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Analyzing Traffic across the Greek School Network

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Introduction

- Internet is growing dramatically.
- Very complex patterns to model the Network Traffic.
- Studies in LAN and WAN have been made since the early 80s.
- Today's findings lead us to the conclusion that
  - Ethernet traffic is statistically self-similar
  - Poisson assumption is valid in special cases
- Recent studies on Peer-to-Peer traffic mainly by Karagiannis et. al have been made.

Introduction

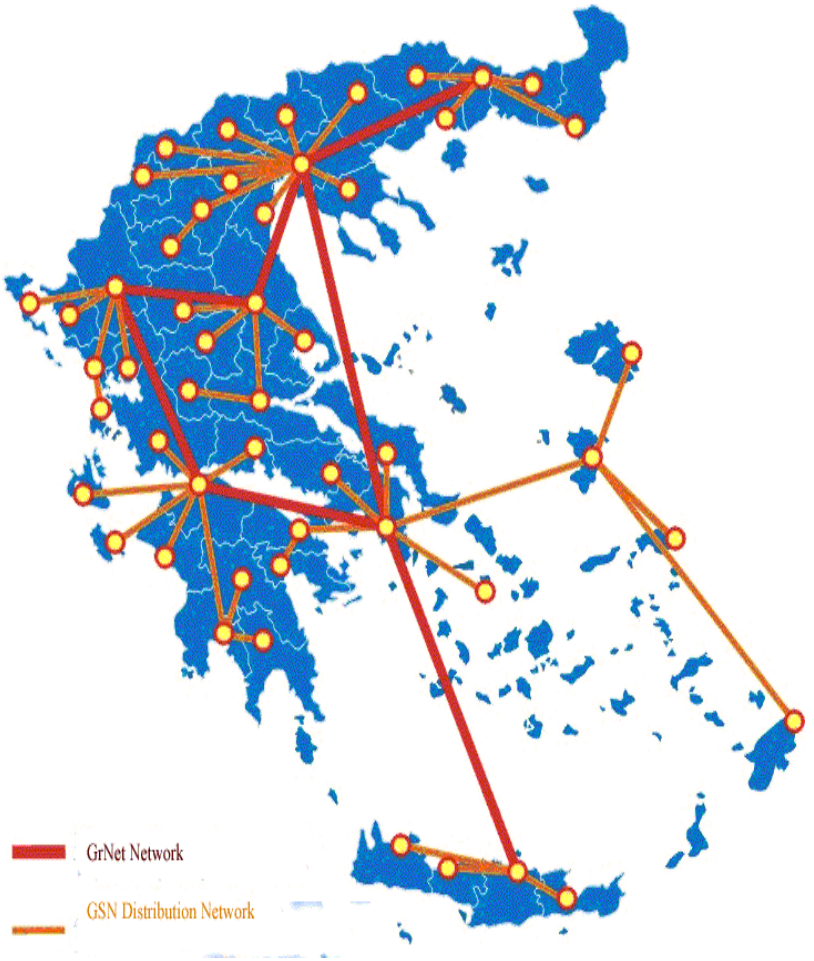
- In this paper we present a study of traffic patterns on the Greek School Network
- We studied in the monitored network
  - the behavior of flows
  - the behavior of the packets
  - the use of each protocol
  - the use of each well known application
  - The use of Peer-to-Peer services
  - The traffic locality phenomenon
- Benefits
  - Understand the impact of network changes and services
  - Improve network usage and application performance
  - Reduce IP service and application costs
  - Optimize network costs
  - Understand the Impact of P2P applications
  - Background to the administrators for
    - dimensioning the network
    - congestion control
    - network management

Overview

- Network Architecture
- Measurement Methodology
- Traffic Statistics
  - Service Analysis
  - Protocol Analysis
  - Flow Analysis
  - Packet Size Analysis
- Traffic locality
- Peer-to-Peer Services
- Conclusions

Greek School Network Architecture

- Nationwide network that spans across Greece. Connects all schools of primary and secondary education including administrator offices.
- Hierarchically structured into three layers.
  - The Backbone network
  - The Distribution Network
  - The Access Network



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Measurement Methodology

- All the measurements took place in the PATRAS prefecture from October 24 00:00:00 GMT+02:00 2004 to March 18 23:30:00 GMT+02:00 2005.

- Monitoring System
  - Cisco NetFlow
    - In terms of NetFlow, flow is defined by Seven Unique Keys:
      - source IP address
      - destination IP address
      - source port number
      - destination port number
      - layer 3 protocol type
      - TOS (Type Of Service) byte and
      - Input logical interface
  - FlowScan
  - cflowd
  - RRDtool

