

Economic Traffic Management (ETM) — Mechanisms for Smoothing Internet Traffic —

UZH, DOCOMO, TUD, AUEB, PrimeTel, AGH, ICOM, UniWue, TID

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Outline

- Motivation and Example Scenarios
 - Requirements
- TripleWin and ETM
 - Incentives to Participate and ETM Mechanisms
- SmoothIT Architecture Design
- Preliminary Evaluations
 - Prototypical SIS Implementation
 - Locality-aware Peer Behavior Simulation
- Summary and Conclusions

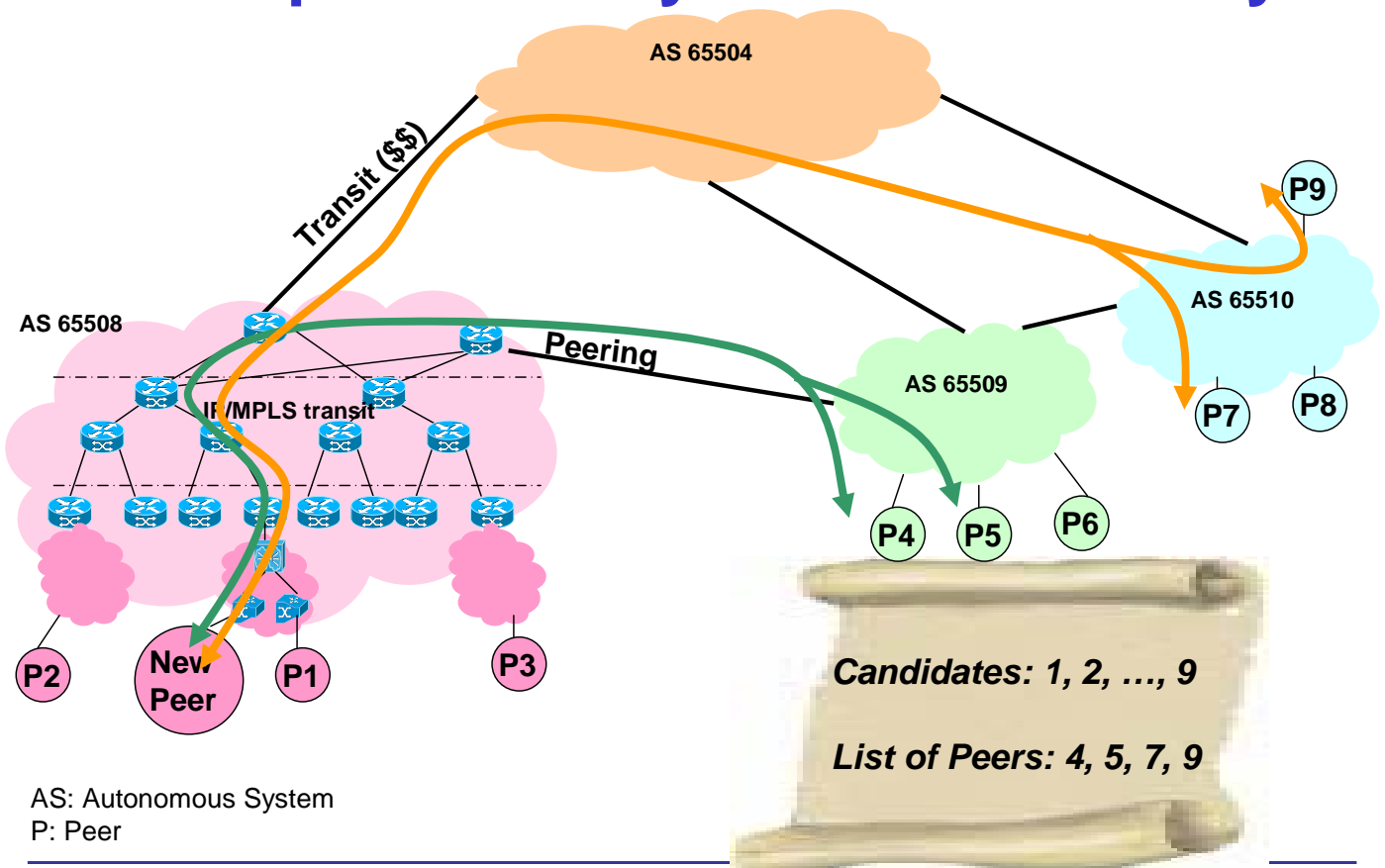


Motivation

- P2P applications and traffic
 - Significant and increasing amount of P2P traffic
 - Suboptimal peer selection due to information asymmetry
 - Underlay topology, incl. routing metrics and values, unknown to overlay
 - Overlay requirements, incl. traffic characteristics, unknown to underlay
- Consequence
 - Non-optimized overlay traffic in the underlay
 - Higher costs in (a) underlay
 - Lower QoS in (b) overlay and for (c) application providers
 - Conventional traffic management techniques not suitable
- Goal of the SmoothIT project
 - Bridge overlay with underlay
 - Apply Economic Traffic Management (ETM)
 - Optimize traffic and achieve TripleWin situations for all parties

