Provisioning On-line Games: A Traffic Analysis of a Busy Counter-Strike Server

Wu-chang Feng, Francis Chang, Wu-chi Feng, Jonathan Walpole

OGI SCHOOL OF SCIENCE & ENGINEERING
OREGON HEALTH & SCIENCE UNIVERSITY

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Goal

- Understand the resource requirements of a popular on-line FPS (first-person shooter) game

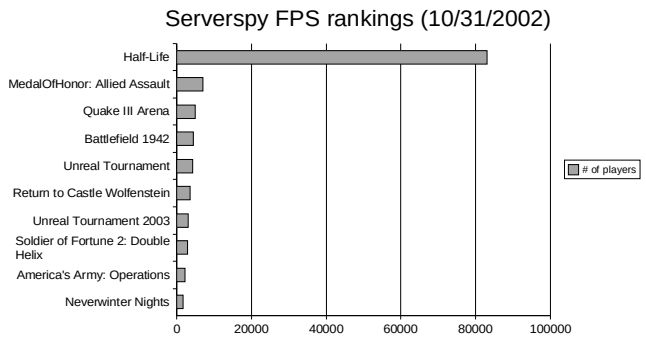
Why games?

- Rapidly increasing in popularity
  - Forrester Research: 18 million on-line in 2001
  - Consoles on-line
    - Playstation 2 on-line (9/2002)
    - Xbox Live (12/2002)
  - Cell phones
    - Nokia Doom port (yesterday)

Why FPS?

- Gaming traffic dominated by first-person shooter genre (FPS) [McCreary00]

Why CS?



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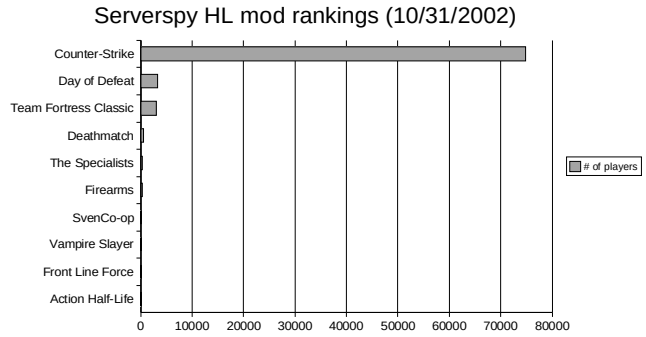

Networked FPS lineage

Doom

↓

Doom II → Quake
+ QuakeWorld variants
+ Team Fortress
+ Capture the Flag

↓

Quake II
+ Soldier of Fortune
+ Heretic II

↙ ↘

Quake III Arena
+ Medal of Honor Allied Assault
+ Return to Castle Wolfenstein
+ Soldier of Fortune 2
+ Jedi Knight II

↓

Doom III

Half-Life
+ Counter-Strike
+ Day of Defeat
+ Urban Terror
+ Team Fortress Classic
+ Team Fortress 2

Unreal

↓

Unreal Tournament

↓

Unreal Tournament 2003
+ America's Army: Operations

8 of top 10 games derived from one of two lineages

Counter-Strike

About the game...

- Half-Life modification
- Two squads of players competing in rounds lasting several minutes
- Rounds played on maps that are rotated over time
- Each server supports up to 32 players

About the game...

- Centralized server implementation
  - Clients update server with actions from players
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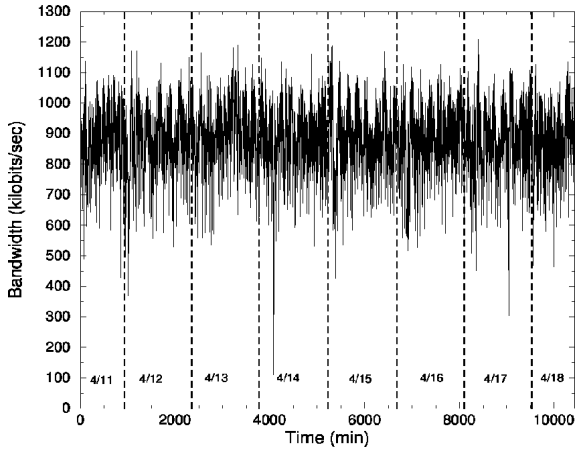
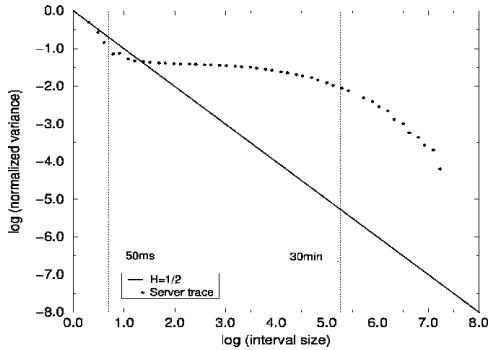
The trace

- cs.mshmro.com (129.95.50.147)
  - Dedicated 1.8GHz Pentium 4 Linux server
  - OC-3
  - 70,000+ unique players (WonIDs) over last 4 months
- One week in duration 4/11 – 4/18
- 500 million packets
- 16,000+ sessions from 5800+ different players

A week in the life...



