Pitfalls for ISP-friendly P2P design

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P2P & ISPs

- P2P systems:
  - *Large volume* of traffic (20–80% of total)
  - *Random and globally diverse* traffic pattern

- ISPs:
  - Costs scale with usage
  - But, consumers charged *flat-rate pricing*
  - Rate-limit (or block) “problem” protocols

- Outcome: *arms-race between users and providers*
A simple solution?

- Whenever possible, prefer local transfers

- Two proposals: (SIGCOMM ’08)
  - Ono: Clients piggy-back on CDNs to infer locality
  - P4P: ISPs advertise path preferences directly

- Key claim: locality-aware distribution is win-win
  - Faster downloads for users
  - Less interdomain traffic for ISPs
Our position

• While significant locality exists in the workload, *a win-win outcome is unlikely in practice*

• Three *pitfalls* for ISP-friendly P2P design:
  1. Limited impact
  2. Reduced performance and robustness
  3. Conflicting interests between ISPs
Potential for reduction

- We collect a trace of swarm membership and measure AS-paths between peers

- Interdomain traffic reduced by:
  - 51%

- With...
  - Most popular swarms
  - Long-lived peers
  - AS-path information and optimal matching
Potential for reduction

- We *collect a trace* of swarm membership and *measure AS-paths* between peers

- Interdomain traffic reduced by:

  - With...
    - *Typical swarms*
    - Long-lived peers
    - AS-path information and optimal matching

  - 44%
Potential for reduction

- We collect a trace of swarm membership and measure AS-paths between peers.

- Interdomain traffic reduced by: 27%

- With...
  - Typical swarms
  - Typical lifetimes
  - AS-path information and optimal matching
Evaluation in the wild

Distribution efficiency for 32 popular swarms

Cumulative fraction of swarms

Average interdomain transitions per-byte
Evaluation in the wild

Distribution efficiency for 32 popular swarms
Evaluation in the wild

Ono does not provide a significant end-to-end benefit
Evaluation in the wild

A modest reduction is achievable with path information
Evaluation in the wild

Shortest AS-path matching reduces interdomain traffic by a median 15%

But short of the 27% suggested by our trace replay
Performance

• Goal: remain *performance neutral*

• Challenge: *fast but distant* or *slow but local?*

• For the largest swarms in our trace, *prioritizing locality degrades performance* for 80% of users

• Most *peers* come from US, while most *capacity* comes from high bandwidth European/Asian ISPs
Additional pitfalls

- Reduced *structural robustness*
- When does this impact performance?

- *Strategic ISPs* can subvert locality mechanisms
- Will ISPs adopt such behavior?
Structural robustness

- Local clustering *changes overlay structure*, potentially creating *bottlenecks*.

- **Quantifying robustness:** fraction of edge removals required to disconnect half of nodes.
Robustness

Optimizing for locality reduces structural robustness
Robustness

Optimizing for locality reduces structural robustness

Worst random topology more robust than 32% of locally clustered topologies
Robustness

Optimizing for locality reduces structural robustness
Conflicting interests

• Typical assumption: ISPs will cooperate to reduce interdomain traffic

• P2P traffic increases costs for some ISPs, but revenue for others

• What if an ISP acts strategically?
  Prefer in order: customers, peers, then providers
Strategic behavior
Strategic behavior

Manipulating paths to induce revenue
Strategic behavior

51% \[\rightarrow\] 16%

Shortest AS path \[\rightarrow\] Strategic matching

*Traffic reduction*
The tussle between users and ISPs over P2P is likely to continue.

- Client-only solutions *don't solve the problem* in BitTorrent.
- Optimizing for locality in isolation *degrades performance and robustness*.
- Conflicting interests among ISPs preclude cooperation and *encourage strategic behavior*. 