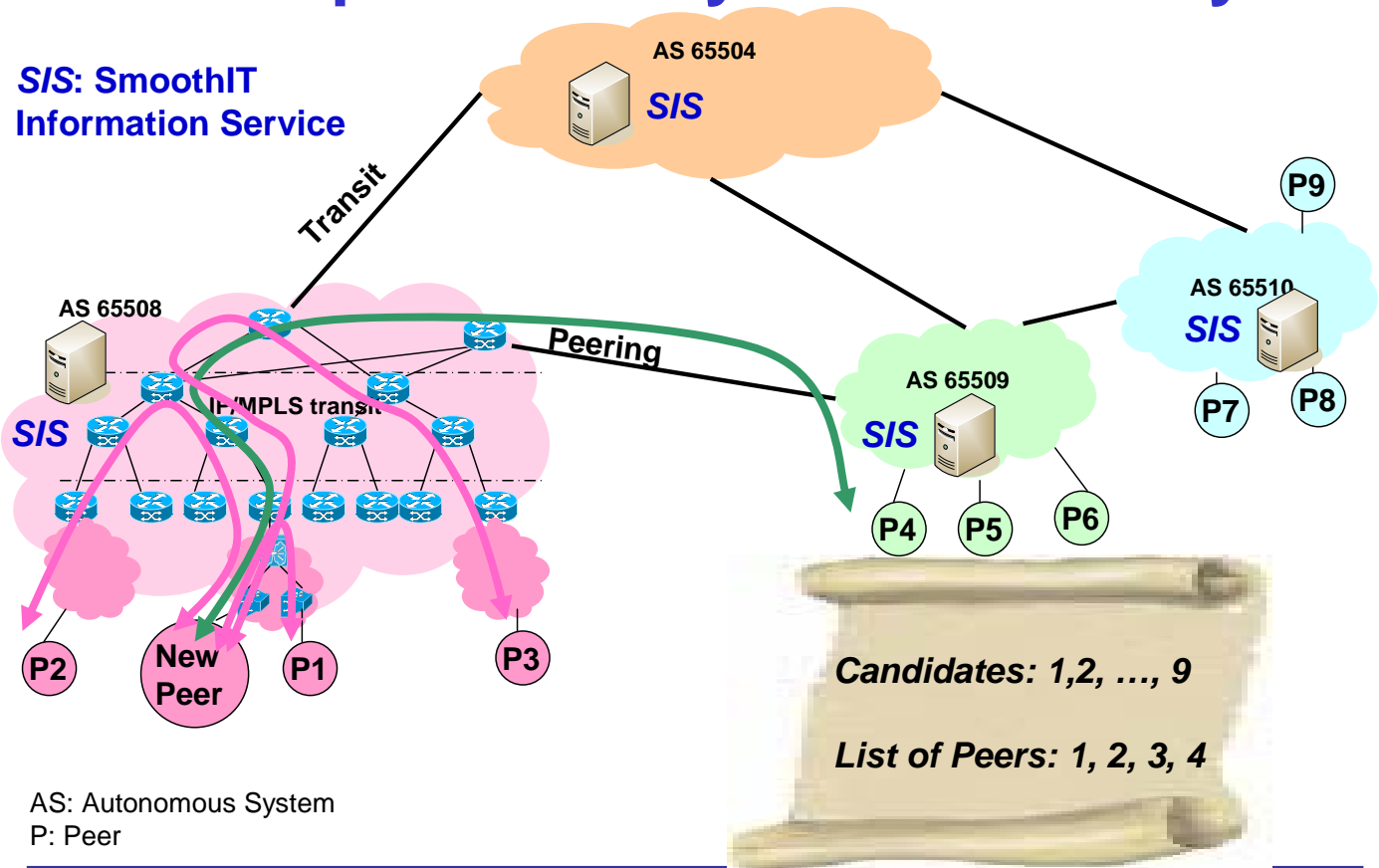


Example: Locality-unaware Overlay



Example: Locality-aware Overlay

S/S: SmoothIT
Information Service



AS: Autonomous System
P: Peer



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Related Work — Systems for Cooperation

- Network Topology Information Desk Service (NTDIS)
 - Sorts list of IP addresses according to preferences
- Oracle Service
 - Ranks IP addresses with a distance metric
- Proactive Network Provider Participation for P2P (P4P)
 - Provides topology information by grouping IP addresses into clusters
 - Keeps state of cluster peerings



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Requirements Analysis

DOCOMO et al.

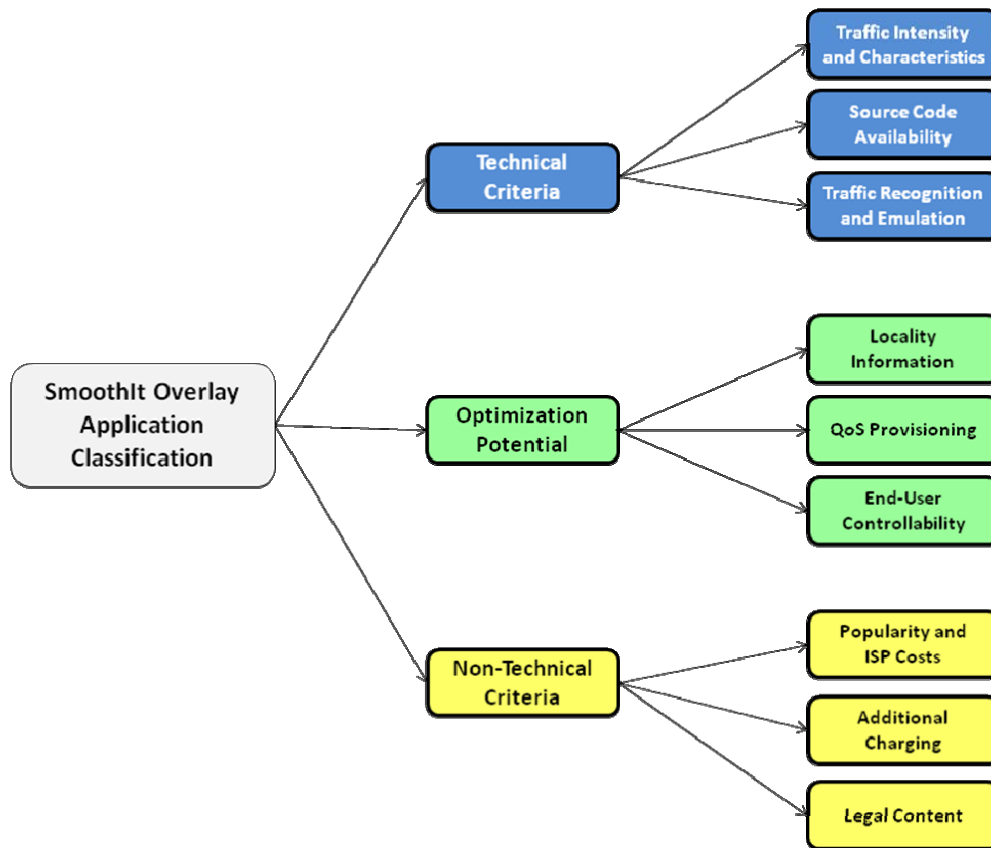


High-level SmoothIT Requirements

- SmoothIT provides for a concise **overview**
 - On overlay applications describing their features, traffic characteristics, and operator/user effects
 - On technical, economic, and functional effects of overlay applications within SmoothIT
- SmoothIT identifies low-level requirements for the SmoothIT architecture based on **technical** and **economic** view points plus **optimization dimensions**
- SmoothIT is addresses **real operators and relevant applications** to
 - Classify overlay applications
 - Select a promising overlay application being evaluated for an internal and external trial



Classification Criteria



Classification: Overlay Application Services

| | source code availability | traffic intensity | traffic recognition | end-user controllability | QoS utilization | locality utilization | popularity | legal contents | ISP costs | additional charging | opportunities | overall |
|------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------|----------------------|------------|----------------|-----------|---------------------|---------------|---------|
| Year 2008 | | | | | | | | | | | | |
| File sharing | 4 | 5 | 3 | 5 | 2 | 5 | 5 | 2 | 5 | 1 | 5 | 42 |
| P2P VoD | 2 | 3 | 3 | 2 | 4 | 5 | 3 | 4 | 3 | 3 | 3 | 35 |
| P2P Live TV | 2 | 3 | 3 | 2 | 5 | 5 | 3 | 5 | 3 | 3 | 2 | 36 |
| P2P VoIP | 1 | 2 | 3 | 1 | 4 | 1 | 5 | 5 | 1 | 1 | 1 | 25 |
| P2P Gaming | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1 | 17 |
| CDN | 1 | 4 | 5 | 1 | 4 | 4 | 5 | 3 | 3 | 2 | 1 | 33 |

| | | | | | | | | | | | | |
|---------|--------------------|---|---|--------------|---|---|------------------------|---|---|---|---|--|
| Weights | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | technical criteria | | | optimization | | | non-technical criteria | | | | | |



TripleWin and Economic Traffic Management (ETM)

AUEB et al.

