ISP-Aided Neighbor Selection for P2P Systems

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P2P traffic

- >50% of Internet traffic
- Examples: Bittorrent, eDonkey, Skype, GoogleTalk...
P2P from an ISPs view

- **Good:**
  - P2P applications fill a void
  - P2P applications are easy to develop and deploy
  - P2P applications spur broadband demand

- **Bad:**
  - P2P systems form overlays at application layer
  - Routing layer *functionality duplicated* at app layer
  - P2P topology agnostic of underlay → performance loss
  - Traffic engineering difficult with P2P traffic

- ISPs are in a *dilemma*
ISP dilemma

Random/RTT-based peer selection → inefficient network resource usage
Solution: ISP-P2P cooperation

- Insight: ISP knows its network
  - Node: bandwidth, geographical location, service class
  - Routing: policy, OSPF/BGP metrics, distance to peers
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- Our idea:
  - ISPs: offer oracle that provides network distance info
  - P2P: use oracle to build P2P neighborhoods
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- P4P
  - Provide interfaces for applications and networks to communicate regarding
  - Example: Modified iTracker for BitTorrent
Oracle service
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- **Oracle concept**
  - Service of AS / ISP
  - Input: list of possible dst IPs
  - Output: ranked list of dst IPs
    - E.g. according to distances between src IP and dst IPs
Oracle service (2.)

Oracle-based peer selection  for topology and content exchange
Oracle service (3.)

Oracle-based peer selection → localizes topology and traffic
ISP-P2P cooperation

- ISP-aided optimal P2P neighbour selection
  - Simple and general solution, open for all overlays
  - Run as Web server or UDP service at known location

- Benefits: P2P
  - No need to measure path characteristics
  - Easy to avoid bottlenecks => better performance

- Benefits: ISPs
  - Regains control over traffic
  - Cost savings
  - No legal issues (as no content is cached)
Evaluation

- Impact
  - Topology
  - Congestion
  - End-user performance

- Methodology
  - Sensitivity study
  - Use different ISP / P2P topologies
  - Use different user behavioral patterns
    - Content availability, churn, query patterns
  - Evaluate effects of on end-user experience
Overlay-underlay topology correlation

Random vs. biased P2P topology
End-user performance evaluation

- Packet-level simulations
  - Scalable Simulation Framework (SSFNet)
  - Models for IP, TCP, HTTP, BGP, OSPF, etc.
  - Limited to about 700 overlay peers (memory constraints)

- Gnutella-based P2P system
  - Content search via flooding
  - Content exchange via HTTP

- Topologies: several
- User behavioral patterns: several
Topologies: ISP vs. P2P

- **Germany**
  - 12 ISP’s (subset derived from published measurements)
  - 700 peers distributed according to ISP-published customer numbers

- **USA**
  - 25 Major ISP’s (from Rocketfuel)
  - 700 peers distributed in AS’s according to city population

- **World topologies**
  - Sub-sample of measured Internet AS-Topologies: 16 AS’s, 700 peers

<table>
<thead>
<tr>
<th></th>
<th>Tier1 (# AS / # peers)</th>
<th>Tier2 (# AS / # peers)</th>
<th>Tier3 (# AS / # peers)</th>
</tr>
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<tbody>
<tr>
<td>World1</td>
<td>1 / 10</td>
<td>5 / 46</td>
<td>10 / 46</td>
</tr>
<tr>
<td>World2</td>
<td>1 / 355</td>
<td>5 / 23</td>
<td>10 / 23</td>
</tr>
<tr>
<td>World3</td>
<td>1 / 50</td>
<td>5 / 46</td>
<td>10 / 42</td>
</tr>
</tbody>
</table>
P2P user behavior

- Churn: online/offline duration
  - Pareto and Weibull – close to observed behavior
  - Uniform – base comparison
  - Poisson – reflects worst-case scenario

- Content: type, availability and distribution
  - Constant size (512kB)
  - Pareto and Weibull – typical (many free-riders)
  - Uniform – base comparison
  - Poisson – hypothetical case (most peers sharing)
ISP experience: Intra-AS content

- Content stays within ISPs network
  - Without oracle 10 to 35%
  - With oracle 55 to 80%
- Consistent with Telefonica field trial results for BBC
ISP experience: Intra AS content (2.)

- Content stays within ISPs network
User experience: Download time

- Mean download time reduction: 1 – 3 secs (16 – 34%)
- Consistent across topologies
User experience: Download time (2.)

- Reduced mean download time
Summary

Oracle
- Simple and easy to implement

Evaluation shows
- Overlay graph structure not affected
- Reduced AS distance
  - P2P topology correlated with AS topology
- Traffic congestion analysis
  - Reduces inter-AS traffic => load and costs
  - Traffic distribution close to theoretical optimum

Benefits
- ISPs: regain control of network traffic
- P2P network: sees performance improvements
Upcoming

- Oracle software release
  - Open source implementation will be available (Based on bind)
- Software patches for popular P2P clients
  - Gnutella
  - BitTorrent
  - eDonkey
  - P2P TV
- http://www.net.t-labs.tu-berlin.de/isp-p2p/
- Upcoming IETF workshop (May 28th)
  - P2P infrastructure workshop