Università degli Studi di Napoli Federico II

Overlay/Underlay Routing Issues in Wireless Mesh Networks

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CONTENT: Workshop Video Streaming over MANETs

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COMICS RESEARCH UNIT

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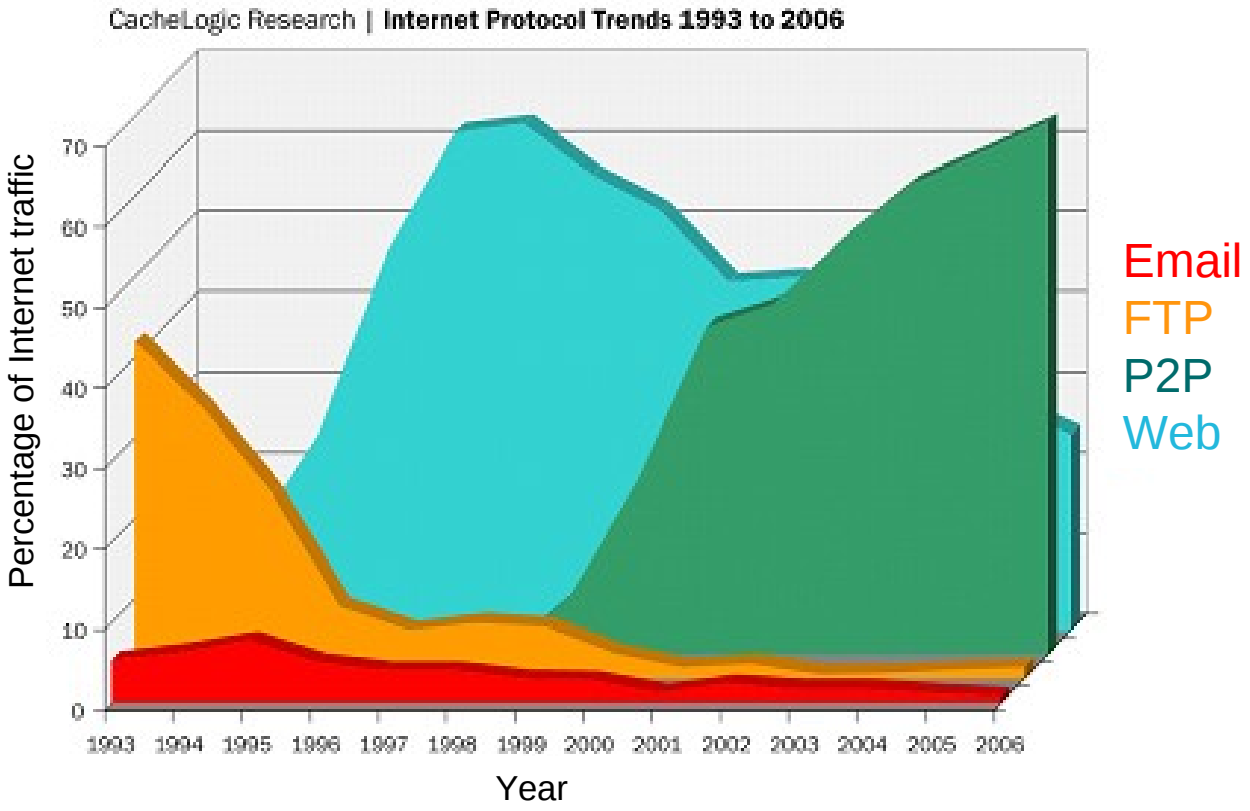
P2P traffic control and management