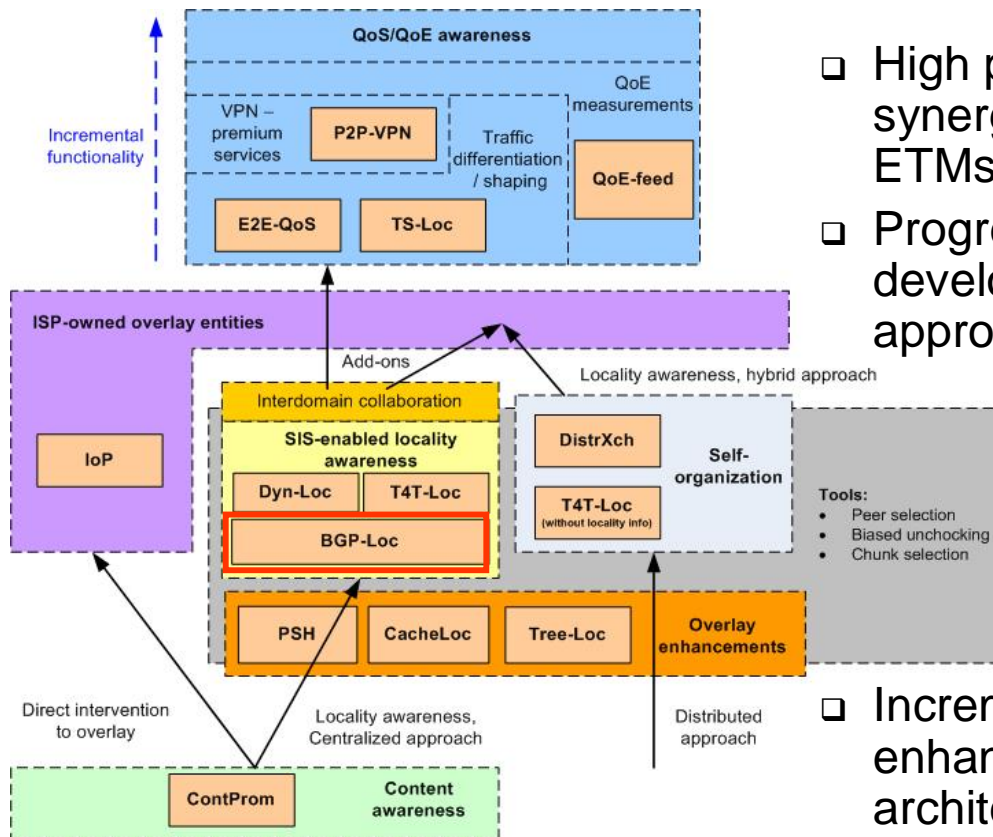


TripleWin

- Management of **overlay networks** based on a collaboration between stakeholders: (a) the overlay provider and (b) the network (underlay) provider (c) in support of the user
 - Cost and investment recovery for providers, utilization fun for users
- Incentives for **operators**
 - Monetary: reduce overlay traffic and inter-domain traffic
 - Traffic management: less congested links, better performance
 - Reputation: keep customers, distinguish from other operators
- Incentives for **overlay providers**
 - Performance: Active role in traffic mgmt increases service quality
 - Reputation: increased user base due to better performing services
- Incentives for **user**
 - Performance: Increased service quality, e.g., reliability, RTT, BW
 - Monetary: lower price for network access



ETM Mechanisms and Synergies



- High potential for synergies between ETMs
- Progressive development of approaches possible

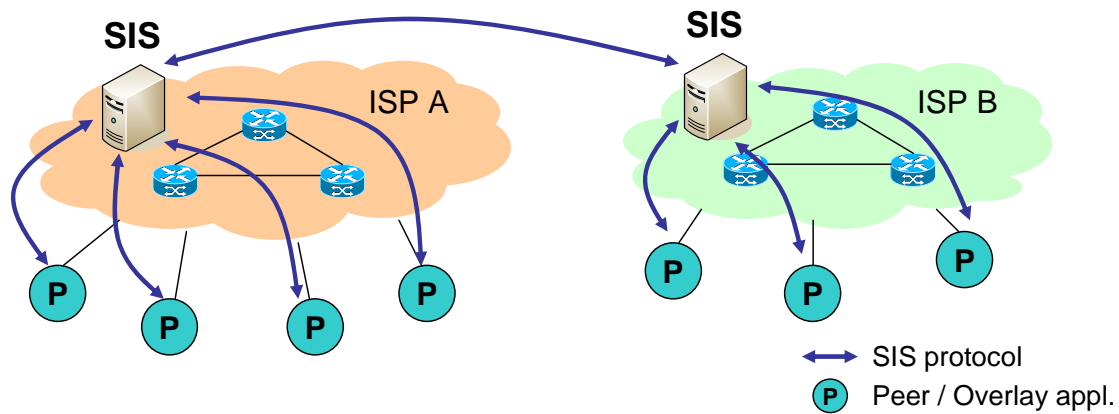
- Incremental enhancement of architecture possible



SmoothIT Architecture Design



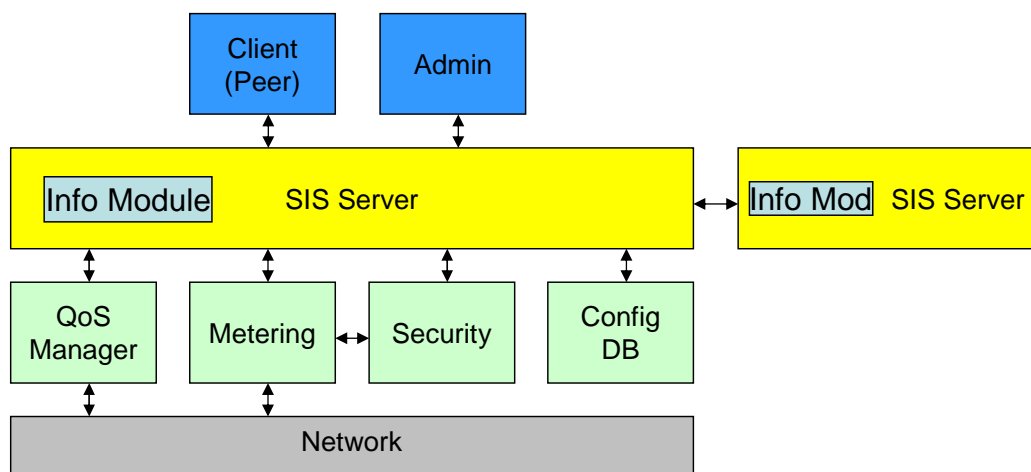
SmoothIT Information Service (SIS)



