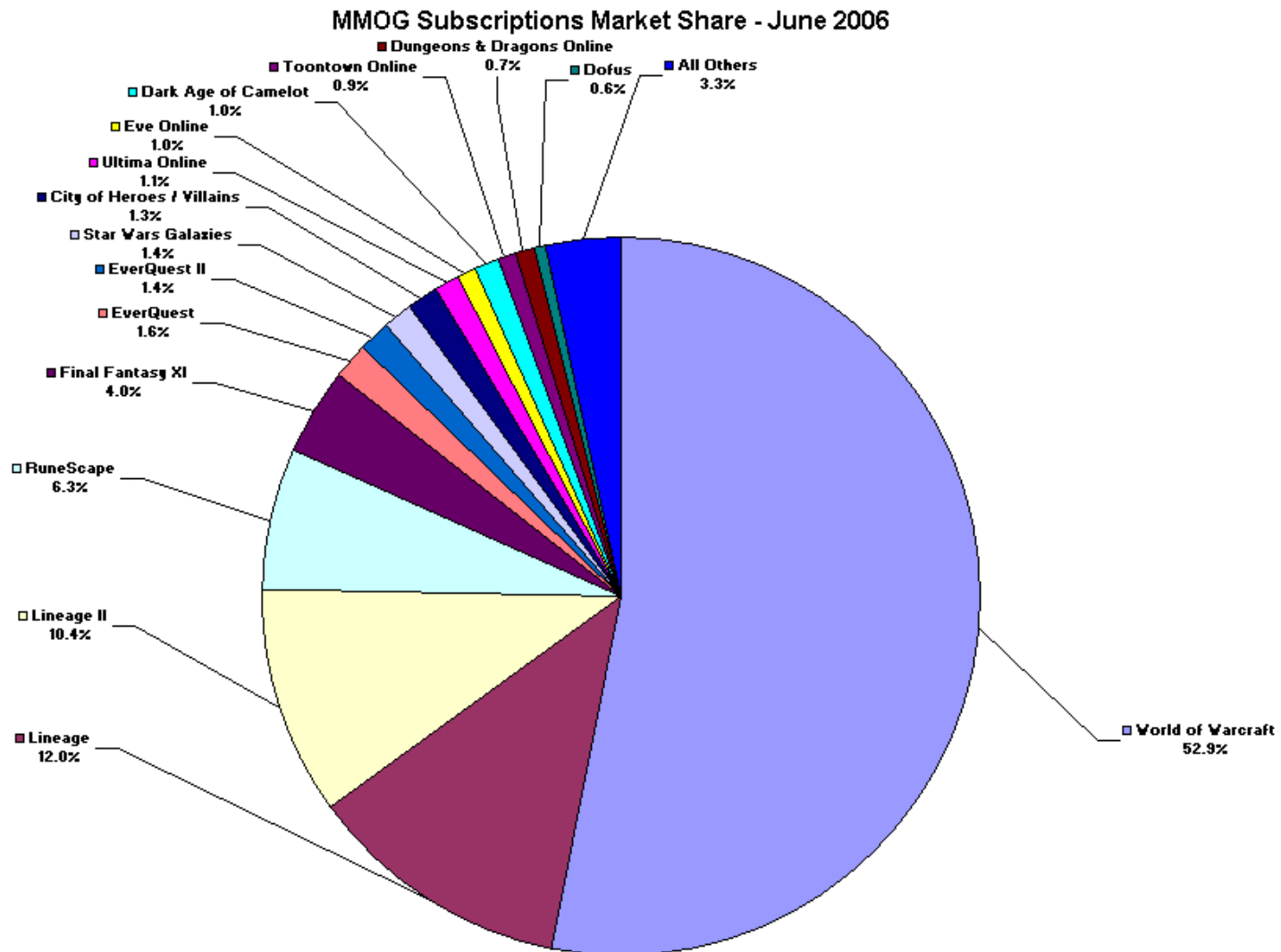
- How many players will there be next week?
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EVE Online statistics