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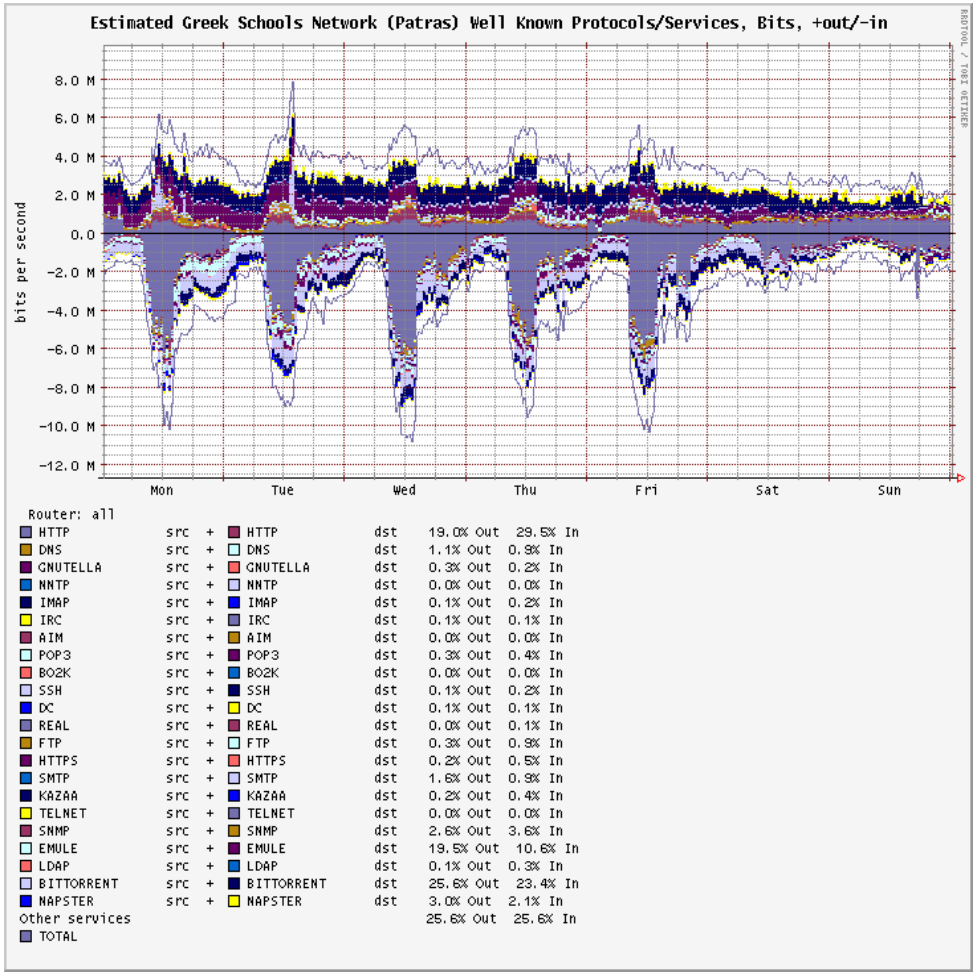
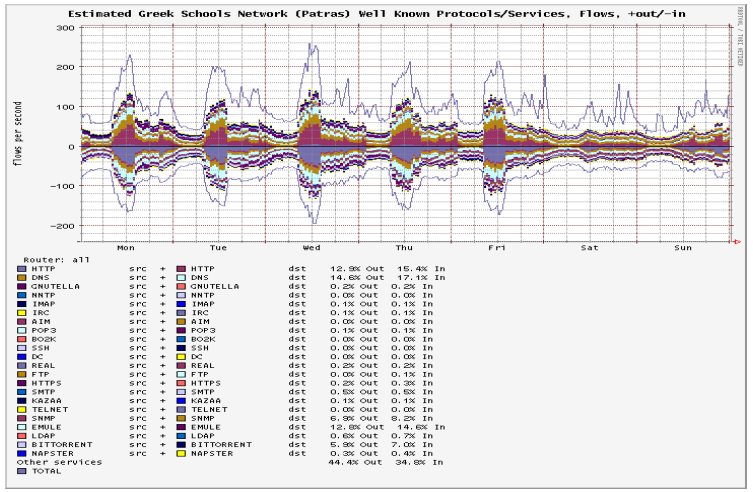
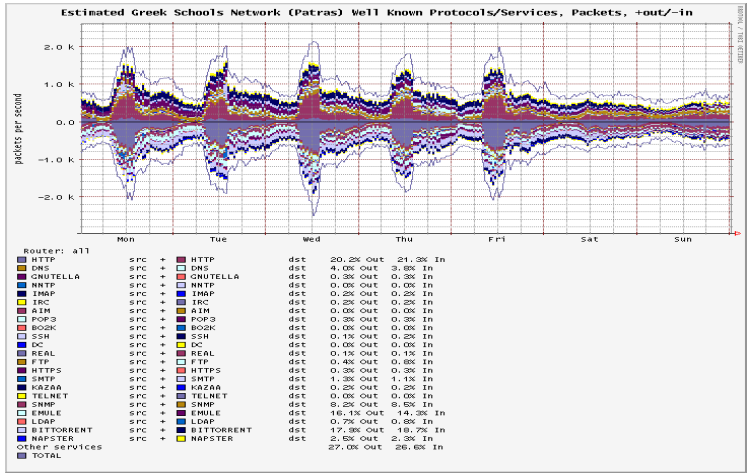
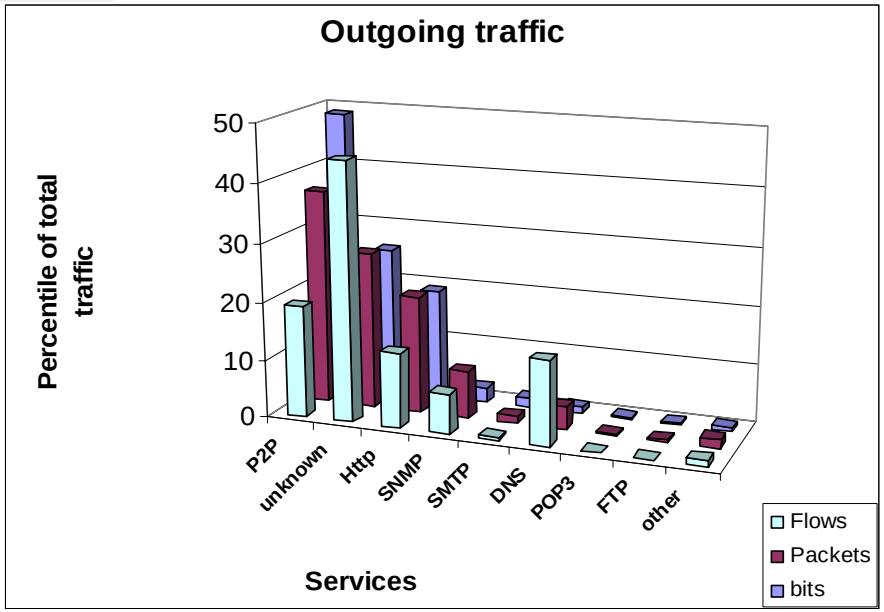
Traffic Statistics - Services