- Deployment of SIS components in the ISPs' network *optional*:
 - To convey information between overlay and underlay
 - May be operated by operator, overlay provider, or third parties
- SIS following client-server architecture
 - Multiple SIS instances possible, bottleneck-free design for domains
- Overlay applications interact with SIS in order to select "better" peers
 - Reducing costs of ISPs
 - Improving QoE of users



SIS Architecture and Components



- SIS Server
 - Contains ETM logic (Info Module)
 - Aggregates information and calculates preference values
- Metering
 - Collects information from the network, e.g., BGP routing, topology
- QoS Manager
 - Performs QoS provisioning
 - Support of QoE schemes
- Security
 - Authentication and authorization
- Config DB
 - ISP policies and information about the network, e.g., topology, capacity



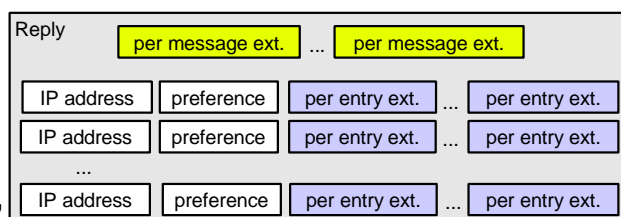
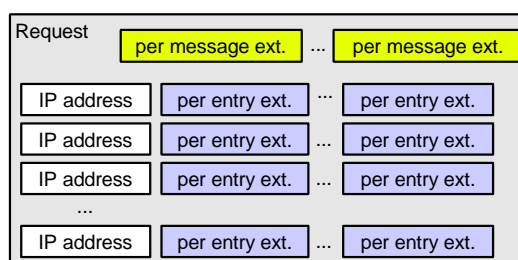
Example: BGP Information Module

- ❑ Collects BGP routing information
 - Reads the routing table over SNMP
- ❑ Provides locality information
 - Based on BGP attributes
- ❑ BGP attributes
 - Assigned to each route and influence the route selection
 - Local Preference
 - Defines the exit point to an AS
 - Distributed among routers in an AS
 - Route with highest local preference is selected
 - AS Path
 - Defines the AS hops to the destination
 - Route with least AS hops is selected
 - Multi Exit Discriminator (MED)
 - Defines the preference for an entry point to an AS
 - Route with lowest MED is selected



SIS Protocol

- ❑ Between SIS and overlay application
- ❑ Stateless request-response interaction scheme
- ❑ Application-independent
- ❑ Basic preference information service
 - Request: list of identifiers/peers (IP addresses)
 - Reply: list with preference values
- ❑ Optional further parameters
 - Per message or per parameter e.g., application type, desired QoS, capacity, locality, pricing information, peer availability