- 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



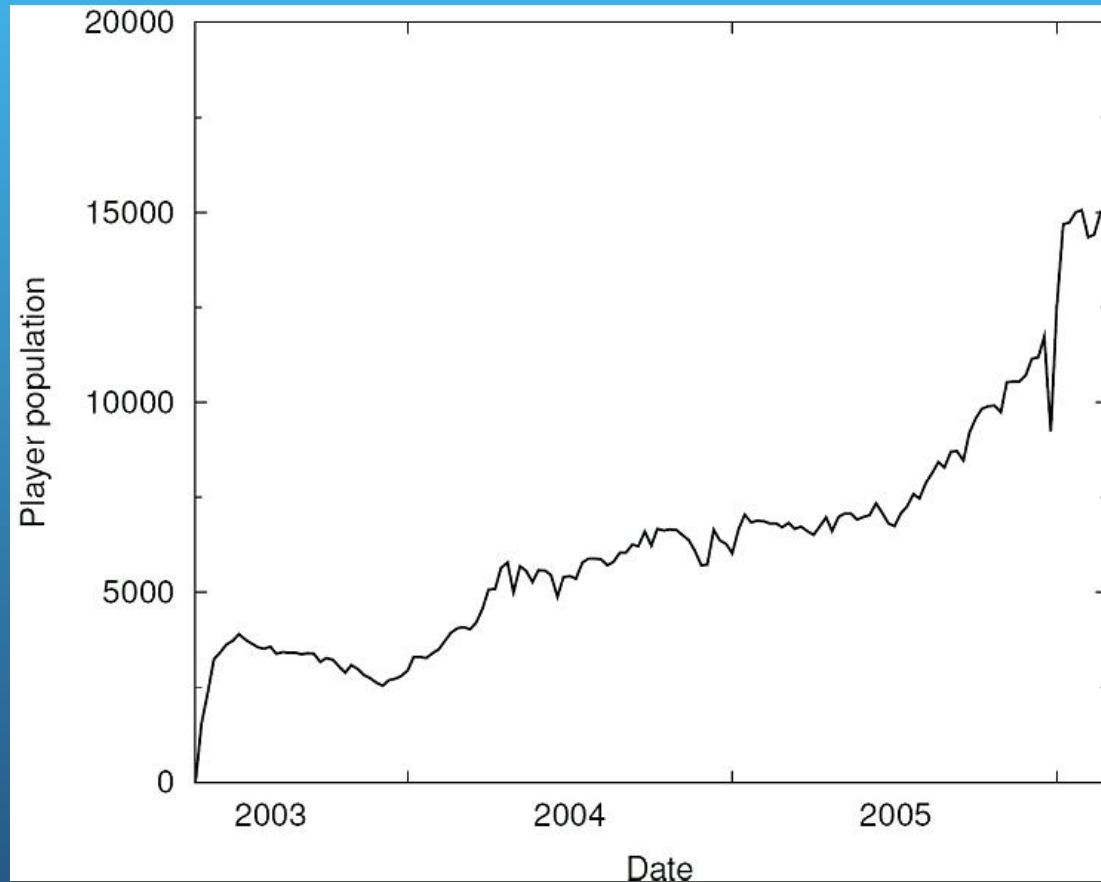
EVE Online trace

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

Duration	May 6, 2003 – March 12, 2006
Total sessions	67,060,901
Total unique players	925,928
Total player time	17,204 years