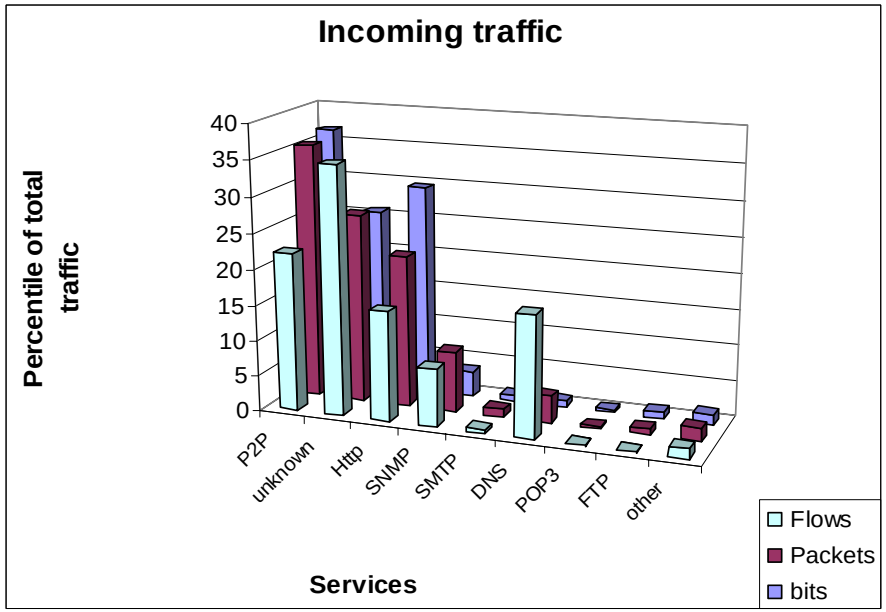






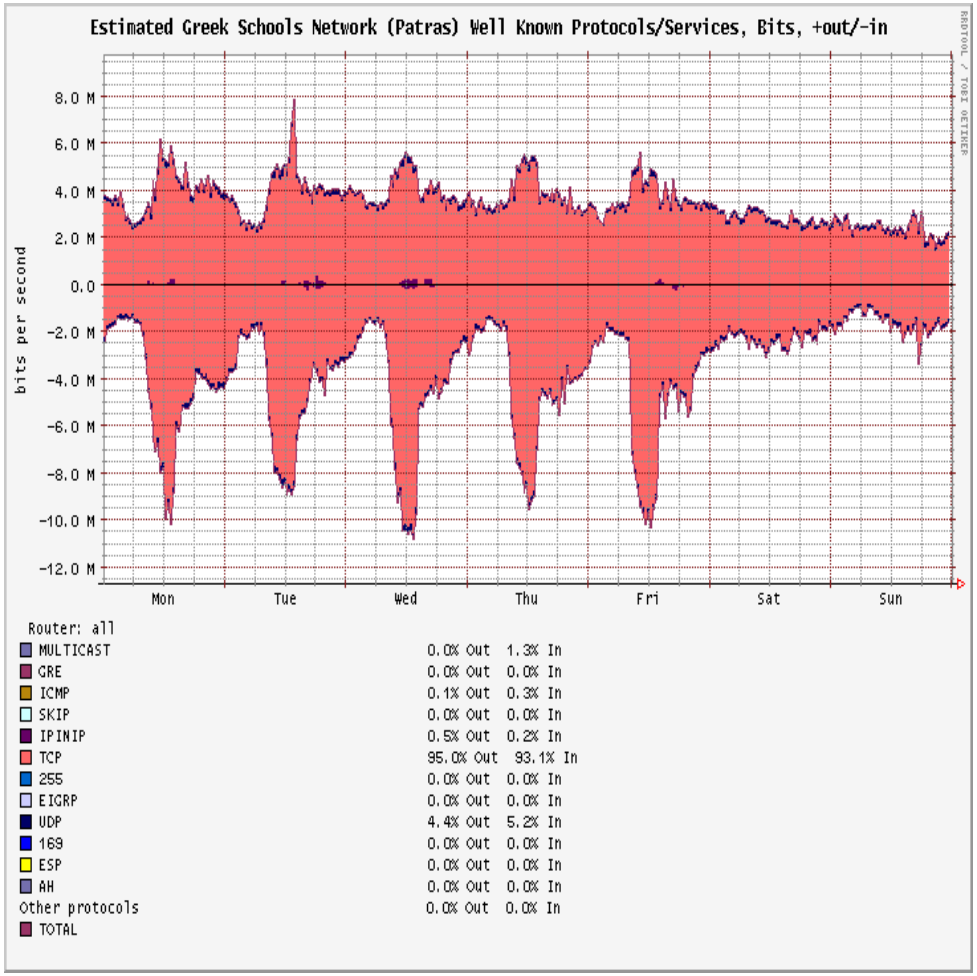
Traffic Statistics - Services

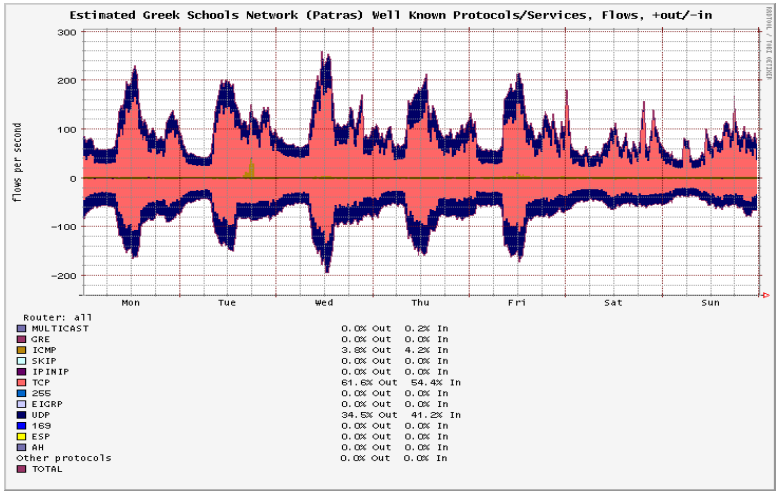


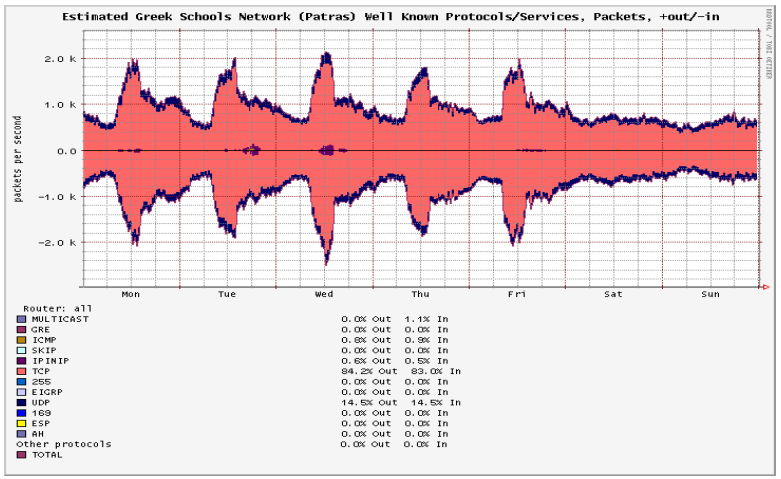


- Outgoing traffic in term of bytes
  - 50% is P2P
  - 19% is HTTP
  - 25.6% is unknown
- Incoming traffic in term of bytes
  - 37% is P2P
  - 30% is HTTP
  - 25.6% is unknown
- DNS and SNMP use UDP