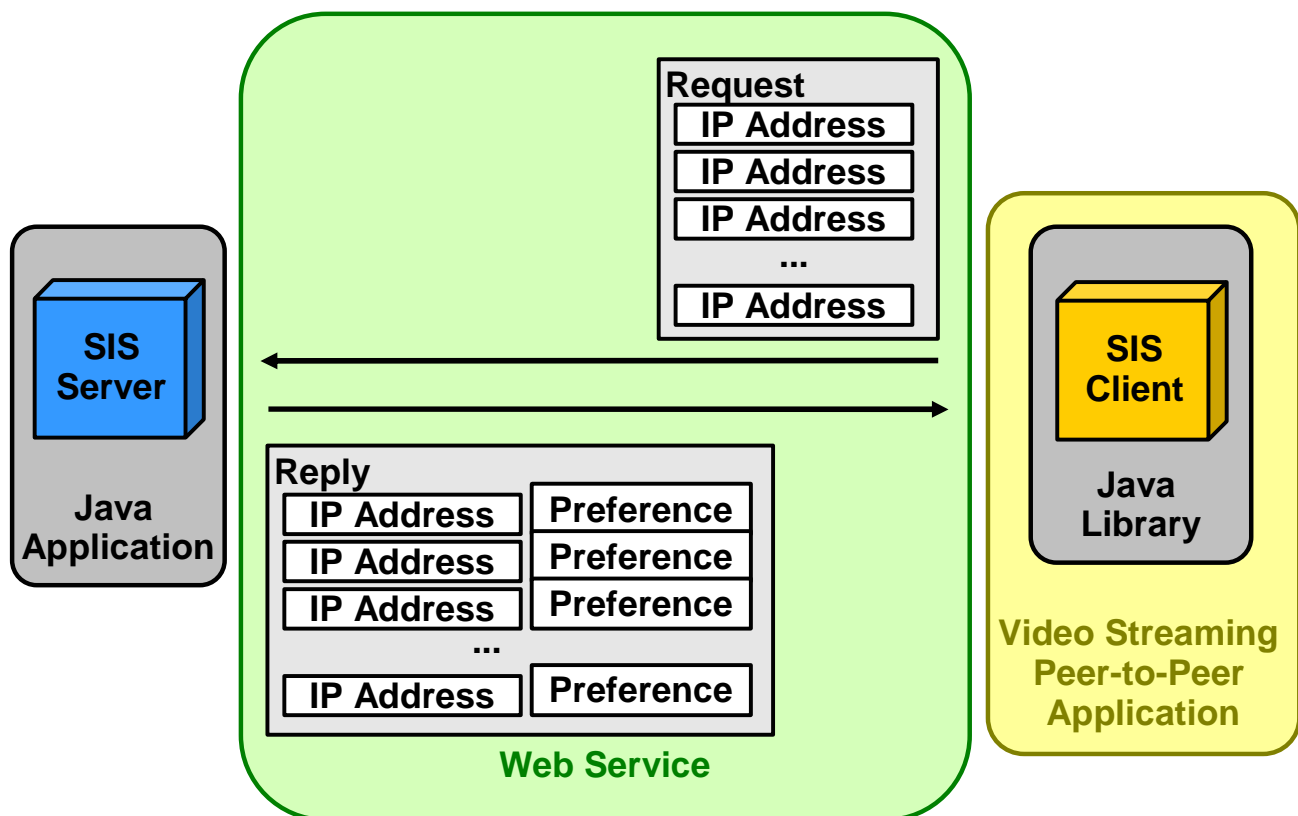


Prototypical SIS Implementation

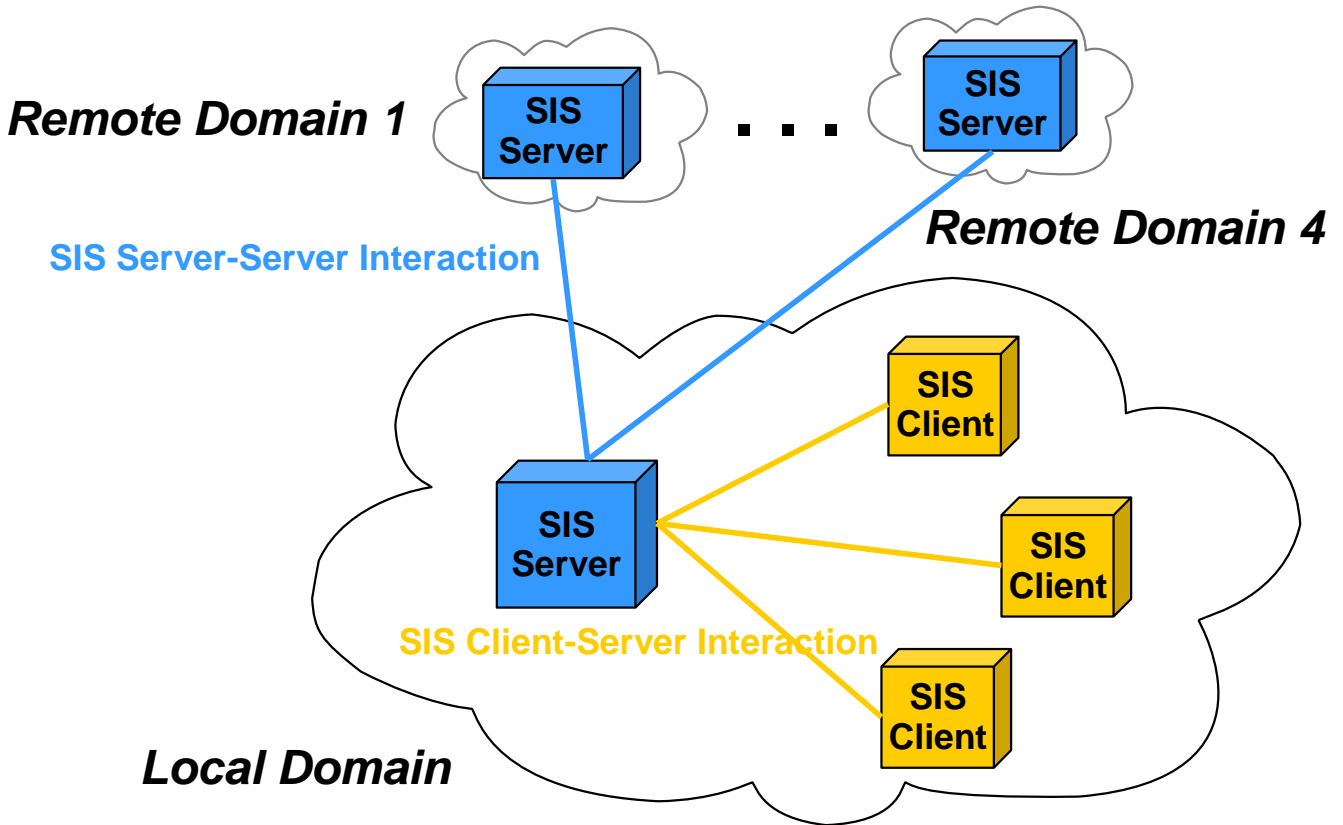
UZH et al.



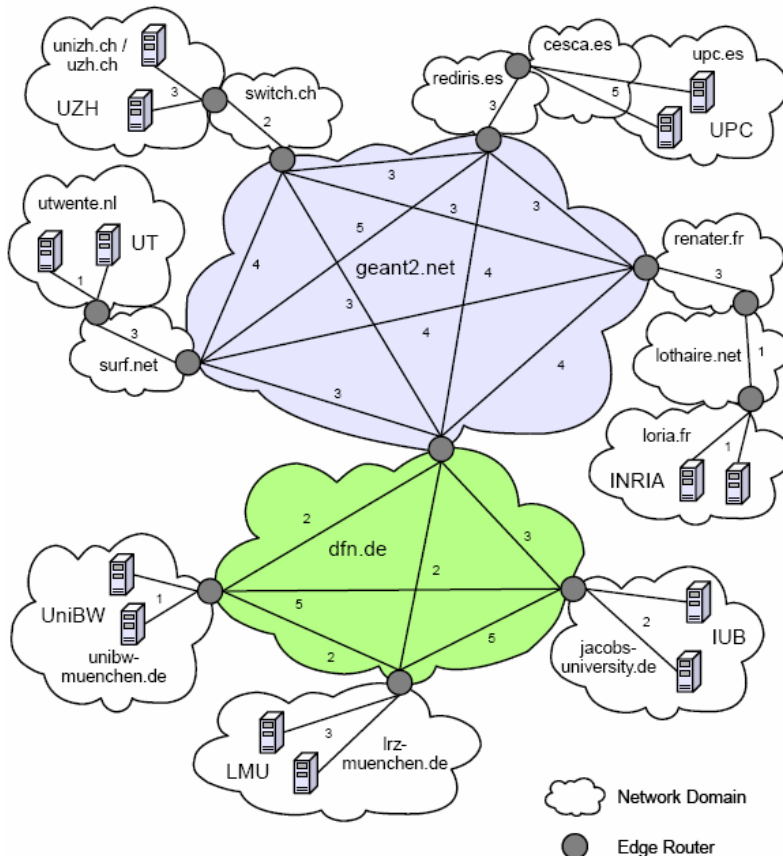
SIS Implementation — SIS, Application



SIS Sample Set-up — Topology (1)



SIS Sample Set-up — Topology (2)

