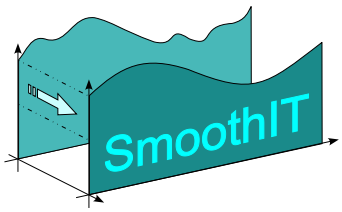
Simple Economic Management Approaches of Overlay Traffic in Heterogeneous Internet Topologies

European Seventh Framework STREP FP7-2007-ICT-216259



The SmoothIt Project

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"Socio-Economic Aspects of Future Generation Internet"
Karlskrona, May 27th
Session 4, 15:15-1645

University of Würzburg, Institute of Computer Science
Department of Distributed Systems
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At a Glance: SmoothIt

Project Coordinator

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Project website:
http://www.smoothit.org

Duration: *Jan, 2008 – Dec, 2010*

Total Cost: *€4.4m*

EC Contribution: *€3.0m*

Contract Number: INFSO-ICT-216259

Partners:

- *University of Zurich (CH)*
- *Technische Universität Darmstadt (DE)*
- *DoCoMo Communications Laboratories Europe GmbH (DE)*
- *Athens University of Economics and Business (GR)*
- *Julius-Maximilians Universität Würzburg (DE)*
- *AGH University of Science and Technology (PL)*
- *PrimeTel Limited (CY)*
- *INTRACOM S.A. Telecom Solutions (GR)*
- *Telefónica Investigación y Desarrollo (ES)*

Outline

- Overlay applications and requirements: QoE++
- Operator's Point of View: Costs--
- New Approach for Overlay Traffic Management: combine QoE, Costs, Security through Incentives

Presentation based on positioning paper

Juan Ferandez-Palacios, Maria Angeles Callejo, Hasan, Tobias Hoßfeld, Dirk Staehle, Zoran Despotovic, Wolfgang Kellerer, Konstantin Pussep, Ioanna Papafili, George D. Stamoulis, Burkhard Stiller.

A New Approach for Managing Traffic over Overlay Applications of the SmoothIt Project.

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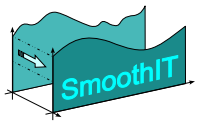

Overlay Applications in the Internet

- Overlay networks emerged in the last years …
  - File sharing: eDonkey, BitTorrent, Gnutella, …
  - Video-on-Demand and live TV streaming: Joost, PPLive, Zattoo, …
  - P2P-based VoIP: Skype
  - and others: gaming, VPNs, CDN Akamai, …
- … to overcome limitations of the Internet,
  - emulate multicast on application layer, not supported by underlay
  - efficient, scalable content distribution
  - easy deployment in complex environments
- … and generate a large portion of Internet traffic !
  - YouTube is about 10% - 20% of entire traffic volume
  - P2P file sharing around 80% according to different ISPs

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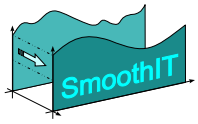
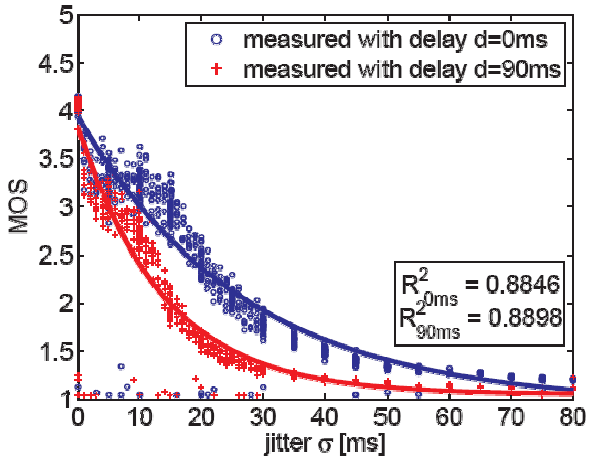