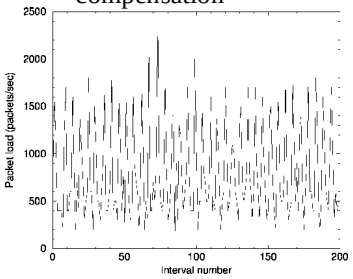
Variance time plot



Normalized to base interval of 10ms

Digging deeper

- Periodic server bursts every 50ms
  - Game must support high interactivity
  - Game logic requires predictable updates to perform lag compensation



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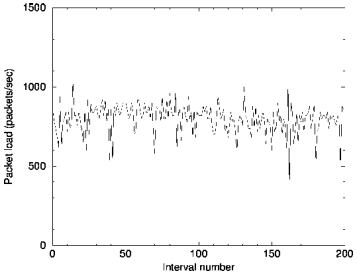

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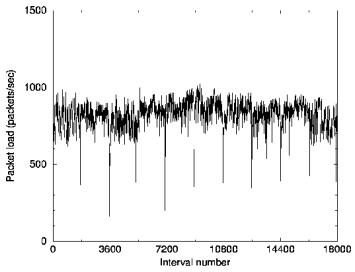

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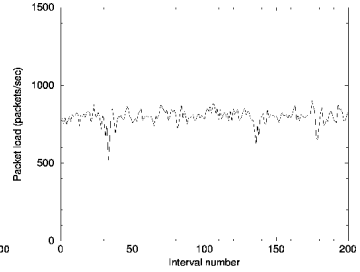
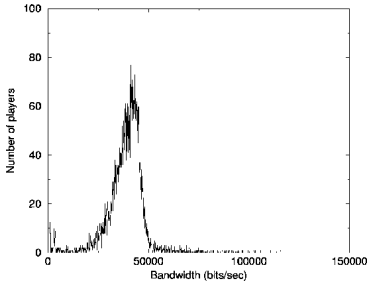


Interval size=30min

Finding the source of predictability

- Games must be fair across all mediums (i.e. 56kers)
  - Aggregate predictability due to “saturation of the narrowest last-mile link”
- Histogram of average per-session client bandwidth



Packet sizes

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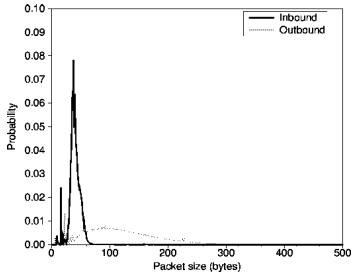

Implications

- Routers, firewalls, etc. must be designed to handle large bursts at millisecond levels
  - Game requirements do not allow for loss or delay (lag)
  - Should not be provisioned assuming a large average packet size [Partridge98]
  - If there are buffers anywhere, they must...
    - Use ECN
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Implications

- ISPs, game services
  - Must examine “lookup” utilization in addition to link utilization
  - Concentrated deployments of game servers may be problematic
    - Large server farms in a single co-lo
    - America's Army, UT2K3, Xbox

On-going work

- Other pieces in the provisioning puzzle
  - Aggregate player populations
  - Geographic distributions of players over time (IP2Geo)
- Impact on route and packet classification caching
- Other FPS games
  - HL-based: Day of Defeat
  - UT-based: Unreal Tournament 2003, America's Army
  - Quake-based: Medal of Honor: Allied Assault
  - Results apply across other FPS games and corroborated by other studies

Future work

- Games as passive measurement infrastructure
  - Only widespread application with continuous in-band ping information being delivered (measurement for free)
  - “Ping times” of all clients broadcast to all other clients every 2-3 seconds
  - 20,000+ servers, millions of clients
- Games as active measurement infrastructure
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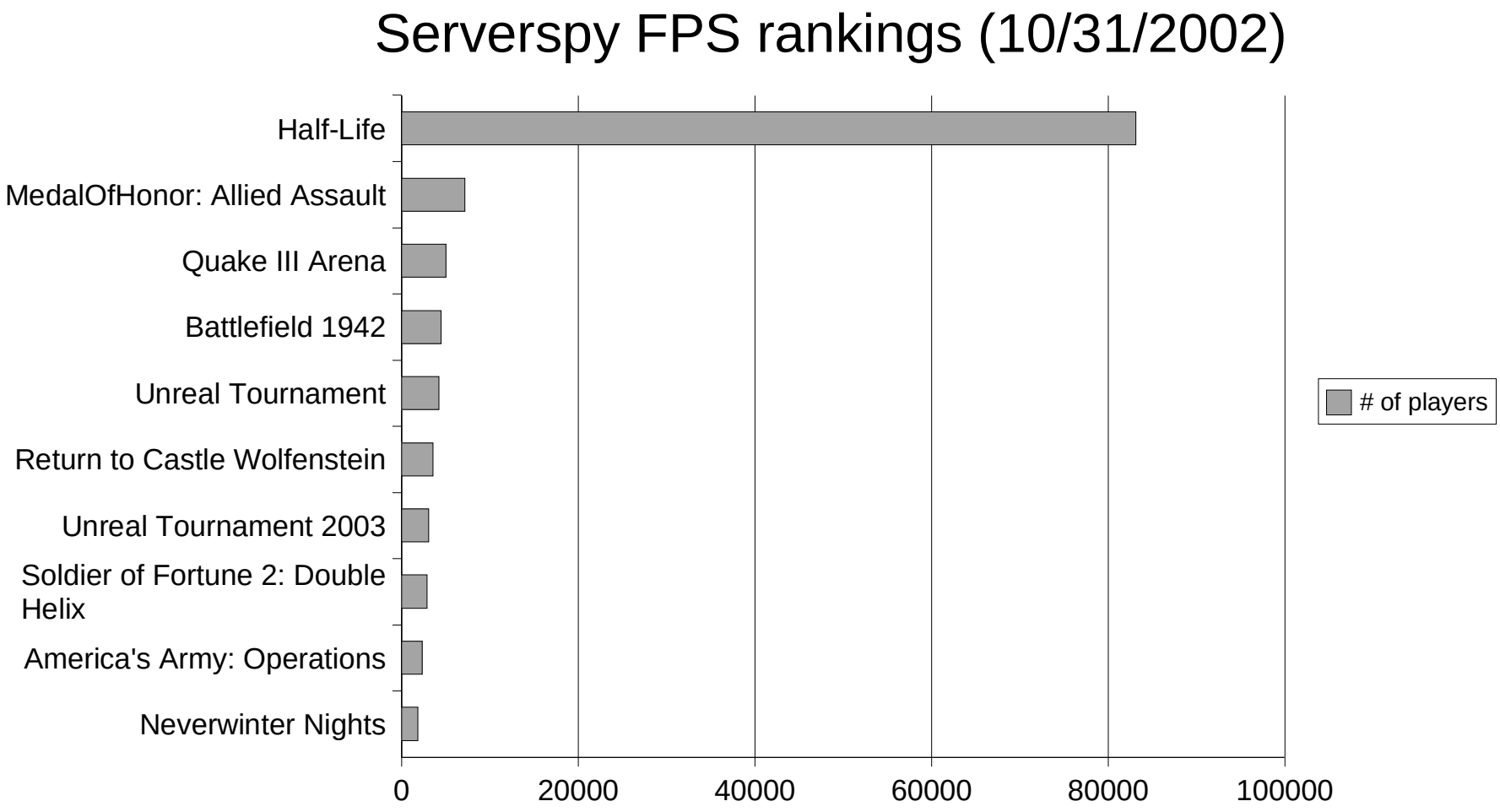
Serverspy FPS rankings (10/31/2002)
Half-Life
MedalOfHonor: Allied Assault
Quake III Arena
Battlefield 1942
Unreal Tournament
Return to Castle Wolfenstein
Unreal Tournament 2003
Soldier of Fortune 2: Double Helix
America's Army: Operations
Neverwinter Nights
0
20000
40000
60000
80000
100000
# of players

