vINCENT: An Incentive-Scheme for Peer-to-Peer Content Distribution Supporting Virtual Nodes

Matthias Wichtlhuber and David Hausheer

Motivation and Background

Mobile content distribution is use case of increasing relevance

- Video streaming
- Distribution of applications and system updates

→ Peer-to-Peer (P2P) offers means for scalable content distribution by utilizing clients’ resources

Incentive Schemes

- Rational (=selfish) peers need to be incentivized to provide resources
  → Reciprocation is a commonly applied scheme
- Discrimination of mobile peers
  → Mobile peers can only reciprocate at high cost
  → Varying bandwidth is a challenge

Incentive Component

- Accounting
  - Inbound: Reciprocation
    - Expensive Link: Energy and bandwidth are scarce goods for mobile peer
      → Monetary and QoE penalty for reciprocation.
  - Outbound: Home Set Clustering
    - Cheap Link: Energy and bandwidth are subordinate problems for wired peer

Related Work

<table>
<thead>
<tr>
<th>Type</th>
<th>Goal/Means</th>
<th>Support for Heterogeneity</th>
<th>References</th>
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<tbody>
<tr>
<td>Reciprocal</td>
<td>Direct: Private or shared history to reward cooperative peers; Indirect: Maintain central or decentralized reputation value.</td>
<td>No, discrimination of poor peers.</td>
<td>[Piatek2010], [Lu2009], [Meulpolder2008]</td>
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<tr>
<td>Reputational</td>
<td>Apply a tax determining the contribution of a peer – punish if contribution is not made.</td>
<td>Yes, by applying differentiated taxation scheme. Only applicable in controlled environments.</td>
<td>[Hu2010], [Chu2004]</td>
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Architecture

P2P Content Distribution Application

- Neighborhood Selection
- Incentive Component
  - Accounting
    - Home
      - Swarm Load Balancing
    - Mobility Support
    - Access Control
- Chunk Scheduling
- Peer Sampling Service

Preliminary Results

- Time Series
  - Measured Device: Samsung Nexus S, Android

Proof of Problem

- Measurement study of the cost of reciprocation on mobile clients
- Energy consumption of P2P Video on Demand Streaming Prototype [Abboud2011] measured with/without reciprocation

Findings for WiFi

- Reciprocation ~100 mW / 7% more expensive than pure download
  → Difference corresponds to transmission power of WiFi
  → Gap might be wider for technologies with higher transmission power (e.g. HSDPA, LTE)
- Upstream packets generate high peak power consumption