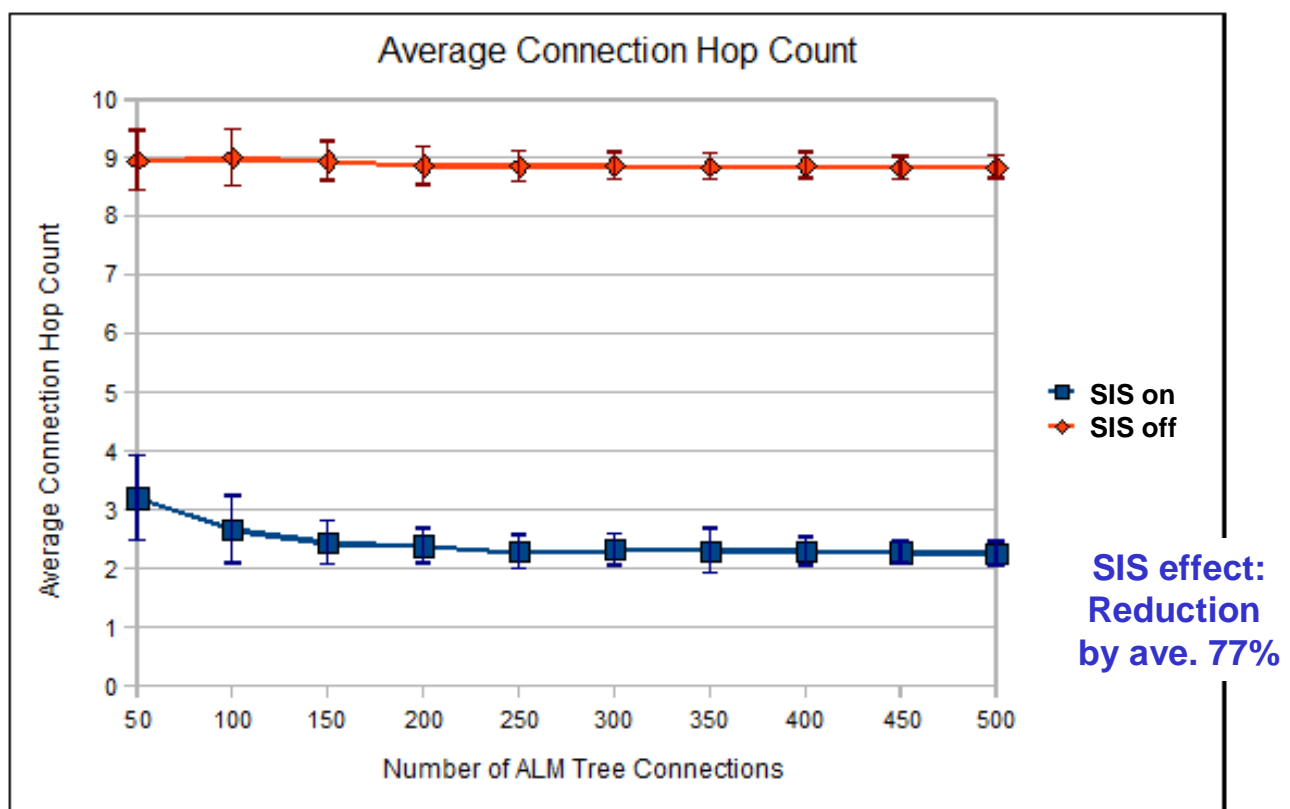


SIS Sample Set-up — Test-bed

- EMANICSLab
 - Selected 5 sites with 2 hosts each (max hop-count 17, min 6)
 - Each site stands for one network domain
- Host configuration
 - 1 SIS server per host
 - N=50 peer-to-peer video stream instances per host
- SIS server configuration
 - Maximum preference for local connections
 - Reduced preference for remote domains according to hop count distance
- P2P video streaming application
 - Creates simple application layer multicast (ALM) tree
 - Selects sources randomly
 - Based on FreePastry substrate for peer lookup
 - Utilizes direct socket connections for ALM tree