  - Large fraction of the flows, small fraction of the packets and an even smaller fraction of the bytes transferred
- HTTP (web) application
  - The profile of its daily load distribution fits closely the corresponding profile of the TCP protocol.

Traffic Statistics - Protocols







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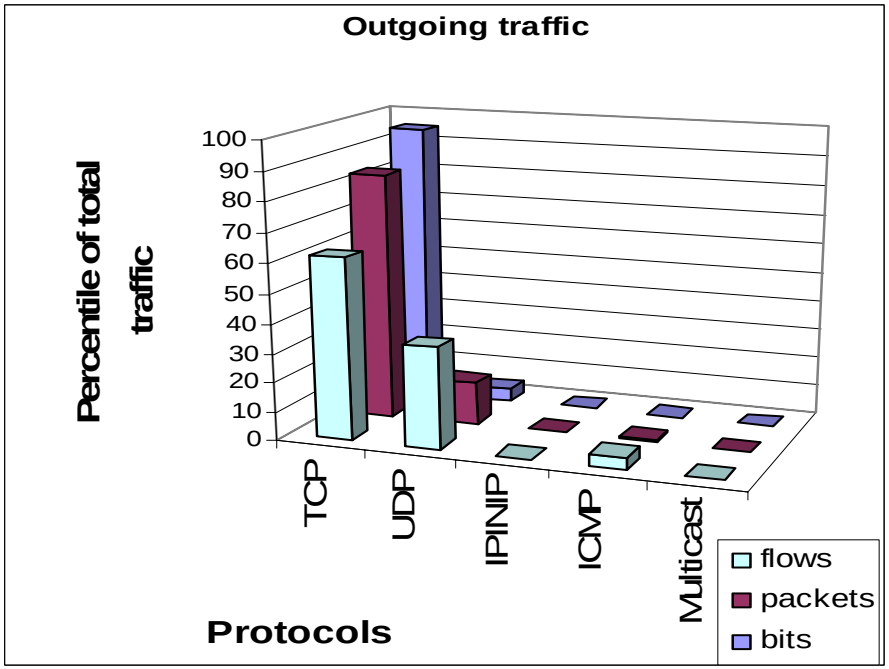
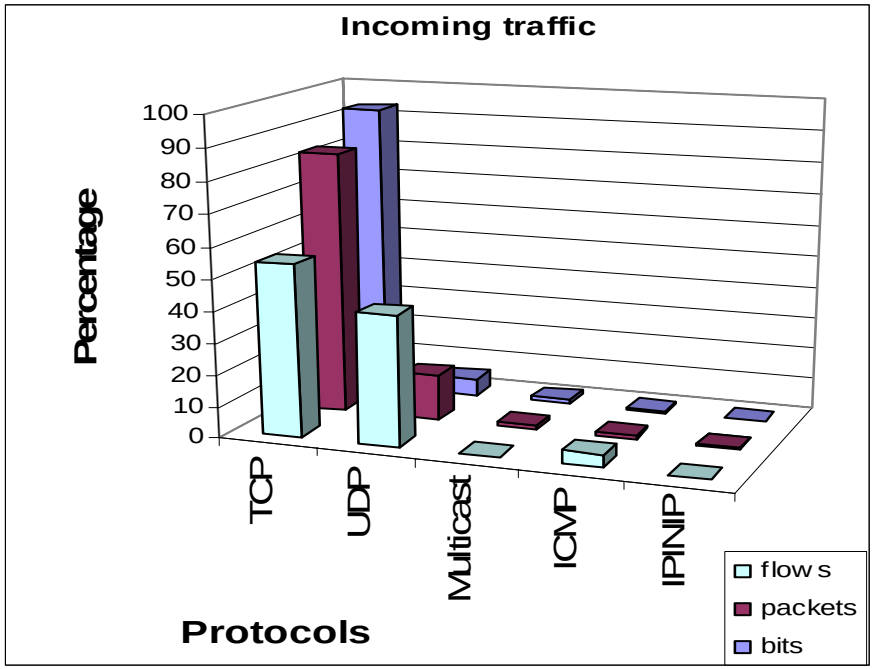