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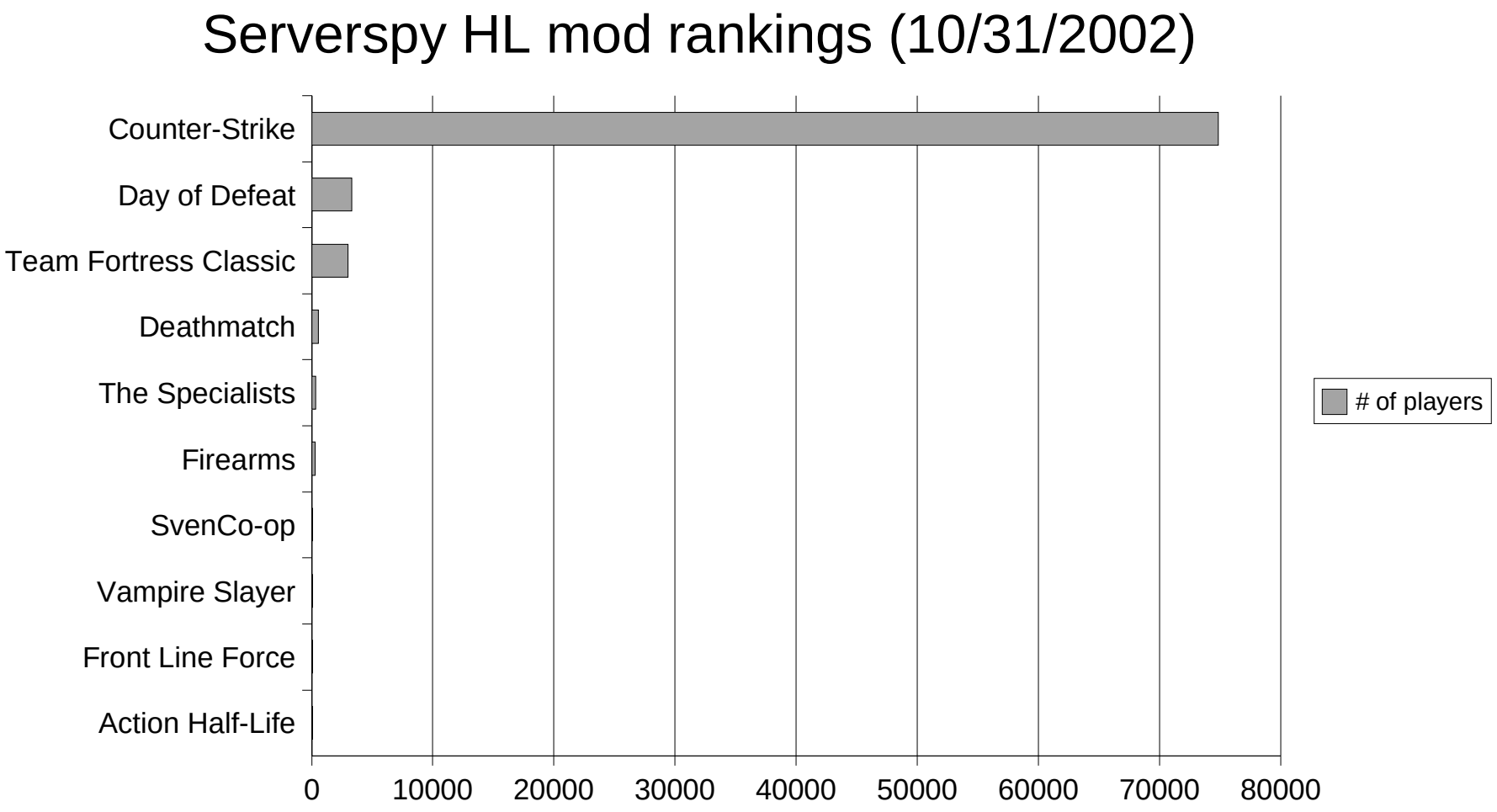
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Counter-Strike
Day of Defeat
Team Fortress Classic
Deathmatch
The Specialists
Firearms
SvenCo-op
Vampire Slayer
Front Line Force
Action Half-Life
0
10000
20000
30000
40000
50000
60000
70000
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# of players

