An Analysis of Internet Content Delivery Systems (and more!)

Stefan Saroiu, Krishna Gummadi, Richard J.Dunn, Steven D. Gribble, and Henry M. Levy

Presented by Bryce Boe (CS290F W2010)
Paper Goals

• Measure how Internet traffic has changed from 1999
  – Highlight peer-to-peer traffic increases in up/down directions
  – Highlight shift (at UW) from client based traffic to server based

• Evaluate caching potential in peer-to-peer networks
Content Delivery Systems

- WWW
- Content Delivery Networks
- Peer to Peer Systems
World Wide Web

- Client / Server model
- Averaged small sized objects 5-10KB
- Zipf popularity distribution
  - Very small number of sites have ridiculously high popularity
  - Very large number of sites have ridiculously low popularity
- Support for caching
  - Fetch object from source when unavailable
  - HTTP Headers for give content providers some control
Content Delivery Networks

• Idea: move data close to end user
  – Accomplished through URL rewriting, DNS, or Anycast

• Grants more control to content providers
  – Expire/Invalidate objects
  – Pre-cache objects
  – Serve homepage primarily from CDN (reddit)

• Benefit from overlay networks
  – Work around unreliable middle mile
  – Fetch content from other CDN nodes rather than ISP
CDNs Continued

• First Mile (server to ISP) $$$ = 20x cap. growth/5yrs
• Middle Mile (ISP to ISP) no $$$ = little growth
  – Peering Wars
  – Physical Outages
  – BGP Attacks
• Last Mile (ISP to end user) $$$ = 50x growth/5yrs

Peer-to-Peer Systems

- Nodes behave as clients and servers
- Searching done through different means
  - Gnutella: query flooding across nodes within n-hops
  - Kazaa: Similar with addition of *supernodes which* contain indexes of all nearby nodes, and query floods across connected supernodes within n-hops
- Support for parallel fragment download
- *Designed* to be highly distributed
Passive Network Monitoring

• Monitor inbound and outbound connections on their 4 backbone connections

• Traffic Classifications
  – Akamai Traffic (akamai hosts)
  – HTTP Traffic (ports 80, 8080, 443)
  – Gnutella Traffic (ports 6346, 6347)
  – Kazaa Traffic (port 1214)
  – P2P (Gnutella + Kazaa)
  – Non-HTTP TCP (All TCP traffic – Akamai – HTTP – P2P)

• Limitations?
WHERE IS THE BANDWIDTH GOING?
Bandwidth Distribution

- Seemingly significant amount of non-HTTP TCP
## WWW v. Kazaa Summary

<table>
<thead>
<tr>
<th></th>
<th>WWW</th>
<th>Kazaa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inbound</td>
<td>outbound</td>
</tr>
<tr>
<td>Bytes Xferred</td>
<td>1.51TB</td>
<td>3.02TB</td>
</tr>
<tr>
<td>Unique objects</td>
<td>72,818,997</td>
<td>3,412,647</td>
</tr>
<tr>
<td>Clients</td>
<td>39,285</td>
<td>1,231,308</td>
</tr>
<tr>
<td>Servers</td>
<td>403,087</td>
<td>1,463</td>
</tr>
</tbody>
</table>
UW Server Bandwidth

Bandwidth Consumed by UW Servers

- Kazaa
- Gnutella
- WWW

Mbps

0
50
100
150
200
250

12:00
0:00
Wed
Thu
Fri
Sat
Sun
Mon
Tue
Wed
Thu
Fri

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Today’s Traffic


- Measurement study of 8 regions around the world (consider Germany trace)
- 14 days captured (v. 9 days)
- 560 terabytes (v. 20 terabytes)
- 100 thousand users (v. 60+ thousand users)
- 53% peer-to-peer traffic (v. 43%)
- 26% web traffic (v. 14%)
Changes from 2007

• P2P: 69.25% → 52.79%
• Web: 14.35% → 25.78%

Breakdown
• P2P
  – 37% BitTorrent
  – 13% eDonkey
• Web:
  – 15% HTTP
  – 10% Filehosting (RapidShare, Megaupload)
VIEW 1: OBJECT VIEW
Bytes Transmitted: 1999 v. 2002

Content Types Ordered by Size

- 1.7% video/x-msvideo
- 2.1% text/plain
- 4.8% MP3
- 7.1% app/octet-stream
- 7.5% GIF
- 8.8% JPG
- 9.9% HASHED
- 11.3% MPG
- 14.6% HTML
- **18.0% AVI**

(by Bytes)

- **25.3%**
- **20.9%**
- **18.9%**
- **6.4%**
- **5.7%**
- **3.9%**
- **3.8%**
- **3.0%**
- **2.0%**
- **1.9%**
- **1.7%**
- **1.5%**
- **1.2%**
- **0.9%**
- **0.8%**
- **0.8%**
- **0.5%**

(b) By Bytes
Object Sizes

The diagram illustrates the distribution of object sizes across different networks. The cumulative distribution function (CDF) is plotted, showing the percentage of objects below a certain size. The Y-axis represents the percentage of objects, while the X-axis represents the object size in kilobytes (KB).

Different networks are represented by different lines:
- Akamai
- WWW
- Kazaa
- Gnutella

The graph shows how the distribution of object sizes varies across these networks, with Akamai having a more uniform distribution compared to the others.
Top 1000 Object Popularity

What does this mean?
VIEW 2: CLIENT VIEW
UW Client Allocation

Top Bandwidth Consuming UW Clients
(as fraction of each system)

% Bytes

Gnutella
Kazaa
WWW + Akamai

Number of UW Clients

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SERVER VIEW
UW Server Allocation

Top Bandwidth Consuming UW Servers
(as fraction of each system)

% Bytes

100%
80%
60%
40%
20%
0%

0 200 400 600 800 1000
Number of UW Servers

Gnutella
WWW
Kazaa
CACHING
Kazaa Caching

Ideal Byte Hit Rate (Kazaa)

Outbound

Inbound

Byte Hit Rate

0%  20%  40%  60%  80%  100%

Criticisms

• UW traffic may not be representative
• What is all that unclassified traffic?
• Why are heavy P2P users called “worst offenders”? 
• Does not include analysis of internal P2P traffic 
  – Speculation that internal users receive much of their data already from internal users
• No suggestion on how to perform P2P caching 
  – DPI and connection hijacking? 
  – Protocol changes to support caches? Why not just prefer local network peers over remote peers (like BitTorrent now does)
• Why did they look at Gnutella?