EVE Online growth

- Active player population throughout trace



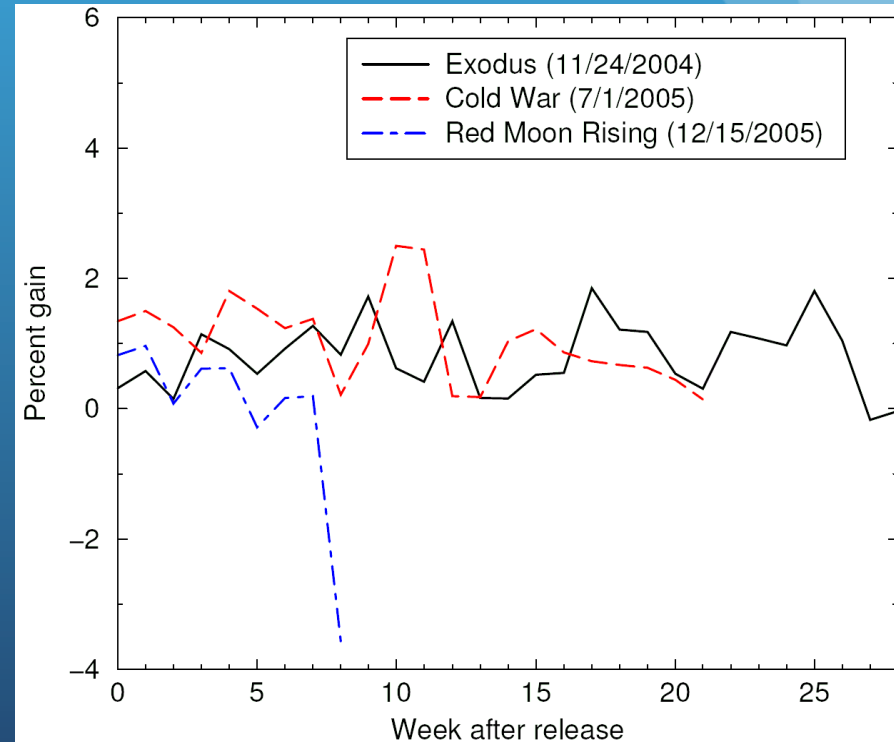
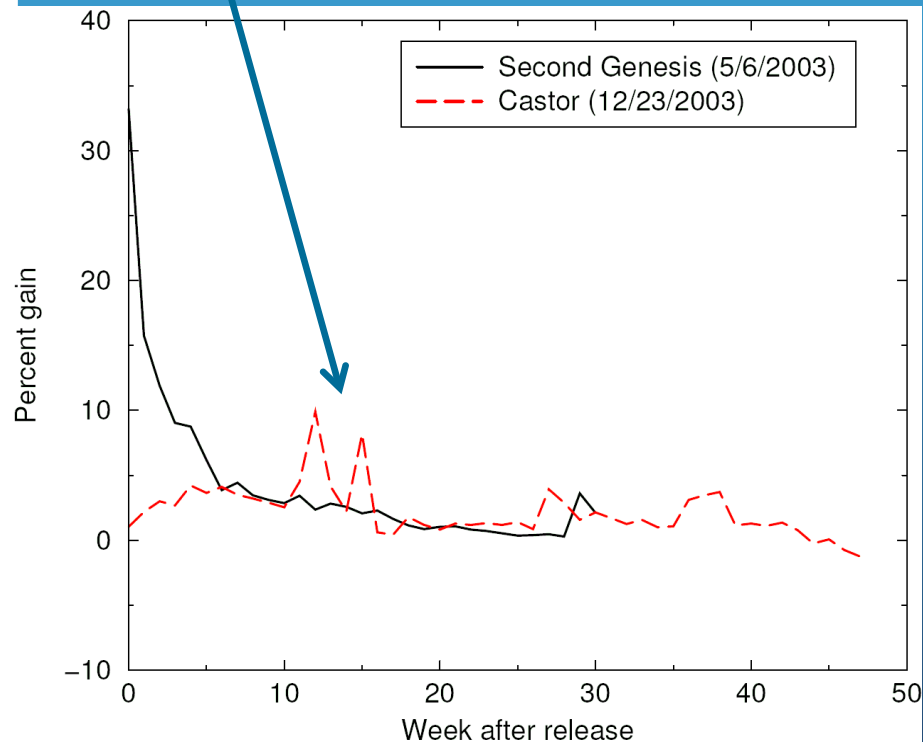
EVE Online