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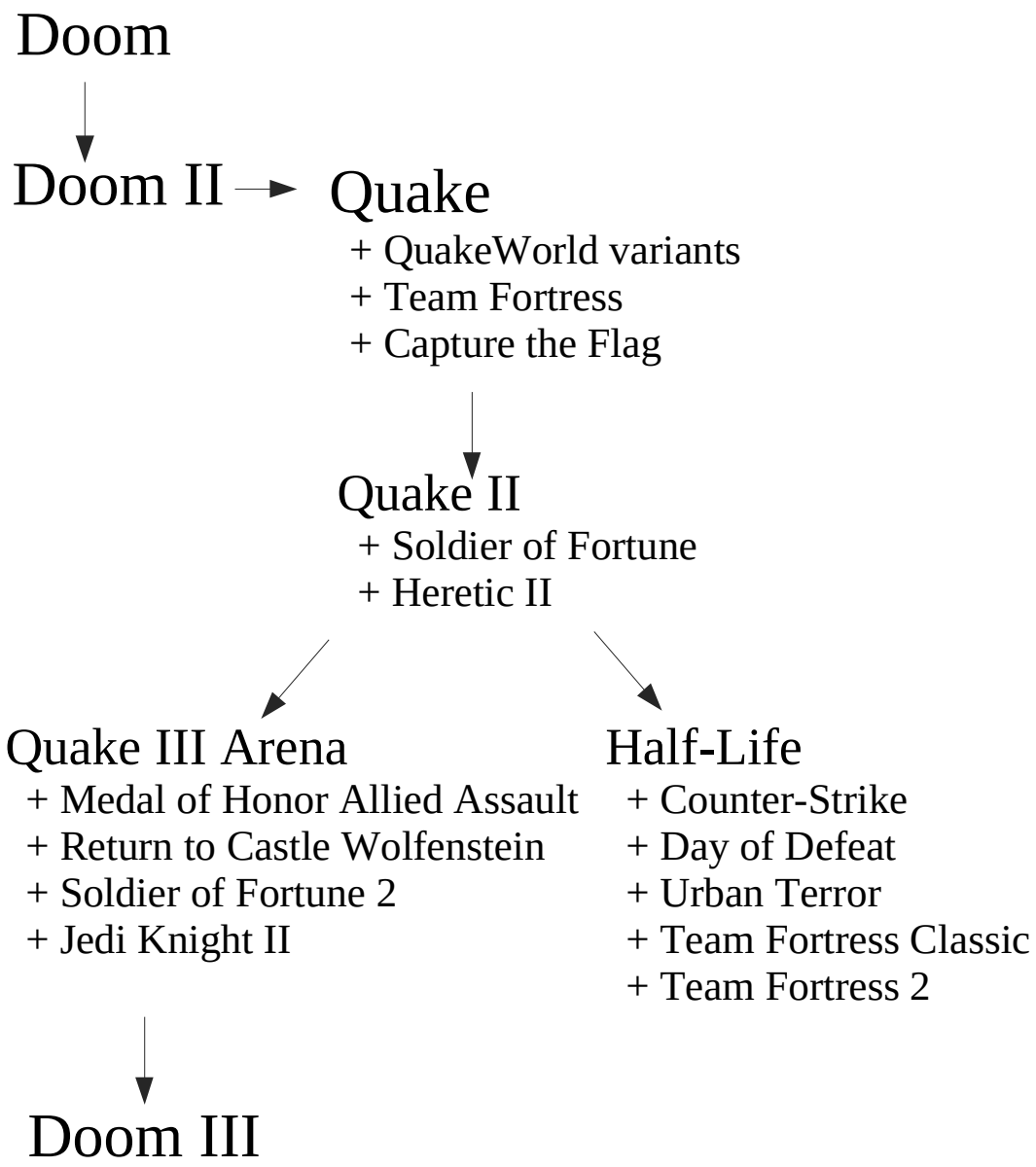

