Topic

- Peer-to-peer content delivery
- Runs without dedicated infrastructure
- BitTorrent as an example
Context

• Delivery with client/server CDNs:
  – Efficient, scales up for popular content
  – Reliable, managed for good service

  • Centralized control/oversight
  • Need for dedicated infrastructure

  … but some disadvantages too:

  • Delivery with client/server CDNs:
P2P (Peer-to-Peer)

- Goal is delivery without dedicated infrastructure or centralized control
- Key idea is to have participants help themselves
  - Initially Napster '99 for music (gone)
  - Now BitTorrent '01 onwards
- Efficient at scale, and reliable
- (popular)
P2P Challenges

- No servers on which to rely
  - Communication must be peer-to-peer and self-organizing, not client-server
  - Leads to several issues at scale ...
P2P Challenges (2)

1. Limited capabilities
   - How will peers find content?

2. Participation incentives
   - Why will peers help each other?
   - How can one peer deliver content to all other peers?

3. Decentralization
   - Why will peers help each other?
Overcoming Limited Capabilities

Peer can send content to all other peers using a distribution tree—Typically done with replicas over time

- Self-scaling capacity
Overcoming Limited Capabilities (2)

- Peer can send content to all other peers using a distribution tree – Self-scaling capacity – Typically done with replicas over time.
Providing Participation Incentives

- Peer play two roles:
  - Download (↓) to help themselves,
  - and upload (↑) to help others

Source
Providing Participation Incentives (2)

- Couple the two roles:
  - I'll upload for you if you upload for me
  - Encourages cooperation

Source
Enabling Decentralization

- Started as academic work in 2001
- Any peer can look up the index
- Index lists peers to contact for content
- Index is spread across all peers
- Index is spread across all peers
- Algorithms for a distributed index
- DHTs are fully-decentralized, efficient
- Use DHTs (Distributed Hash Tables)
- Peer must learn where to get content
BitTorrent

Main P2P system in use today

Developed by Cohen in ’01

Very rapid growth, large transfers

Much of the Internet traffic today!

Used for legal and illegal content

Delivers data using “torrents”:

Transfers files in pieces for parallelism

Notable for treatment of incentives

Tracker or decentralized index (DHT)

By Bram Cohen (1975—)

By Jacob Appelbaum, CC-BY-SA 2.0, from Wikimedia Commons
Steps to download a torrent:

1. Start with torrent description
2. Contact tracker to join and get list of peers (with at least one seed peer)
3. Or, use DHT index for peers
4. Trade pieces with different peers

By slowing your upload to them, favor peers that upload to you rapidly; “choke” peers that don’t.

BitTorrent Protocol
All peers (except seed) retrieve torrent at the same time
• Dividing file into pieces gives parallelism for speed

BitTorrent Protocol (3)
Choking unhelpful peers encourages participation

BitTorrent Protocol (4)
BitTorrent Protocol (5)

- DHT index (spread over peers) is fully decentralized
- Expect hybrid systems in the future
- E.g., part of Skype, Amazon

P2P and DHT technologies finding more widespread use over time

- With potential advantages
- Server content distribution
- Alternative to CDN-style client

P2P Outlook