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

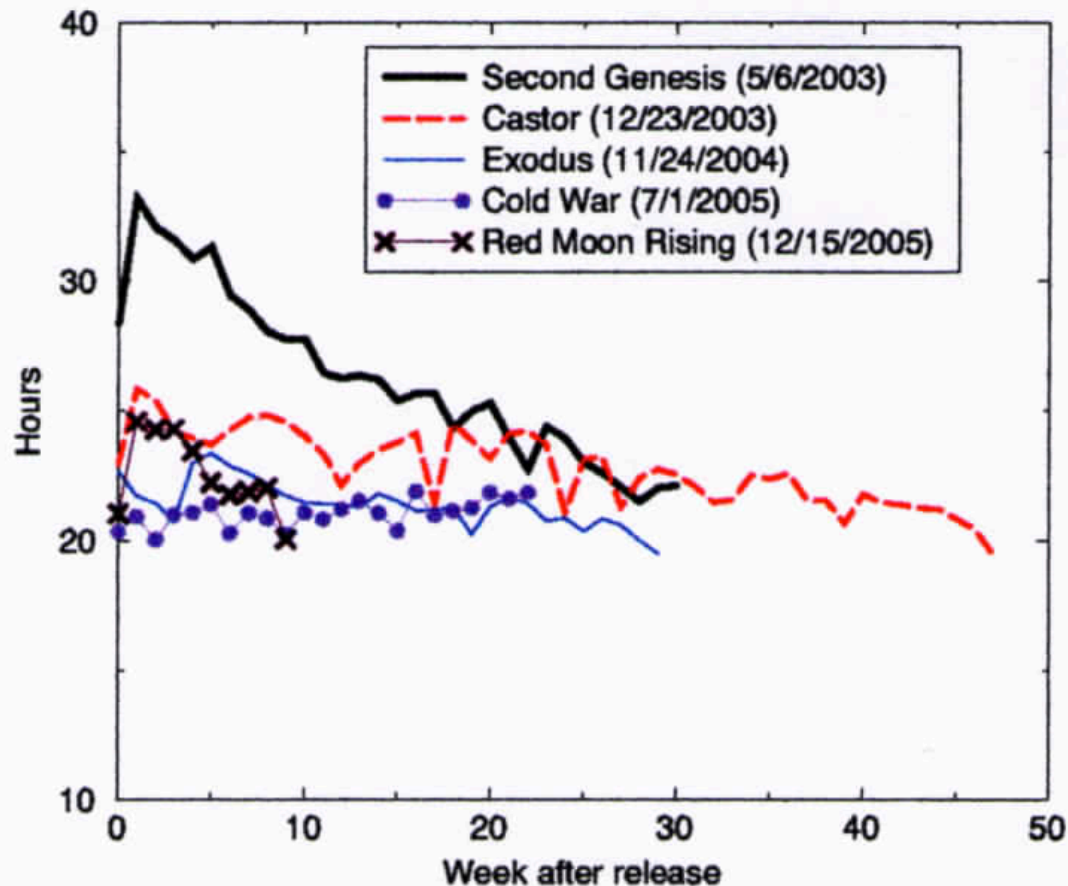


Fig. 15. Weekly minutes played per player after EVE Online updates.

Questions

- How many players will there be next week?
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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