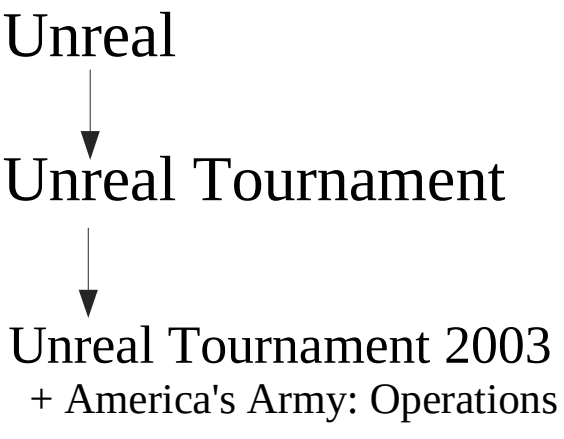

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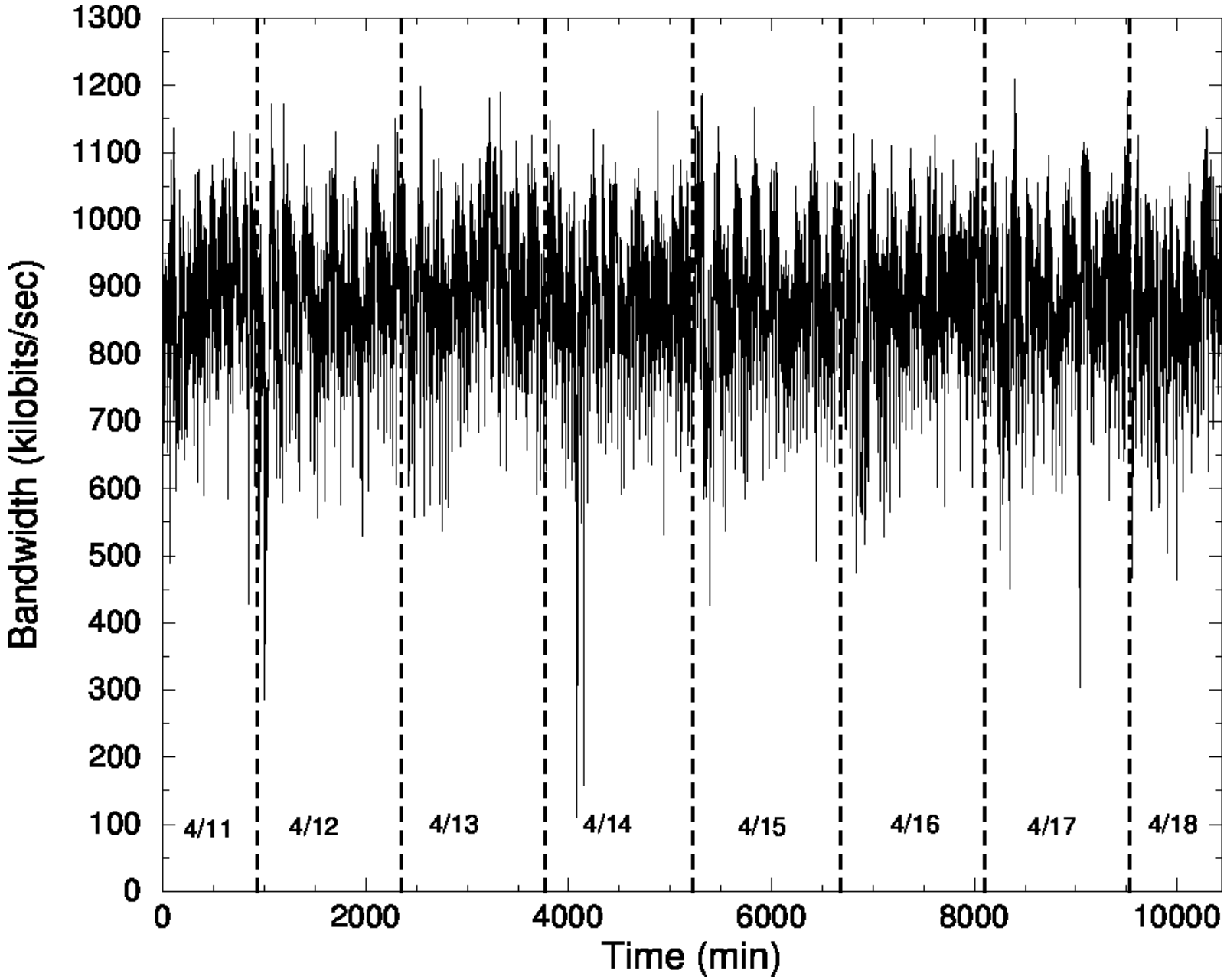

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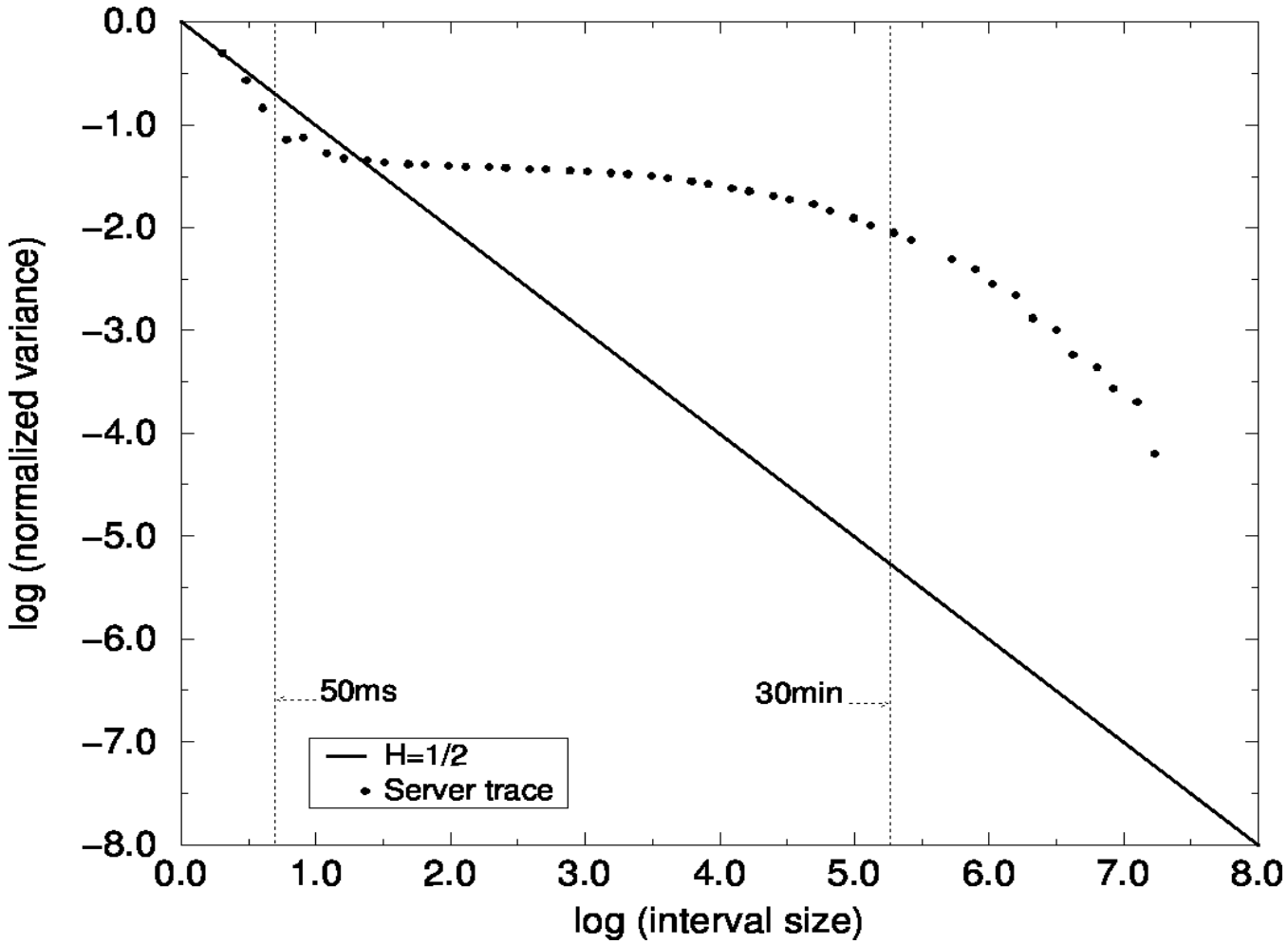