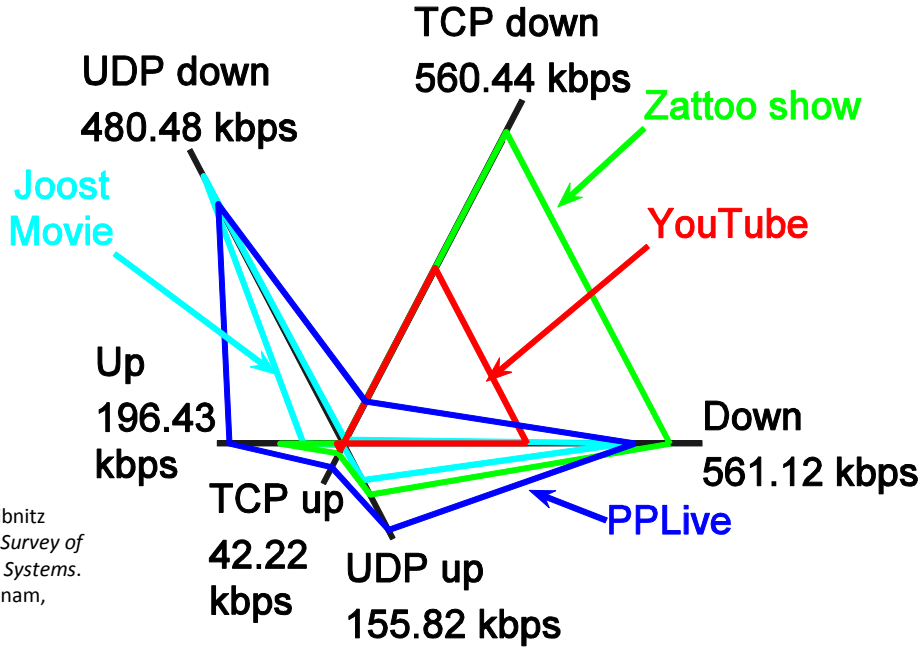
Application Requirements

- Internet traffic transported according to a “best effort” approach
- However, some overlay applications such as IP-TV, VoD, VoIP, videoconference or gaming present strict requirements in terms of delay and/packet loss
- Example: iLBC codec

T. Hossfeld, D. Hock, P. Tran-Gia, K. Tutschku, M. Fiedler
Testing the IQX Hypothesis for Exponential Dependency between QoS and QoE.
ITC Specialist Seminar, Karlskrona, 2008



Characteristics of Applications: Video Streaming as Example



Tobias Hoßfeld and Kenji Leibnitz
A Qualitative Measurement Survey of Popular Internet-based IPTV Systems.
HUT-ICCE 2008, Hoi An, Vietnam, June 2008.

From Operator's Point of View: QoE

- Application-aware transport services able to provide the required QoS for each application would improve the QoE perceived by the end user
- Incentives for operators to increase QoE of overlay applications?
  - revenue ☺, as improved QoE
    - increases the broadband customers fidelity and reduces the churn rate
    - sells new broadband connectivity services specially adapted to Internet real-time and streaming applications

→ QoS differentiation and provisioning as key element for overlay traffic management

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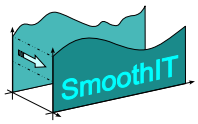
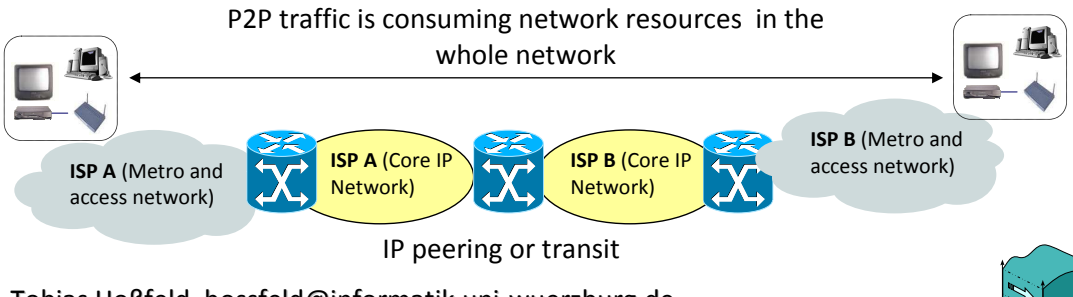


ISP's Costs for P2P Traffic

- Amount and distribution of overlay traffic strongly impacts total network costs (CAPEX and OPEX)
- If an ISP customer is exchanging P2P traffic with a customer of another ISP then such traffic is consuming resources in the whole ISP network: access, aggregation, IP "national" core and IP interconnection
- Peering: Two networks exchange traffic between each other's customers freely (as long as not important traffic asymmetries are detected)
- Transit: An ISP pays to another ISP for the traffic exchange



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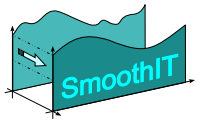
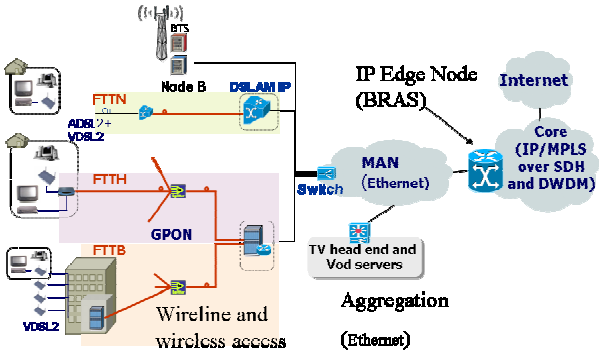