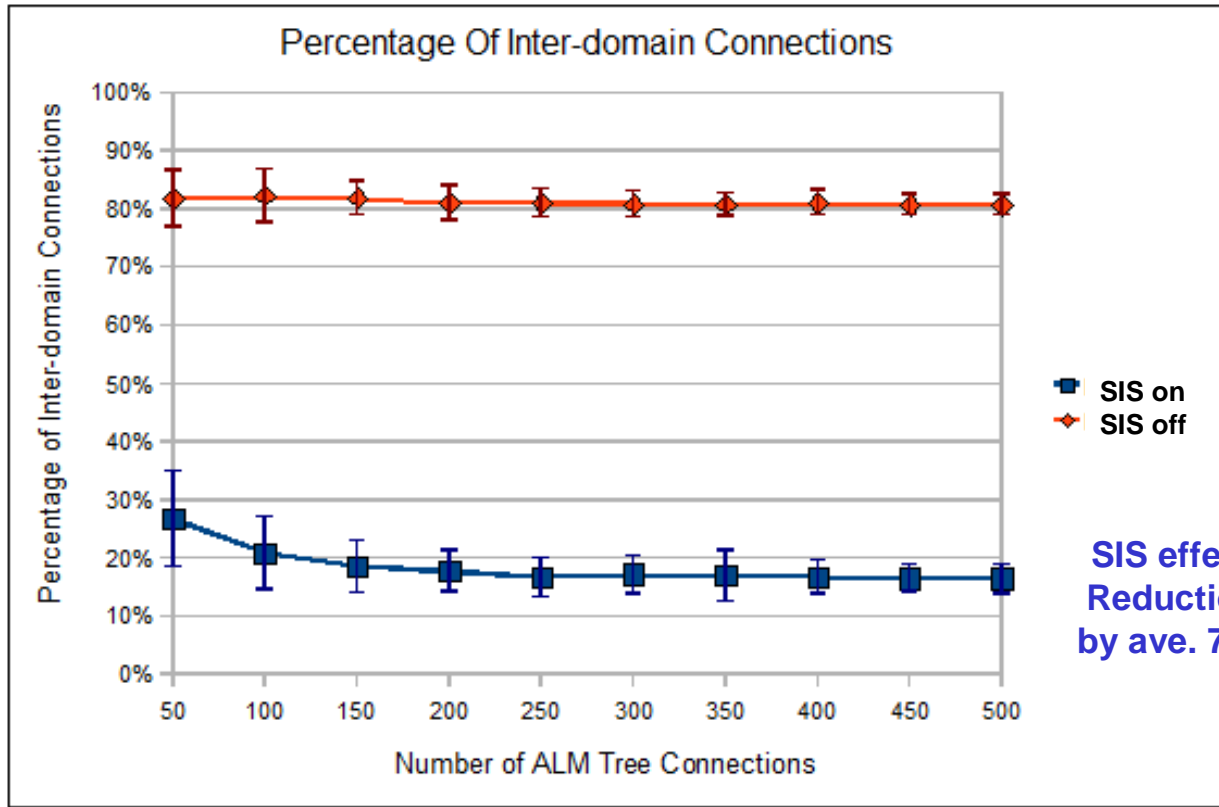
Evaluation (1) — Connection Hop Count



Averages per evaluation point: 100 test runs



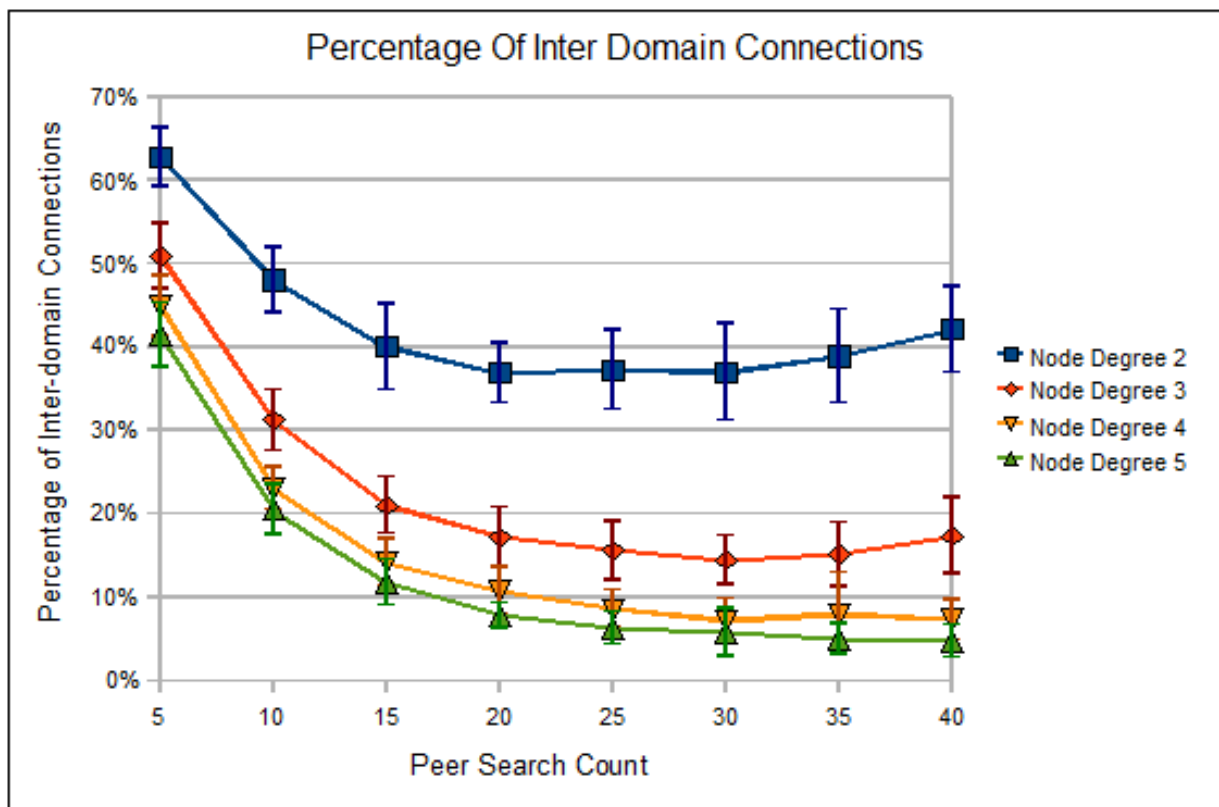
Evaluation (2) — Inter-domain Connections



Averages per evaluation point: 100 test runs



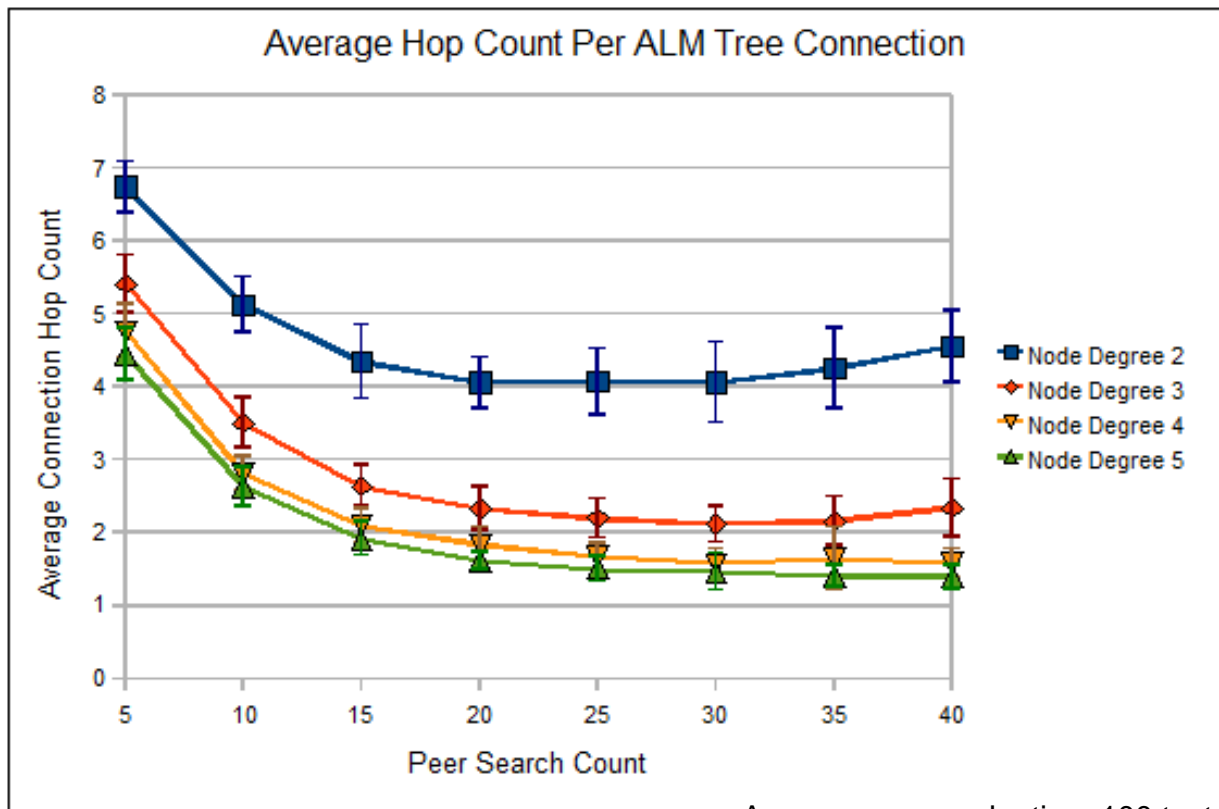
Evaluation (3) — Inter-domain Connections