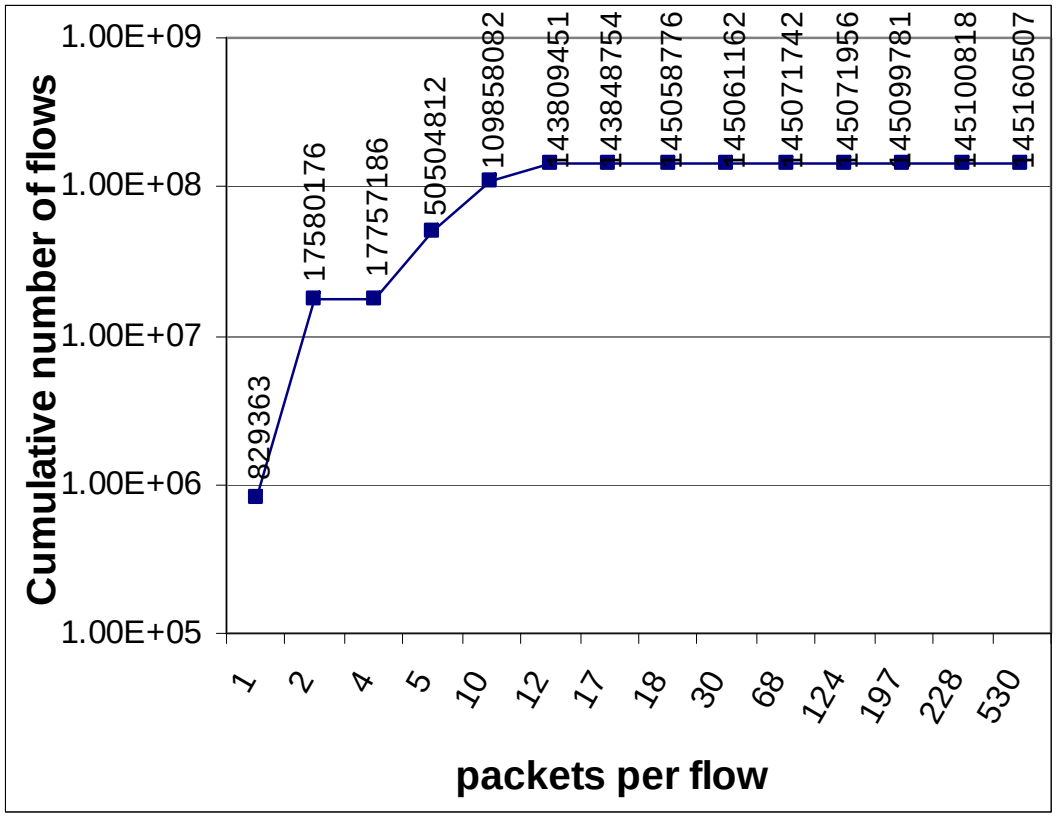


	Outgoing traffic			Incoming traffic		
Protocols	Bytes	Flows	Packets	Bytes	Flows	Packets
TCP	95%	61.6%	84,2%	93.1%	54.4%	83%
UDP	4,4	34,5	14,5	5,2	41,2	14,5

- The other IP protocols individually make up a negligible percentage of the overall traffic

- The size of the incoming packets is much larger than the size of the outgoing packets.
- TCP uses more and larger packets per flow than UDP