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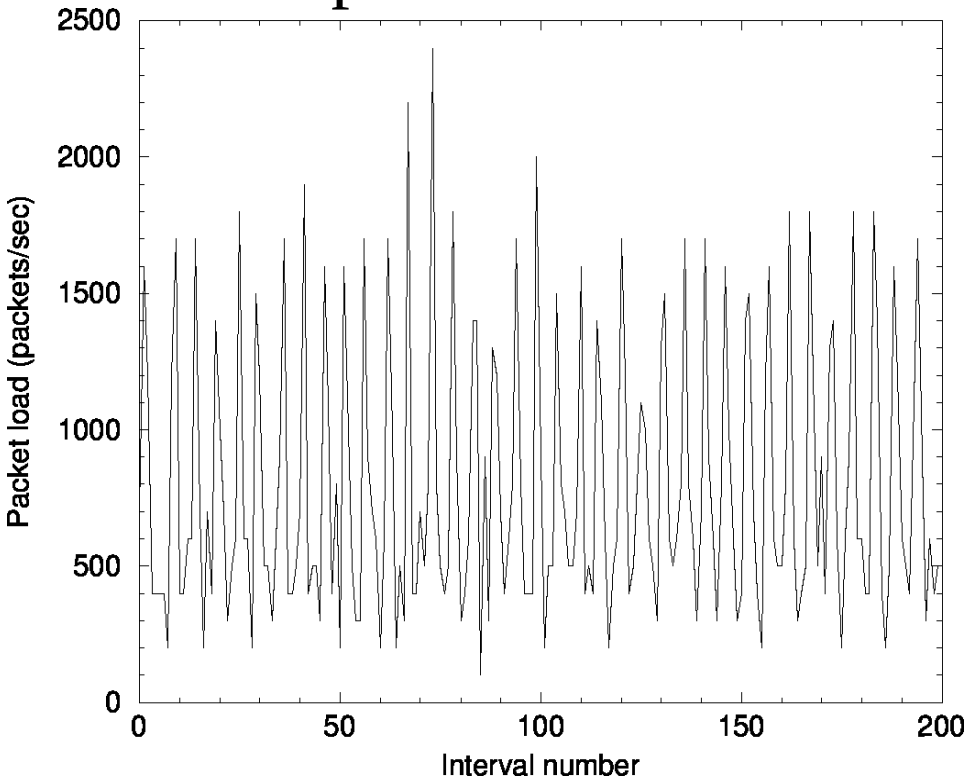

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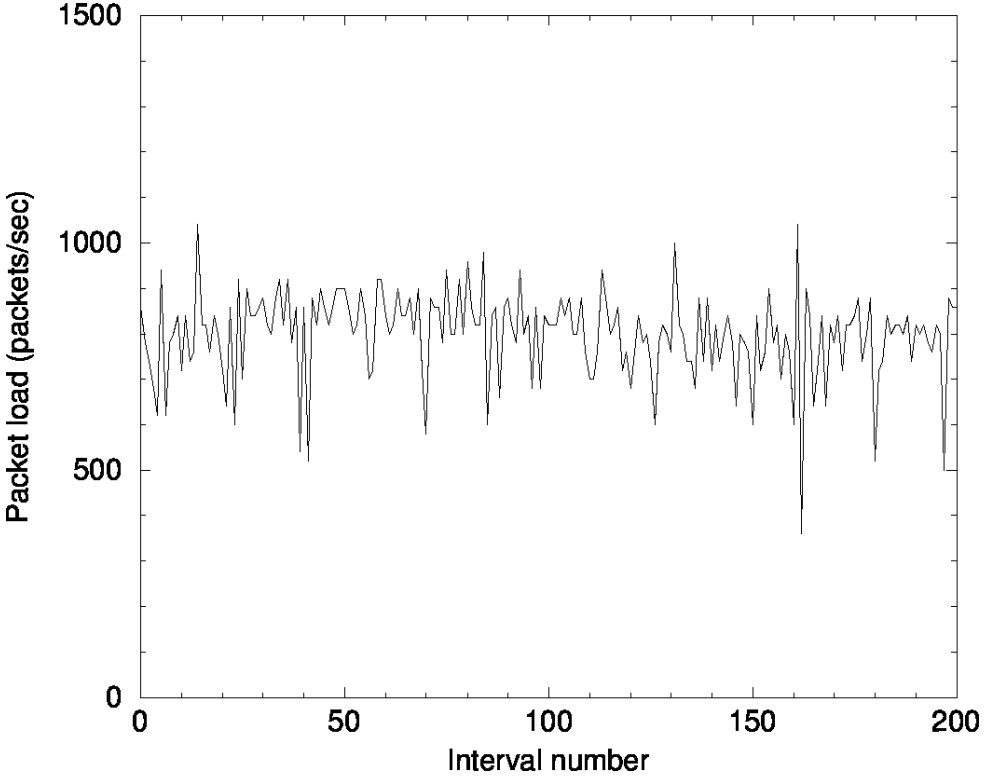