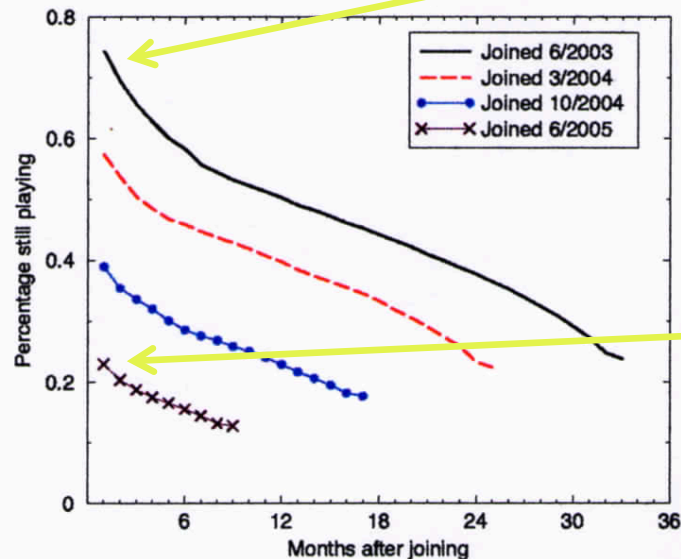


Fig. 13. Player retention over time for 4 different months.

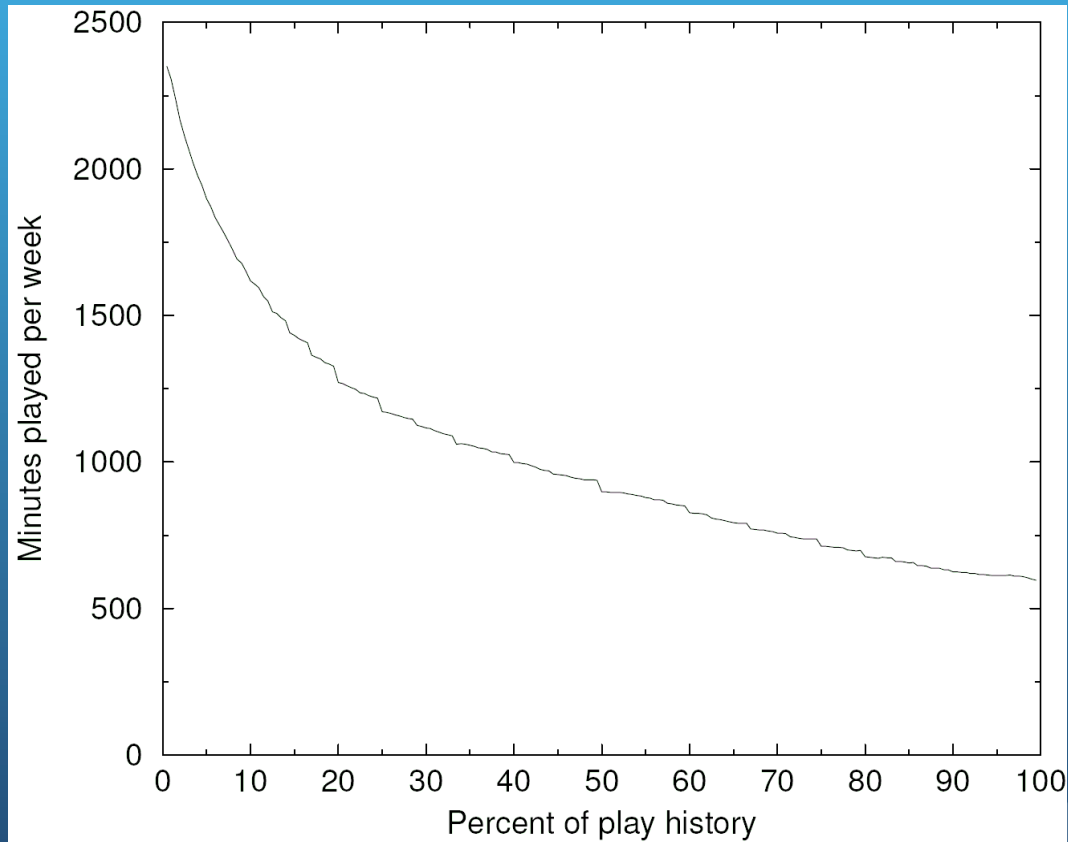
Only 25% still playing one month later

Can we measure disinterest?