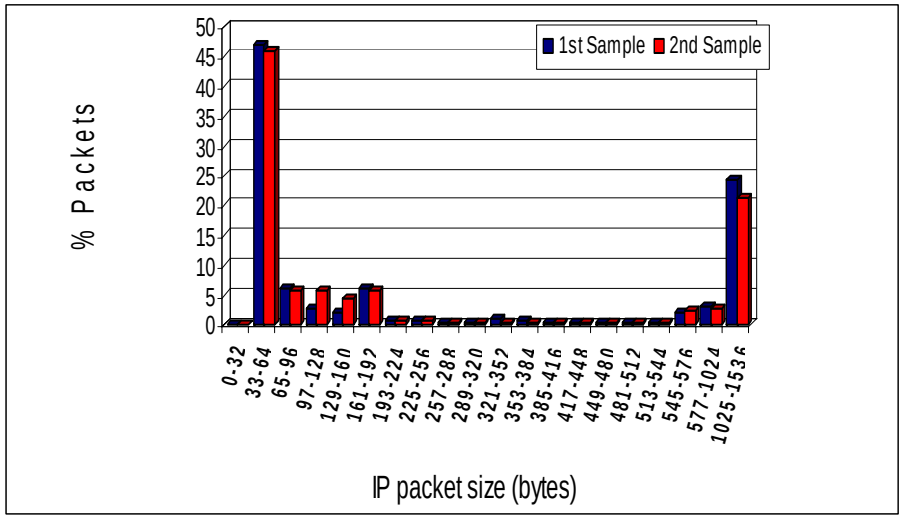
Traffic Statistics – Flow Analysis

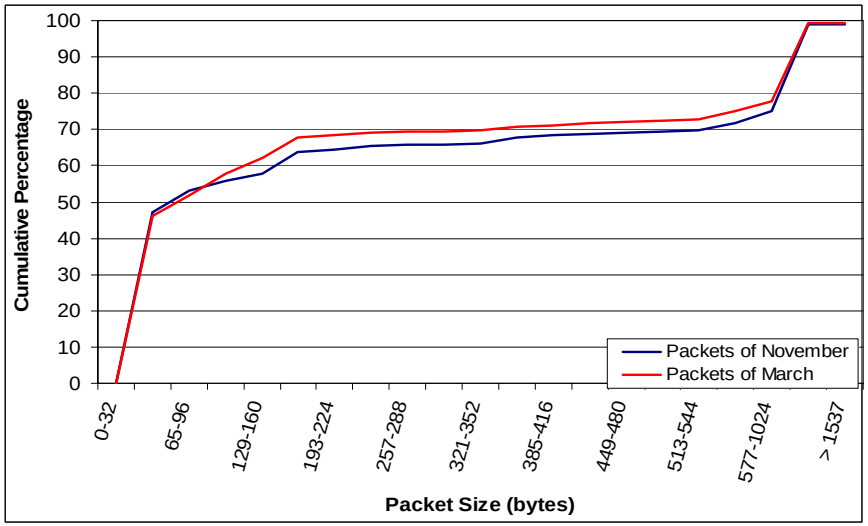


- 87% of the flows carry 5-12 packets
- The majority of the flows last 6 - 6.5 sec.
- Data transfers*
  - interactive: TCP-telnet, ICMP, UDP-NTP
  - transaction oriented: TCP-FTP, TCP-SMTP
  - bulk data transfer: TCP-FTPD, TCP-WWW

- A cross-check of the findings of k. Claffy et al. at “Traffic Characteristics of the T1 NSFNET Backbone”.

Traffic Statistics – Packet Size Analysis





- Dual-modal pattern
- Predominance of small-sized packets caused
  - by TCP control segments

  and
  - by HTTP application

- Large size packets caused
  - By Ethernet full size packets

  and
  - By p2p applications

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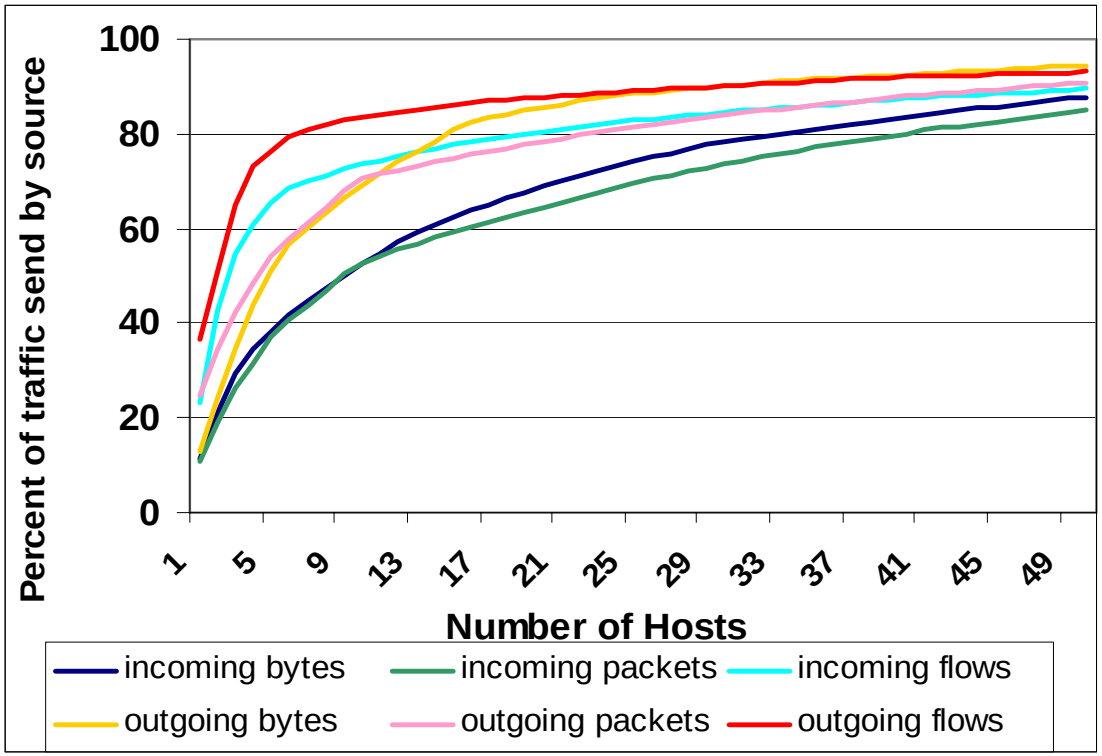
Traffic Statistics – Traffic Locality



- Outgoing traffic: The 50 most busy sources (of the 6188) in a 5-minute sample, are responsible for
  - 94.5% of the bytes
  - 93.1% of the flows
  - 90.9% of the packets.
- Incoming traffic: The same users:
  - 76.6% of the bytes
  - 77.5% of the flows
  - 52.5% of the packets.
- The same results were observed in the 250 minutes samples.