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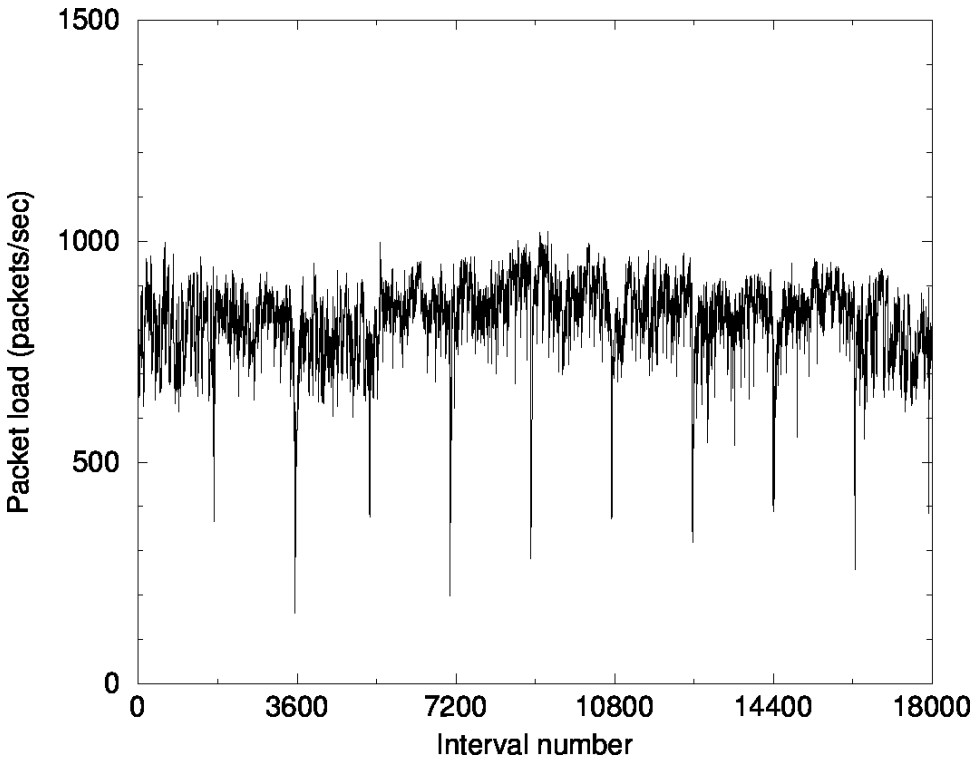

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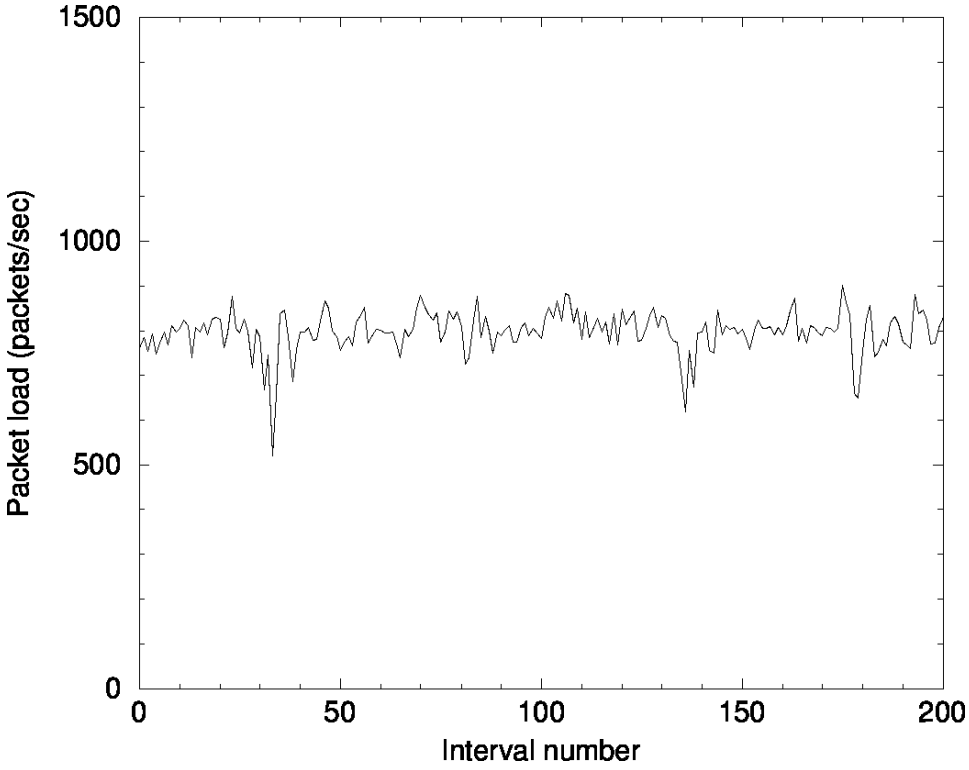