Example of Metro and Access

- E2E path of inter-carrier flow begins in access network
- Traffic aggregation over layer 2 networks
- Broadband Remote Access Server checks destination address
- IP packets aggregated in MPLS flows
- Internal: another BRAS
- External: IP interconnection point
- ISPs networks interconnected as Autonomous Systems with BGB → cost of overlay traffic



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Example: Measurement of Joost VoD

- Test PC in Würzburg: mainly connections to peers in Europe
- insight into traffic patterns, used protocols, topologies, …

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Example: Zattoo Live TV

- license agreements, user groups according to content (channel, country regulation, also e.g. for eDonkey)
- group users in cluster, based on network topology

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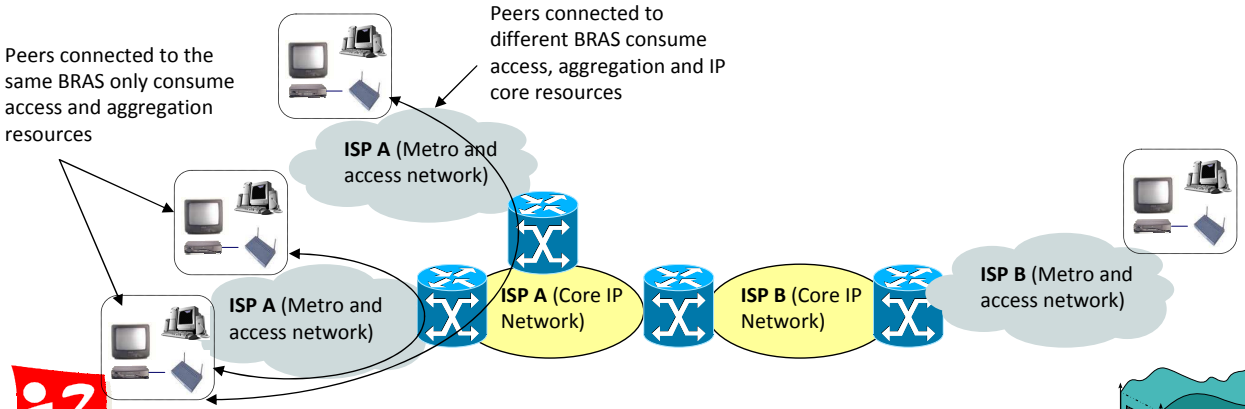
Locality of P2P Traffic

- As higher the percentage of “multidomain” traffic as higher the network resources consumption and total costs
- Internal P2P traffic doesn’t consume interconnection bandwidth
- Traffic locality may reduce both network investments and transit costs
- How to promote traffic locality? Economic Traffic Management



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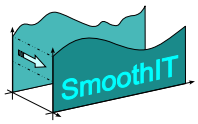

Key Elements of Overlay Network Management

- **QoS differentiation** increases QoE of sensitive applications
- **Promotion** of overlay traffic **locality** may
  - reduce both network investments and transit costs
  - increase QoE, e.g. close peers are preferred in BitTorrent for uploading and get a higher download bandwidth (tit-for-tat)
- **Combination** of Locality Promotion and QoS differentiation might result in mutual benefit
  - ISP A guarantees QoS for internal traffic
  - Overlay is location-aware and keeps traffic locally within ISP A

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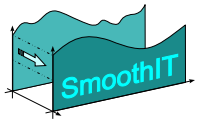

Optimization Potential: File Sharing and Video Streaming

- File-sharing
  - very popular, often illegal contents, high traffic volume
  - can utilize location, not QoS provisioning (delay, jitter)
  - QoE = high throughput (and small upload)
  - significant differences between platforms w.r.t. SmoothIt
- P2P-based VoD
  - already very popular, high traffic volume
  - mainly proprietary; several open-source variants
  - can utilize location; small jitter handled by playout buffer
  - QoE = throughput>video rate, small jitter
- P2P-based Live TV
  - can utilize QoS provisiong, high QoS req. (jitter, delay)
  - QoE = throughput>video rate, small delay, small jitter