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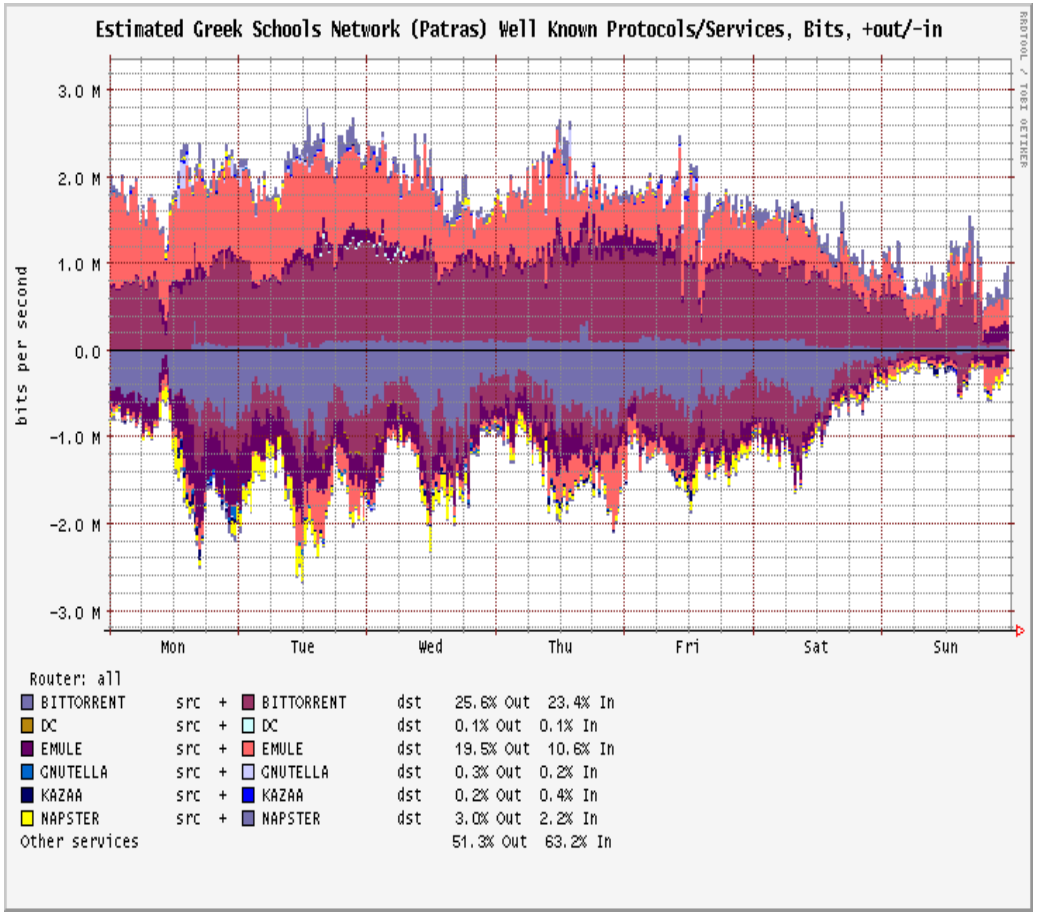
Peer-to-Peer Services

Protocol	outgoing traffic			incoming traffic		
	bits %	packets %	flows %	bits %	packets %	flows %
BitTorrent	25,6	17,9	5,9	23,3	18,7	7
eMule	19,5	16,1	12,8	10,6	14,3	14,6
Napster	3	2,5	0,3	2,2	2,3	0,4
Gnutella	0,3	0,3	0,2	0,2	0,3	0,2
Kazaa	0,2	0,2	0,1	0,4	0,2	0,1
Direct Connect	0,1	0	0	0,1	0	0
Total	48,7	37	19,3	36,8	35,8	22,3

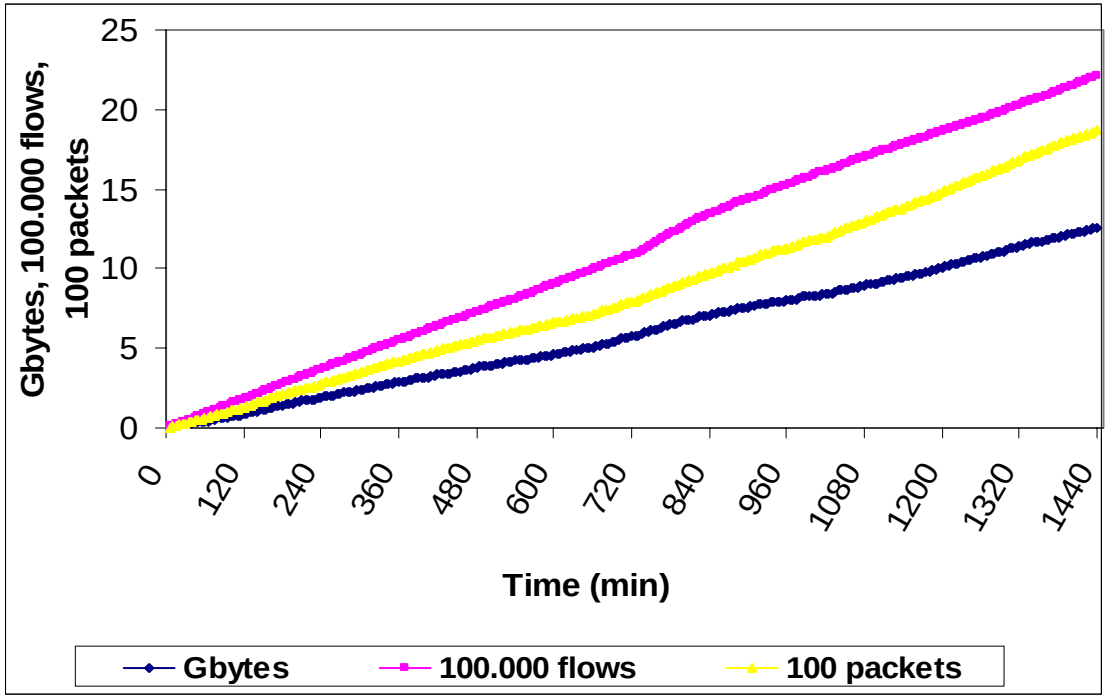
- Very Difficult to identify P2P traffic
  - The 3rd generation P2P systems use arbitrary ports for the P2P connections
- Still 25% of the traffic is unknown
- 32,3% - 48,7% of the outgoing and 14% - 39% of the incoming bytes are caused by P2P services