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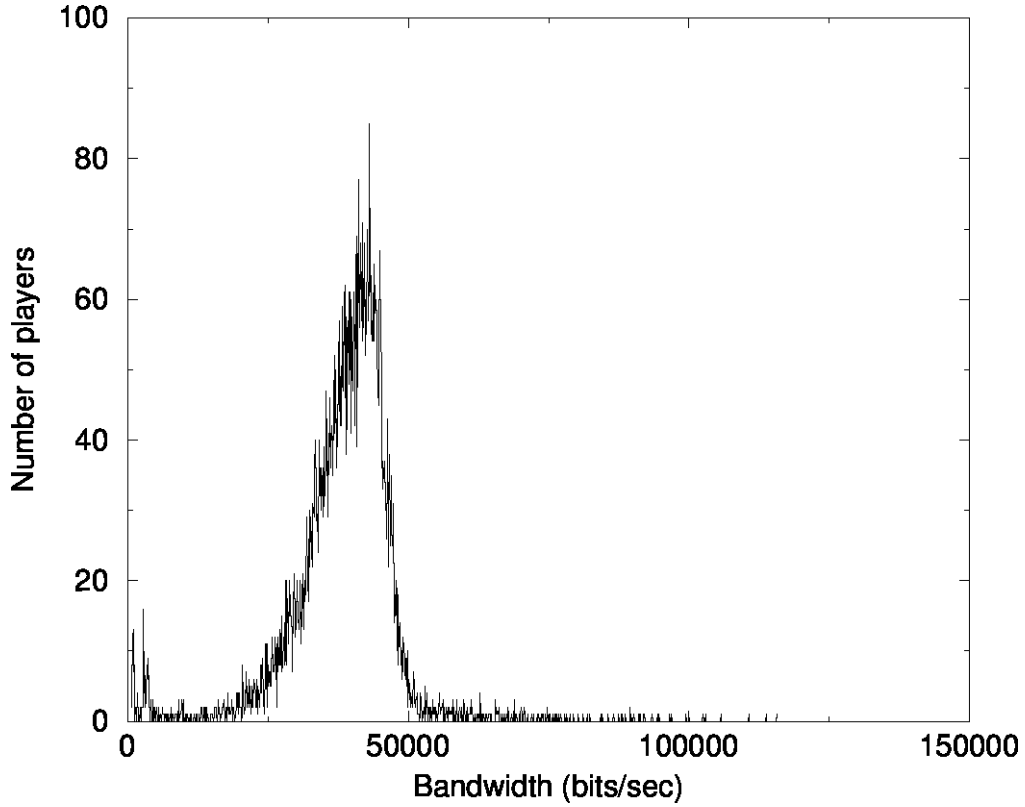

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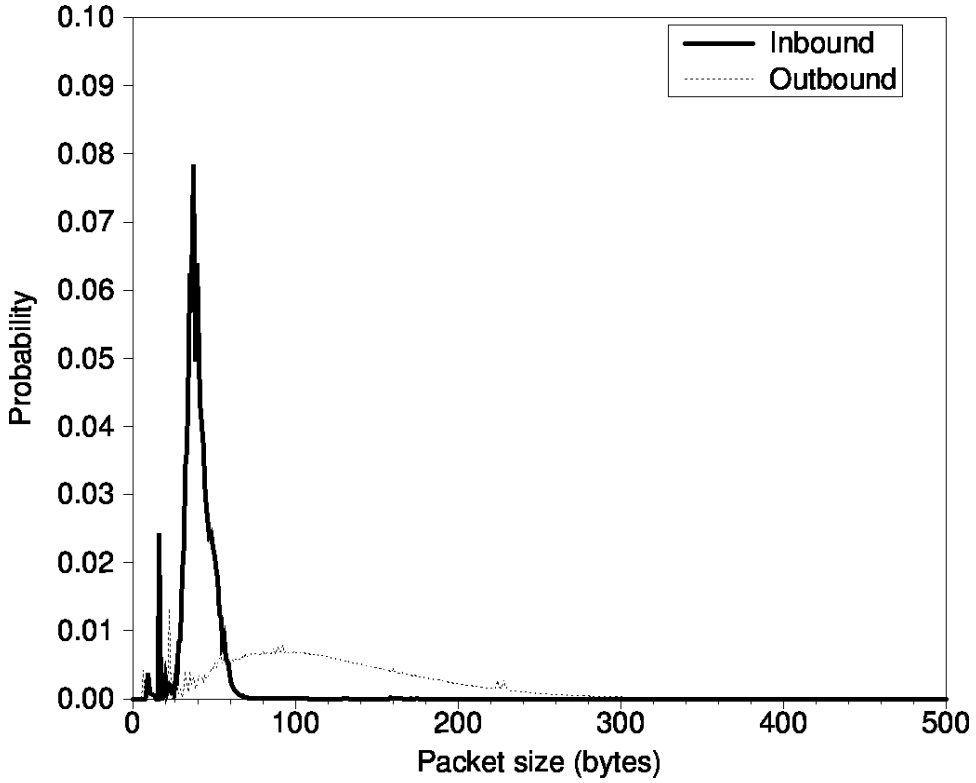

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