Averages per evaluation: 100 test runs



Evaluation (4) — Connection Hop Count



Averages per evaluation. 100 test runs

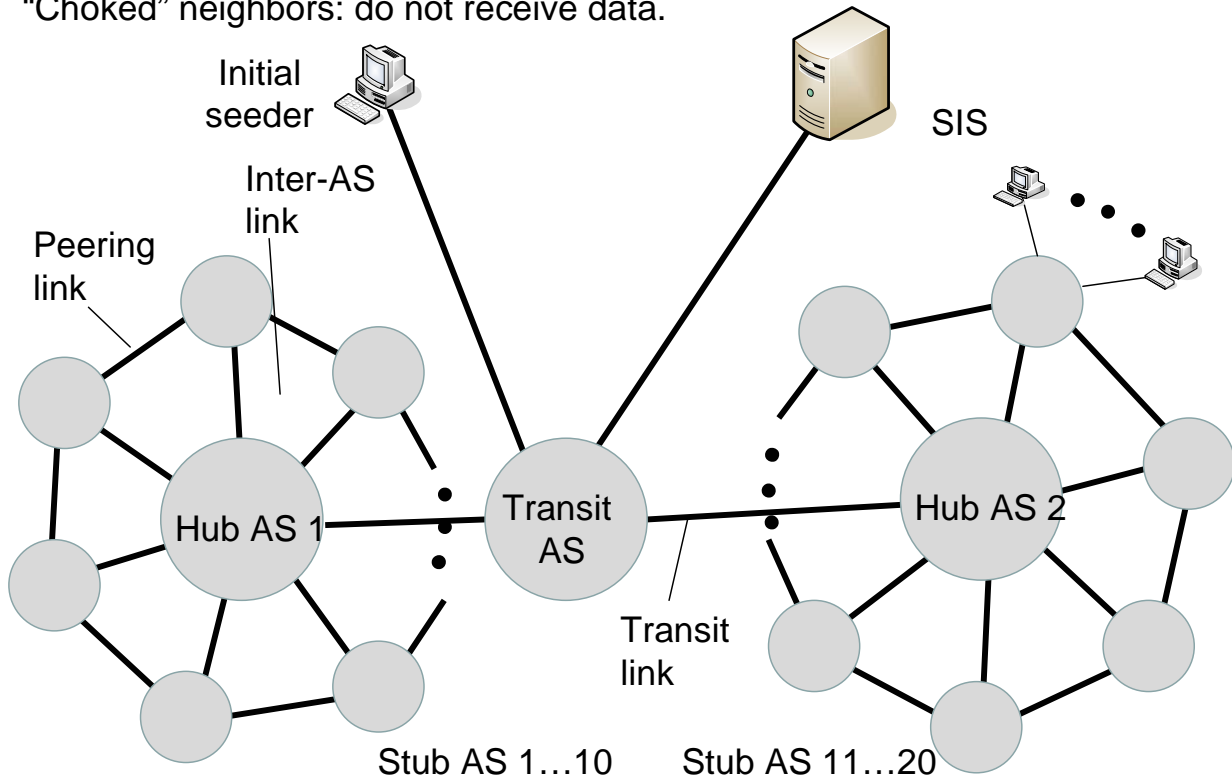


Simulative Evaluation of Locality-aware Peer Behaviors



Simulated Network Topology

Allocate **upload capacity** to neighbors: “Unchoked” neighbors receive data or
 “Choked” neighbors: do not receive data.



Scenario Description

| | Mean Swarm Size | Overlay | Content Type | Total Seed Capacity |
|--------------------------|-----------------|---------|--------------|---------------------|
| General Parameter | 120-200 | Tribler | Simpsons | 3-2% |

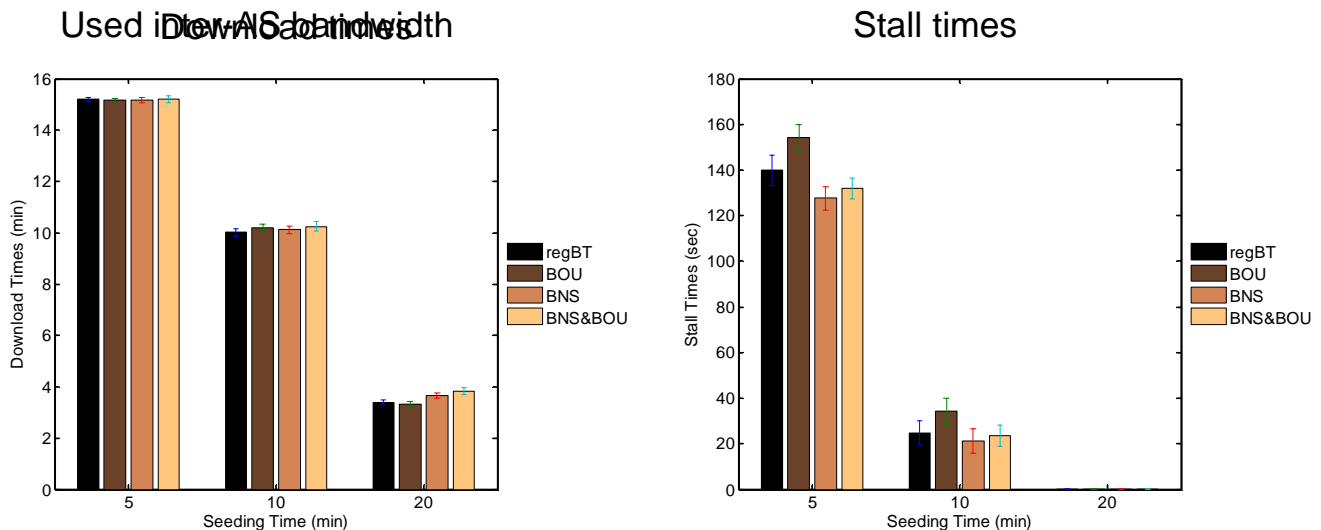
| | Type 1 ISP | Type 2 ISP |
|----------------------------------|------------|----------------------|
| Quantity | 3 | 20 |
| Tier | 1 | 2 |
| Relative Local Swarm Size | 0 | 1 |
| Relative Seed Share | 0,0,1 | 0 |
| Swarm/Peer behavior | - | Steady Swarm/Leecher |
| Category | - | Top Quality |
| Percentage of SIS Usage | - | 100% |



Experiment 1: Load

- Load: fraction of leechers in swarm
- Influenced by **seeding time** (after download)
- ⇒ Small load makes BOU less effective
- ⇒ (Slight) Effect of BOU on stalling times

Regular BitTorrent
Biased Neighbor Selection
Unchoking
Combination



Brief Discussion

- Effects on traffic: **reduction**
 - Combination of BNS and BUO performs best in homogeneous scenarios traffic-wise
 - Especially normal inter-AS traffic and transit traffic is reduced
- Effects on stall times: **optimization and indifference**
 - Performance gain for the end user only in scenarios with network bottlenecks
 - BOU alone even has a slightly negative impact on stall times in the access bottleneck scenarios



Summary and Conclusions



Summary and Conclusions

- ❑ Dedicated **management of overlay traffic** is necessary
 - Due to smoothing needs of large amounts of overlay traffic
 - Due to the minimization of high(er) costs for ISPs
- ❑ Detailed **requirements analysis** undertaken
- ❑ SmoothIT **architectural design** in final steps
 - **SmoothIT Information Service (SIS)**
 - Optional deployment in ISP networks
 - Providing information to overlay applications
 - Optimizing traffic and achieving the TripleWin situation
- ❑ Prototypical SIS **implementation** undertaken
- ❑ First implementation and simulative **evaluations** in place
 - Beneficial SIS views on locality for certain scenarios
- ❑ SmoothIT transfers work into **ALTO** (2 drafts) and covers socio-economic aspects of overlay communications



Thank you for your attention!

Thanks to all SmoothIT's project partners:

UZH, DOCOMO, TUD, AUEB, PrimeTel, AGH, ICOM, UniWue, TID