More than 50% of Internet traffic is generated by P2P applications

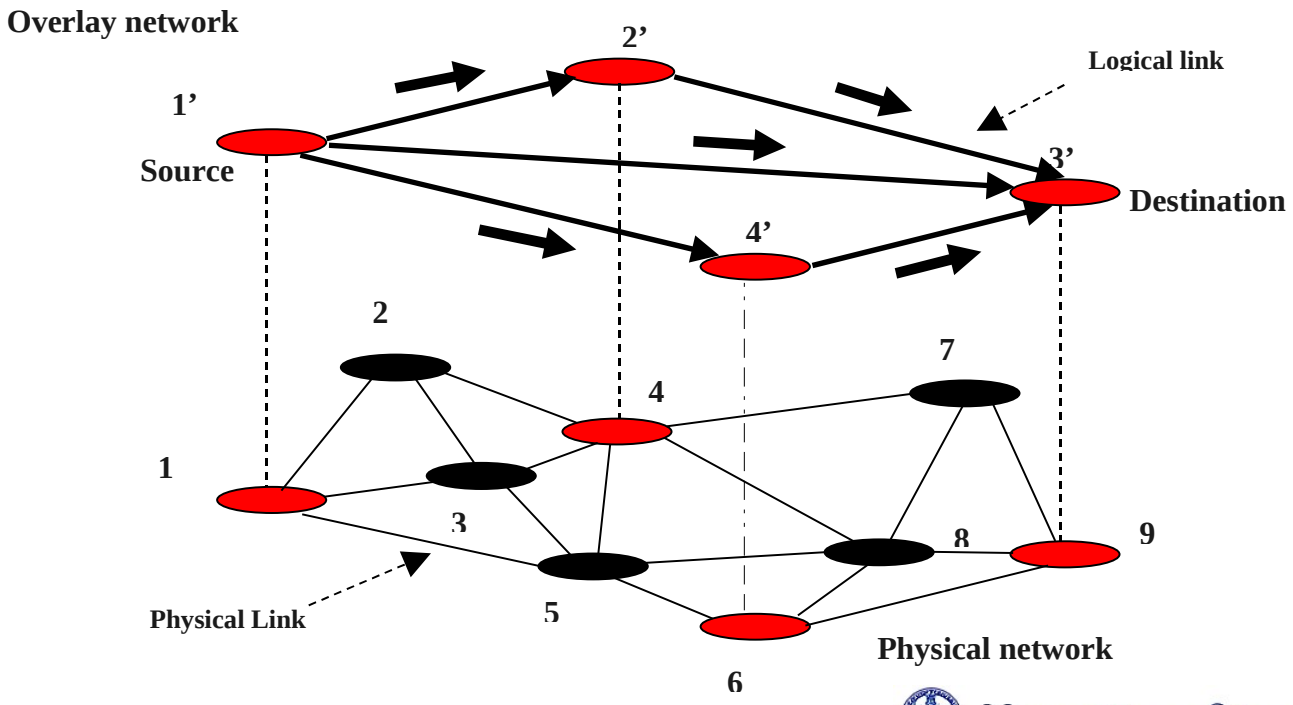


The need for overlay networks

P2P applications create overlay networks in order to:

- Provide services like file sharing and video streaming

Overlay networks are unaware of the underlay topology



Overlay/Underlay Routing Instability

Overlay routing goals:

- High bandwidth for file transfer
- End-to-end latency optimization

Underlay routing goals:

- Network domain load balancing
- Minimization of link utilization and inter-AS traffic

Duplication of routing functionalities and collision in optimization objectives lead to

ROUTE INSTABILITY

Overlay/Underlay Inefficiency

- ISPs are unable to perform an efficient traffic engineering due to the inability to control traffic and to influence the peer selection mechanism

- Overlay are not able to build an optimal topology, since they ignore physical topology

- Overlay networks indipendently perform network metrics measurements

Overlay/Underlay cooperation: The Oracle

The Oracle is a service supplied by the ISP to the overlay P2P users:

- Information is provided, like link delay, bandwidth estimations, etc.
- As input, a list of P2P nodes sharing a known content is given and the list of nodes ranked according to different performance metrics is returned
- P2P applications will not have to perform such measurements by themselves
- The Oracle gives ISPs a way to control overlay routing
- Underlay to overlay information exchange improves overlay operations and underlay network usage

V. Aggarwal, A. Feldmann, C. Scheideler, *Can ISPs and P2P systems co-operate for improved performance?*. In ACM SIGCOMM Computer Communications Review (CCR), 37:3, pp. 29-40, July 2007

Overlay/Underlay cooperation: The Oracle

Open issues:

- Metric definition
- Communication and coordination between different ISP is needed for optimal inter-AS paths
- Impact on topology creation
- Architectural structure definition

V. Aggarwal, A. Feldmann, C. Scheideler, *Can ISPs and P2P systems co-operate for improved performance?*. In ACM SIGCOMM Computer Communications Review (CCR), 37:3, pp. 29-40, July 2007

Overlay/Underlay cooperation:

ALTO Working Group

Application Layer Traffic Optimization

Motivation:

- Standardize information exchange between applications and ISPs in order to help in peer selection

Objective:

- Optimize performance in the application while minimizing resource consumption in the underlaying network infrastructure
- Avoid overlay nodes overhead traffic due to independent performance sensing operations

http://www.ietf.org/html.charters/alto-charter.html

Overlay/Underlay cooperation:

ALTO Working Group

Possible rating criteria:

- Topological distance, e.g., AS hop count, or whether peer is reachable via its own network
- Expected cost for data transport

Criteria that should not be used:

- Performance metrics related to instantaneous congestion status

http://www.ietf.org/html.charters/alto-charter.html

Overlay/Underlay cooperation: P4P Working Group

Provider Portal for Applications

Framework:

- Cooperative traffic control between application and underlying network
- Explicit cooperation between P2P and ISP
- Several interfaces provided to networks in order to communicate with applications regarding:
  - Network capabilities
  - Distances between nodes in terms of provider policy and network status