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

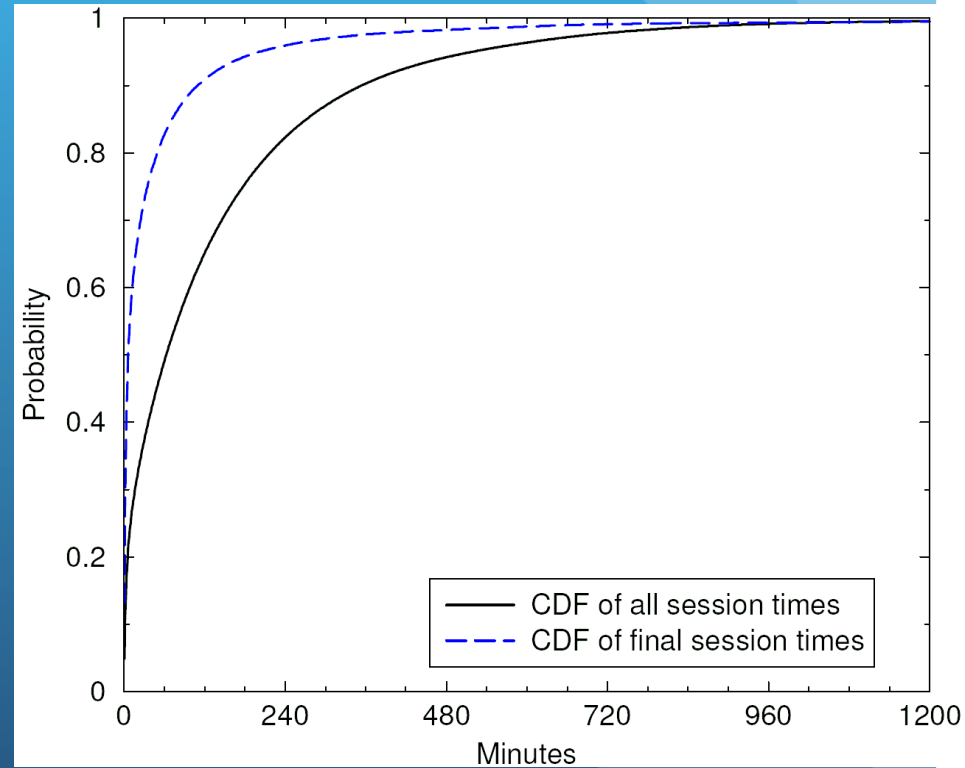
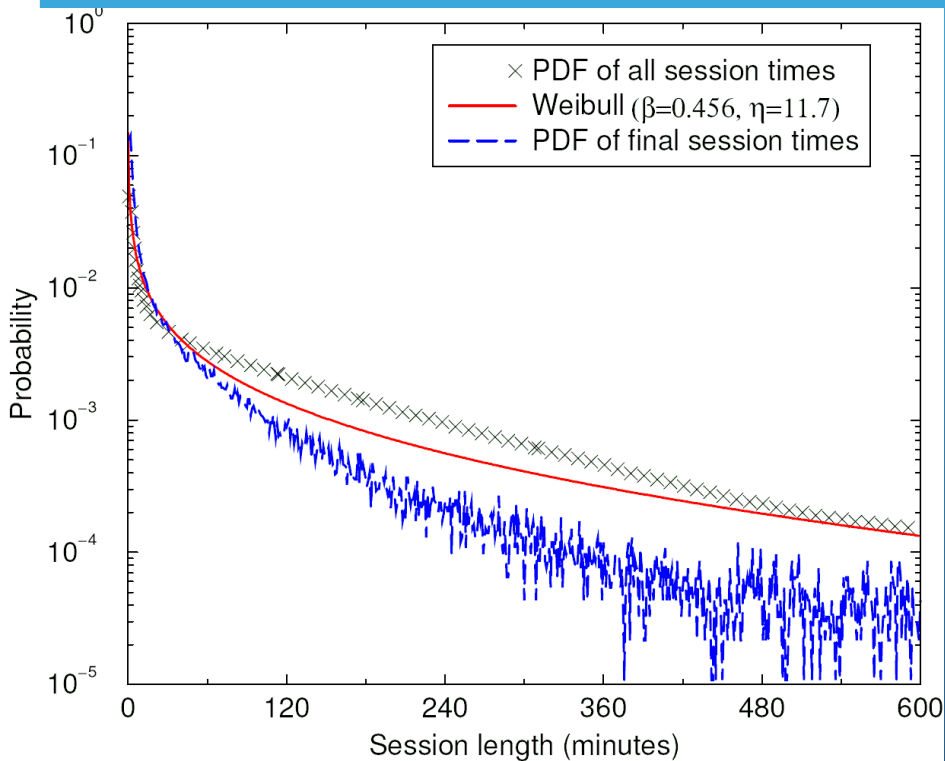
Metric #1: Minutes played per week