Peer-to-Peer Services



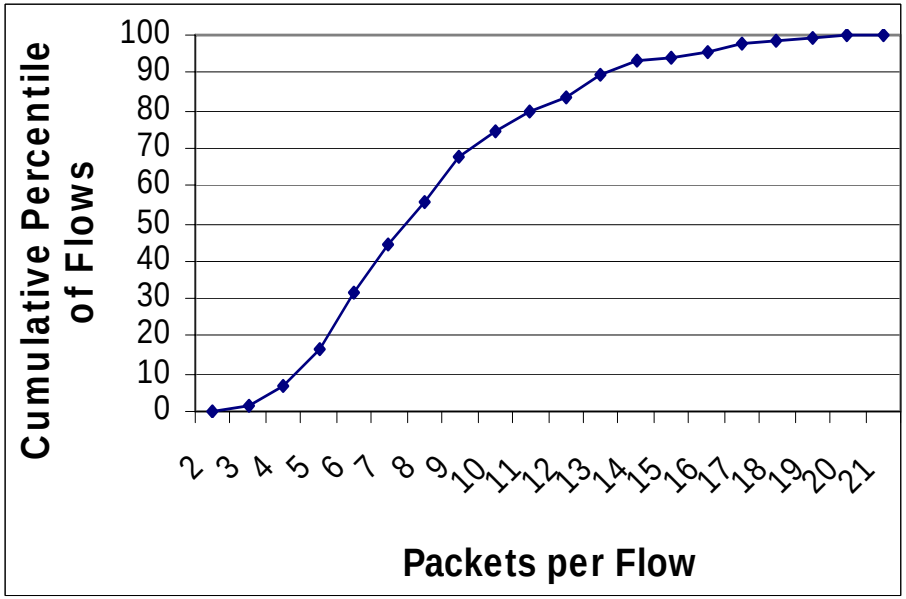
- P2P services are active 24 hours per day
  - + they do not follow the traffic pattern of the overall traffic
- Emule and BitTorrent were the two most prevalent protocols.
  - After 19/12/2004 the use of BitTorrent was reduced significantly because of the shut down of Suprnova.org

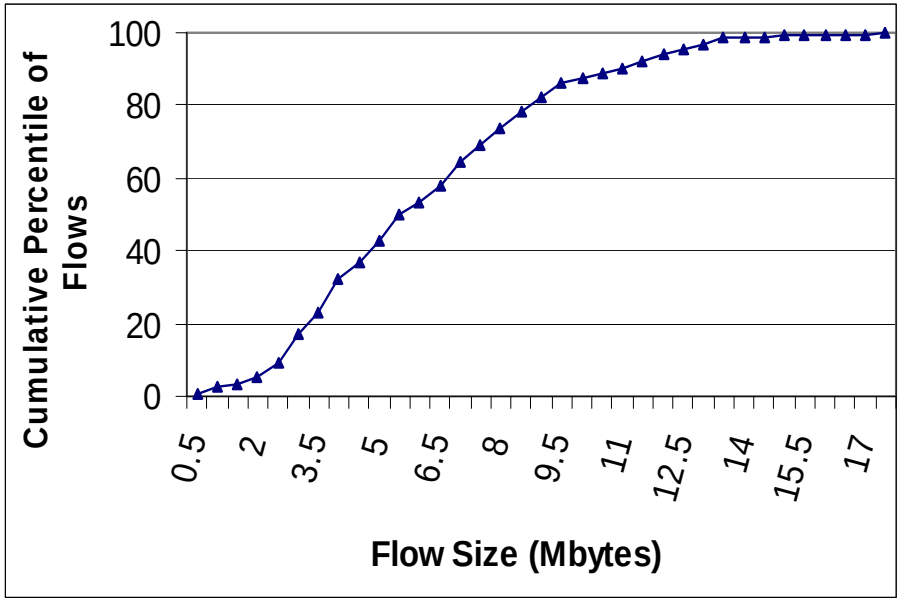
Peer-to-Peer Services



- The arrival rate remains relatively constant throughout the day.
- The same pattern on a weekly interval
  - A constant rate during the weekdays and a different rate (but constant again) during the weekends.

Peer-to-Peer Services





- The majority of P2P flows contain a relatively small number of packets.
- The average size of a P2P flow was 9 packets.
- P2P applications belong to the bulk data transfer-style applications.
- The mean P2P flow size is 6.1 Mbytes which is much bigger than the mean flow size of web traffic and other bulk data transfer services.

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Summary – Future Work

- The traffic has daily and weekly periodic components as well as a long-term trend
  - Non-stationary model
- The traffic is increasing in time
  - In 4.5 months 100% increment of traffic rate during the peak hours
- TCP by far dominates the network traffic.
- HTTP and P2P services are the most frequently used applications
  - have to be taken into account in a future network extension
  - Tools like FlowMonitor have to be implemented
- Strong traffic locality phenomenon. 1% of the sources correspond to 95% of the outgoing bytes.
- The majority of the flows last a few seconds and carry few packets
- Predominance of small packets
- Apply realistic models that captures all the trends of the traffic.

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Thank you!

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