H. Xie, R. Yang, A. Krishnamurthy, Y. Liu, A. Silberschatz, *P4P: Provider Portal for Applications.* ACM SIGCOMM Computer Communications Review (CCR), 38:4, pp. 351-362, October 2008

Overlay/Underlay cooperation:
P4P Working Group

Core Group	Observers
▪ AT&T ▪ Bezeq International ▪ BitTorrent ▪ Velocix ▪ Cisco Systems ▪ Grid Networks ▪ Joost ▪ Limewire ▪ Manatt ▪ Oversi ▪ Pando Networks ▪ PeerApp ▪ Telefonica Group ▪ Verisign ▪ Verizon ▪ Vuze ▪ Washington University ▪ Yale University	▪ Abacast ▪ AHT International ▪ Alcatel Lucent ▪ CableLabs ▪ Cablevision ▪ Comcast ▪ Cox Communications ▪ Juniper Networks ▪ Microsoft ▪ MPAA ▪ NBC Universal ▪ Nokia ▪ RawFlow ▪ Solid State Networks ▪ Thomson ▪ Time Warner Cable ▪ Turner Broadcasting

http://www.pandonetworks.com/p4p

Underlay layer

Wireless Mesh Networks

Wireless Mesh Networks:

- Absence of wired infrastructure, exception made for Internet gateways
- Easy deployment

Frequency sharing leads to communication interference:

- Multi-radios are needed to alleviate the problem
- Multi-channel assignment involving each radio on each node

Why is Overlay/Underlay cooperation more critical in WMNs?

Overlay nodes generate probe messages:

- Overhead traffic is more critical due to interference

Overlay network topology criticality:

- Presence of Internet gateways represents strong bottleneck

WMN network optimization strictly dependent on traffic profile:

- Otherwise poor usage of resources and lower throughput

A new approach:

Bidirectional Crosslayering

Overlay applications get information from the underlay network:

- ISPs are the only knowledgeable sources of information about underlay networks
- Help in topology creation
- AS bounds respected
- Decrease in overlay sensing overhead traffic

Underlay routing gets information from the applications:

- Channel assignment optimization
- Throughput improvements all over the WMN

Crosslayer information flow in Wireless Mesh Networks

For WMN, Oracle-like strategies may not be sufficient:

- WMN configuration is sensible to traffic demands
- Poor performance may be obtained if channel assignment configuration is static and it is not adapted to the new traffic flows
- A new architecture is needed

Overlay/underlay optimization for Wireless Mesh Networks

Possible solutions to apply Oracle-like strategies to WMN:

- P2P applications should send list of neighbors to WMN routers TOGETHER with information about bandwidth requirements
- Mesh routers analyze the overlay requirements and, based on the underlay network situation, can:
  - Dinamically reassign channel
  - Sort the overlay neighbor list and send it back to the overlay user

Result:

- Overlay and Underlay networks optimization

Overlay/underlay optimization for Wireless Mesh Networks

Research directions:

Architectural design of the new crosslayer structure

- Communication between application layer and underlying wireless network
- How to and where to deploy the overlay/underlay “oracle” functionalities
- Parameters have to be defined in order to rank the list

Overlay/underlay optimization for Wireless Mesh Networks

Research directions:

- The underlaying network reconfiguration phase should take into consideration the following parameters:
  - The churn activity of P2P users, through statistical modelling and measurements
  - Underlying network degree of optimization after the possible reoptimization should be predicted
  - Based on the P2P churn past history and possible underlay performance improvements, underlay reconfiguration is taken into consideration:
    - If traffic variation is high, total reconfiguration may be considered
    - For low traffic variation just forwarding paradigm reconfiguration may be considered

Overlay/underlay optimization for Wireless Mesh Networks

Research directions:

Wireless Mesh Network routing protocol:

- should consider the bandwidth available on every link as a result of the computed channel assignment
- should be robust to minor variations in the traffic offered to the network, in order to maintain the network performance at an acceptable level
- should be able to rapidly react to temporary link unavailability or quality degradation, which may often occur in wireless environments

Overlay/underlay optimization for Wireless Mesh Networks

Research directions:

- Introduce new metrics to describe as close as possible the P2P user traffic demand
- Study new churn models in order to “predict” the ephemeral network reconfigurations
- Study the feasability of dynamic channel allocation, characterizing the time constant
- Simulation and realistic testbed implementation

Conclusions

Overlay/Underlay interaction is critical:

- Oracle-like solutions are proposed
- The problem is under consideration and Working Groups have been formed

Overlay/Underlay interaction in Wireless Mesh Networks:

- Interaction is even more critical and Oracle-like solutions are not sufficient
- A new architecture is needed:
  - Applications and mesh routers have to continuously exchange information between each other
  - WMN have to reconfigure themselves in order to adapt to new traffic demands

Thank You

Questions?