Management of Overlay Traffic by Means of Economic and Incentives’ Mechanisms

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Outline

- Introduction and motivation
  - Project SmoothIT

- Economic management of overlay traffic

- Insertion of ISP-owned Peer

- Collaboration of ISPs

- Concluding remarks
Introduction and Motivation
The Internet Ecosystem

- Many different players acting simultaneously
  - Customers/Users
  - Providers
    - ISPs
    - Overlay application providers
    - Over-The-Top providers
    - Content providers
    - ...

Economic mechanisms and overlay traffic - 4
Tussles in Internet

- Players are self-interested, with:
  - substitute or complementary roles/functionalities
  - conflicting interests,
and contend even on the same service
- e.g.: application providers desire high quality, which is costly to ISPs.
Overlays & Information asymmetry

- Peer-to-Peer (P2P) and other overlays generate significant traffic volumes
  - 40+% of the traffic

- Overlays built independently of physical network
  - Flexibility, but …
  - potential inefficiencies wrt overlay traffic insertion in underlay, due to information asymmetry
Conventional Traffic Management

- Aims at achieving a global optimum
  1. for a single criterion, possibly combined metric
  2. by a central entity, with full information

- Not suitable for overlay traffic, due to tussles
Target: All-Win Situation

- traffic management taking into account:
  - the interests of individual players
  - the distribution of information and functionality
  - the large scale of Internet

aiming for a “good” equilibrium operating point
Incentives and Mechanism Design

- ... incentive constraints should be considered coequally with resource constraints in the formulation of the economic problem.
  
  R.Myerson, Nobel Prize in Economic Sciences, 2007

- Mechanisms can help us: attain an outcome in a complicated optimization problem, in a distributed way
  
  The “engineering” side of economic theory.
  
  E.Maskin, Nobel Prize in Economic Sciences, 2007
The FP7-ICT Project *SmoothIT*

**Simple Economic Management Approaches of Overlay Traffic in Heterogeneous Internet Topologies**

- **Main objective**: To optimize *overlay* traffic mutually beneficially for all ISP, user, application provider
  - File-sharing and Video-on-Demand

- **Approach**: *Economic Traffic Management (ETM)*, with *mechanisms* based on the *incentives* of players
SmoothIT at a glance

- Duration: January 2008 – March 2011
- Total budget: 4,37 MEuro
- Coordinator: University of Zurich (CH)
- Industrial partners:
  - DoCoMo EuroLabs (DE)
  - Intracom S.A. (EL)
  - PrimeTel (CY)
  - Telefonica Investigation y Desarollo (ES)
- Academic partners:
  - AGH University of Science and Technology (PL)
  - Athens University of Economics and Business (EL)
  - Julius Maximilians University of Wuerzburg (DE)
  - Technical University of Darmstadt (DE)
Win-Win

Economic mechanisms and overlays - 13
Economic management of overlay traffic

Incentives and TripleWin

- Assume flat rate Internet access pricing

→ TripleWin = simultaneous Win (ISP) wrt providers’ revenue/cost of overlay traffic & Win (user + overlay provider) wrt performance

- ETM deployment costs taken into account later
Optimization in Overlays

- Overlays already include mechanisms to optimize user performance
  - tit-for-tat in BitTorrent,
  - give-to-get in NextShare VoD

- Possible inefficiencies
  1. Suboptimal performance
     - due to incomplete information (\(\rightarrow\) asymmetry)
  2. conflict with the incentives of the ISP
Overlay Choices

Content Provider

Tracker (Overlay Provider)

Overlay

ISP 1

ISP 2

User

User
ETM Mechanisms (I)

- Exploit the existing overlay structure and mechanisms involving choices; e.g. overlay neighbor selection
  - Are highly distributed and scalable

- Stimulate information sharing among players

- Do not impose decisions - can be bypassed
ISP affects users’ individually optimal choices and overlay traffic patterns desirably by:

1. providing users with extra underlay information
   - locality promotion
   - For ISP: Win – for user: ? $\rightarrow$ Win/No-Lose

2. offering extra resources in the overlay to “help” local users
   - For user: Win – for ISP: ? $\rightarrow$ Win
The main ETM Mechanisms

1. BGP-based Locality Promotion (BGP-Loc)
   - A server provides proximity-related information, employed optionally by the querying peer

2. Insertion of ISP-owned Peers (IoP) in swarms
   - A resourceful entity enhancing both user performance and traffic locality within an ISP

3. Promotion of Highly Active Peers (HAP)
   - ISP boosts regular peers’ capacity in order to serve as IoPs
Concluding remarks
Main Conclusions

- ETM can lead to TripleWin
  - Existing overlay optimization can benefit from ETM

- Locality promotion does reduce costly inter-domain traffic
  - … but does not always lead to TripleWin
    - possible performance deterioration

- Use of resourceful entities (e.g. IoP) is effective

- ISP collaboration is effective

- Monetary benefits can break-even with costs
Final Remarks

- No ETM approach can fit all cases/applications
- ETM deployed by a subset of users or ISPs can be beneficial for them
  - Others (e.g. smaller ISPs) may be forced to adopt ETM too
- Special modeling and assessment methodologies used for TripleWin evaluation
- ETM should not affect adversely other applications
Thank you for your attention!

More information:
www.smoothit.org
http://nes.aueb.gr