- Minutes played per week throughout play history
 - Players play less over time



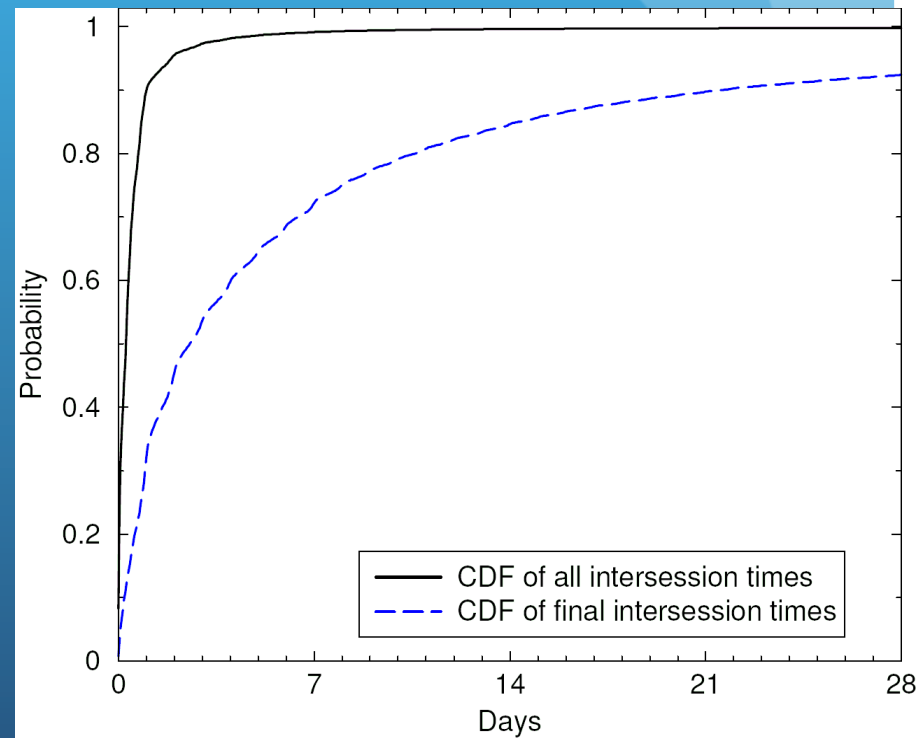
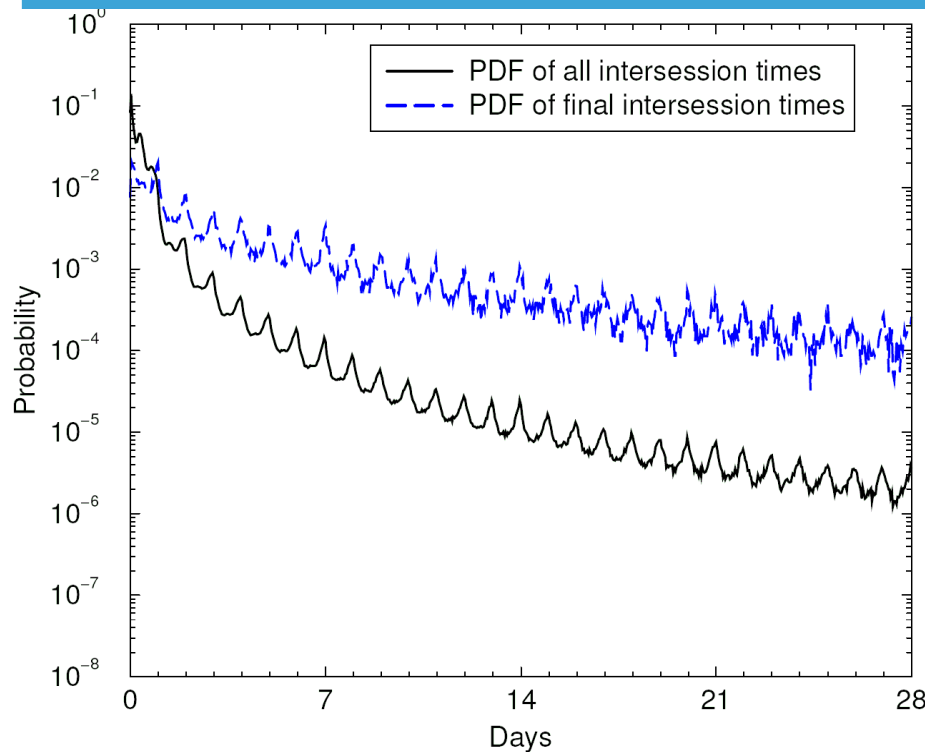
Metric #2: Session times

