P2P Networks-General

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# Schedule

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<td>Tue 17.9.2013</td>
<td>Introduction to P2P (example P2P systems, concepts, trends)</td>
<td>(BitTorrent and CoolStreaming)</td>
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<td>Tue 1.10.2013</td>
<td>Unstructured content search (Napster, Gnutella, Kazaa)</td>
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<td>Energy-efficiency &amp; Mobile P2P</td>
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Introduction to P2P

• What is P2P
• History of P2P networks
• Example systems
• Why P2P is successful
• Multiple view points
  1. A set of widely used applications
  2. Interesting set of technologies
  3. Increasingly finding legal use to save server costs
Definition of Peer-to-peer (or P2P)

- A peer-to-peer (or P2P) computer network is a network that relies primarily on the *computing power* and *bandwidth* of the *participants* in the network rather than concentrating it in a relatively small number of servers.
- A pure peer-to-peer network does not have the notion of clients or servers, but only equal peer nodes that simultaneously function as both "clients" and "servers" to the other nodes on the network, so-called “servent”.
- This model of network arrangement differs from the client-server model where communication is usually to and from a central server.

*Source: www.wikipedia.org*
Architecture of client-server model

Every client contacts to the centralized server to get the desired content
Architecture of P2P Networks

Centralized Index Server

1\textsuperscript{st} Gen. Napster

Peer

Super Peer

2\textsuperscript{nd} Gen. Gnutella

Peer

3\textsuperscript{rd} Kazaa

Hierarchy-based

Flooding-based
Structured P2P networks organize the participants of the whole overlay network according to certain DHT algorithm, which makes the overlay network look like some structure, e.g., a ring, a tree, thus inspires the name “structured”.

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Related Concepts: Overlay Network

One hop at an overlay network can be mapped to multiple hops at a physical network

Source: NTT
History of P2P Networks (Cont.d)

Content sharing: Azureus BitTorrent client

- Music
- Movies
- Games
- Typically copyright violating material
Even on mobile: Symella and SymTorrent
As a technology behind a service: Skype

PPLive

• Founded in 2004, the first online video service provider in China.
• The largest aggregator of China TV programs with over 120 TV stations, thousands of TV shows and programs.
• Has more than 200 million user installations and its active monthly user base (as of Dec 2010) is 104 million, i.e, PPLive has a 43% penetration of Chinese internet users.
• Average viewing time per person per day has reach over 2 hours and 30 minutes.


http://cool.pptv.com/
Is this peer-to-peer?
Processor as the shared resource: SETI@home

- Currently (~2007) the largest distributed computing effort with over 3 million users
- SETI@home is a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI). You can participate by running a free program that downloads and analyzes radio telescope data.
Folding@home (http://folding.stanford.edu/)

Folding

Username: anonymous

Working on: EngHomeodomain

WU progress: 10/100

Finished WUs: 81
Benefits of P2P

• Scalable – It’s all about sharing resources
  – No need to provision servers or bandwidth
  – Each user brings its own resource
  – E.g. resistant to flash crowds
    • flash crowd = a crowd of users all arriving at the same time

Resources could be:
• Files to share;
• Upload bandwidth;
• Disk storage;…
Client/Server: Poor scalability

Three bottlenecks:
1. Server load
2. Edge capacity
3. End-to-end bandwidth

(Streaming TV quality picture to 4000 users would require 3 Gbps outbound bandwidth)
Collaborative Communications

Through cooperation, data transfer from the server can be reduced. Releases some or all of the bottlenecks.

“The server workload is reduced by 41% even when users share only videos while they are watching. When users share videos for one day, the server workload reduces by a tremendous 98.7%, compared to a client-server approach.”

Benefits of P2P (cont’d)

• Cheap
  – No infrastructure needed
  – Or less infrastructure needed

• Everybody can bring its own content (at no cost)
  – Homemade content
  – Ethnic content
  – Illegal content
  – But also legal content

• High availability – Content accessible most of time
P2P data currently represents 44.0% of all consumer traffic over the Internet and 33.6% in North America. Much of this data is audio and video files (over 70%).

- P2P Traffic to Grow Almost 400% over the Next 5 Years
- legitimate P2P traffic is expected to grow 10 times as fast as illicit P2P traffic

Multimedia Intelligence, November 2008

• 1999: Napster, first widely used p2p-application
... and the fall

Petabytes per Month

Online gaming and VoIP forecast to be 1% of all consumer Internet traffic in 2016.
Source: Cisco VNI Global Forecast, 2011-2016

~P2P
Driving Forces Behind Peer-to-Peer

Development of the terminal capabilities:

- **1992:**
  - Average hard disk size: ~0.3Gbyte
  - Average processing power (clock frequency) of personal computers: ~ 100MHz

- **2002-04:**
  - Average processing power (clock frequency) of personal computers: ~ 3GHz
  - Average hard disk size: 100 Gbyte
  - → Personal computers have capabilities comparable to servers in the 1990s

- **2007: Nokia N95 mobile phone**
  - ARM9 ~1GHz clock frequency
  - Up to 2GB external Micro SD

Development of the communication networks:

- **Early 1990s:** private users start to connect to the Internet via 56kbps modem connections
- **1999**
  - Introduction of DSL and ADSL connections
  - Data rates of up to 8.5Mbps via common telephone connections become available
  - The deregulation of the telephone market shows first effects with significantly reduced tariffs, due to increased competition on the last mile
  - → bandwidth is plentiful and cheap!
- **2007 Nokia N95**
  - HSDPA 1.8 Mbps

Battery consumption is a key differentiator between mobile and fixed
Driving forces behind P2P decline

• Consumer content increasingly, easily, and affordably, available in commercial services
  – Spotify, Netflix, HBO, Hula, Katsomo, …
  – Less hassle, better UX for the consumer

• Rise of cloud services
  – Logically centralized model is simple in comparison to distributed P2P

• Tougher legal action and legislation
From Piracy to Business

• The share of P2P networks of Internet traffic is on decline
  – 2007 about 40% of all traffic
  – 2009 about 18% of all traffic
  – Lähde: Arbor Atlas, 2009

• P2P technologies increasingly used as a service platform
  – Skype calls
  – Word-of-Warcraft updates
  – Spotify music streaming

• According to theoretical analysis YouTube could save 40-98% of network capacity with P2P technology (Cha et al., 2007)
  – This is a lot since it is estimated that YouTube data transfer costs are even $1.000.000 per day (Credit Suisse, 2009)
Spotify, 2008

- Music streaming, encrypted content
- Commercial, legal
- Proprietary protocol
- P2P reduces the load of Spotify servers

Spotify server

Part of the song (typically beginning)
List of peers are likely to have pieces of song

Other pieces of song downloaded from peers
WoW Distribution of patches and software
Development of P2P Applications

Traffic portions of the different P2P applications and protocols from the traffic measured per week in the Abilene backbone from 18.02.2002 until 18.010.2004

Data source: http://netflow.internet2.edu/weekly/
Some P2P research topics

- Science of networks
- Self-organization
- Business models
- P2P middleware
- Applications
- Mobile use
- Browser use
- Copyrights & legal
- Trust and reputation
- Anonymity
- Security
- Incentives
- Content search (unstructured, structured)
- Content distribution (downloading, streaming)
Contact Information

• Course web page:
  • [https://noppa.aalto.fi/noppa/kurssi/t-110.5150/etusivu](https://noppa.aalto.fi/noppa/kurssi/t-110.5150/etusivu)

• Questions & Suggestions?