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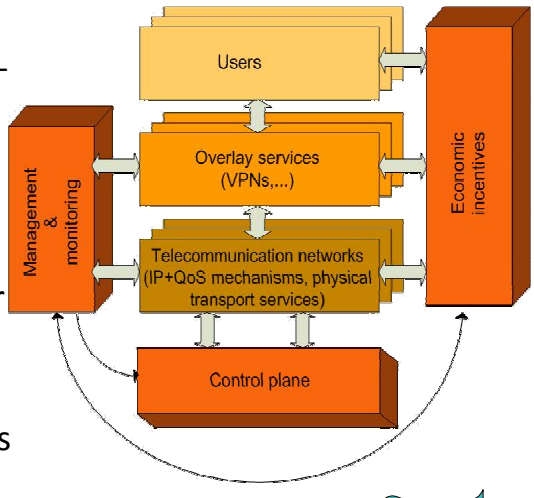
SmoothIt: Technical Approach

- Economic Traffic Management: Interactions between roles and technical as well as economic mechanisms
- traffic analysis methods and requirements for overlay applications (WP1)
- develops the respective theory for incentive-based schemes, evaluates performance (WP2)
- flexible set of networking protocol and a systems architecture being able to perform measurements, accounting, and charging for overlay networks (WP3)
- Internal test-bed trial and external trial to collect and assess practical-applicable results in a larger scale(WP4)



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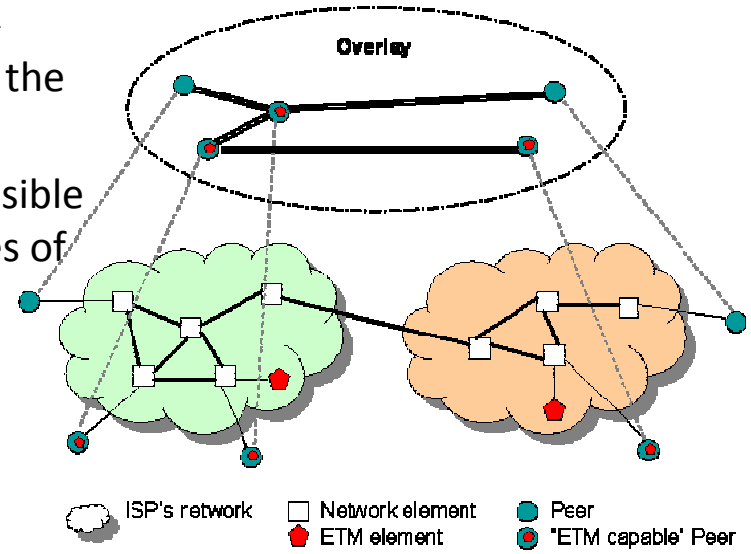
Design Space

- ETM elements to enable a peer to acquire information from underlaying network
- ETM capable peer in the overlay

→ Elements are responsible for evaluating utilities of each party involved



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Possibilities within Design Space

Dimension	Possibility
Pricing scheme for network resources	1) congestion-based, 2) demand-based, 3) performance-based, 4) flat-rate
Incentives	1) performance improvement, 2) price reduction, 3) reliability, 4) security
Information useful for overlay, which can be provided by the underlay	1) locality of nodes, 2) performance of a transport service, 3) path reliability to a node
Architecture	1) ETM elements constitute or organize themselves as a "cross ISP infrastructure" providing a special service to evaluate utility similar to indexing service provided by a DHT. 2) Each ISP operates its own ETM elements independently.
Parameter for utility evaluation	*User*: Resource quality (impact on QoE), resource charges, network performance (impact on QoE), network usage charges, reliability, security. *ISP*: Interconnection bandwidth usage (costs), utilization of ISP's core networks, charge of network usage billable to customers (depending on pricing scheme or amount of usage)

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Summary: SmoothIt Key Objectives

- **Structure overlays** by means of incentive mechanisms → **optimal** for both, user communities and ISPs
- **Define key requirements** for a commercial application of **Economic Traffic Management** schemes for ISPs and telcos
- Advance traffic management beyond traditional limits, specialized **economic theory** will be applied
  - for building - in a **fully decentralized** way - network efficient Internet-based overlay services in competitive **multi-provider scenarios,**
  - solving the information asymmetry problem between overlay and underlay network.
  - for provision of **security, privacy and trust for economic management schemes**

Summary: SmoothIt Key Objectives(f.)

- **Design, prototype, and validate** necessary networking infrastructure and ETM components in **IP test-bed and trial**.
- Optimized **incentive-driven signaling approach**
  - for defining (theory) and
  - delivering (technology) economic signals across domain boundaries
  - in support of **co-operating and competing providers** in an interconnected **heterogeneous network environment**.
- SmoothIT will stress **operator-orientation** by verifying key results of the work through ISP and telco requirements as well as its supporting technology.