- Session time distribution
 - Session length of “final” session shorter than normal



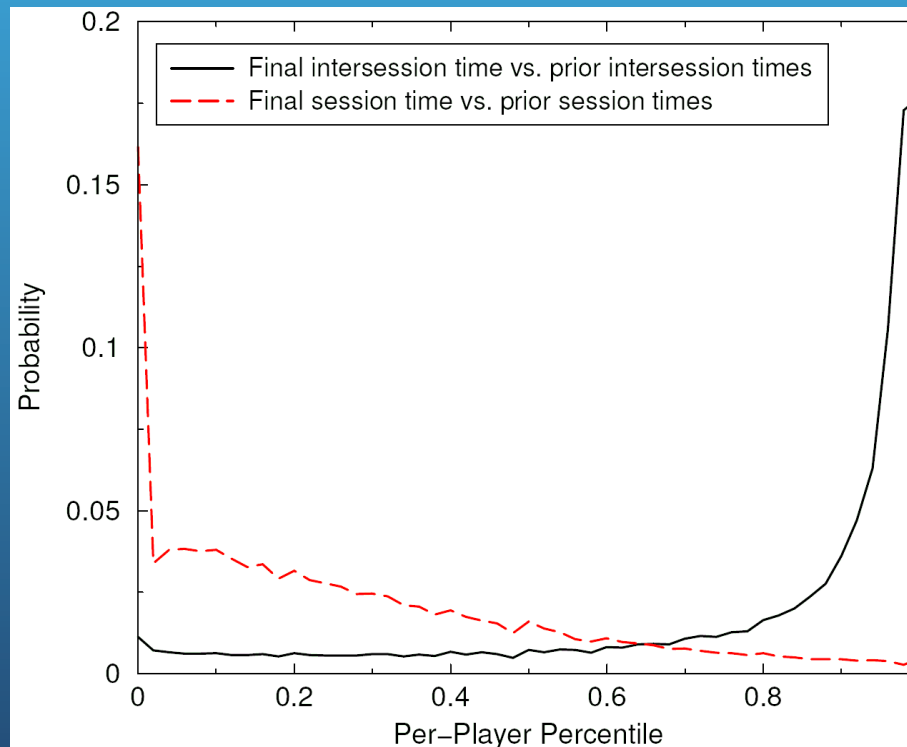
Metric #3: Inter-session times

- Inter-session time distribution
 - “Final” inter-session 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 inter-session times fall into versus player's prior times?
 - “Final” intersession time a very good predictor!



Paper

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