Debugging end-to-end performance in commodity operating system

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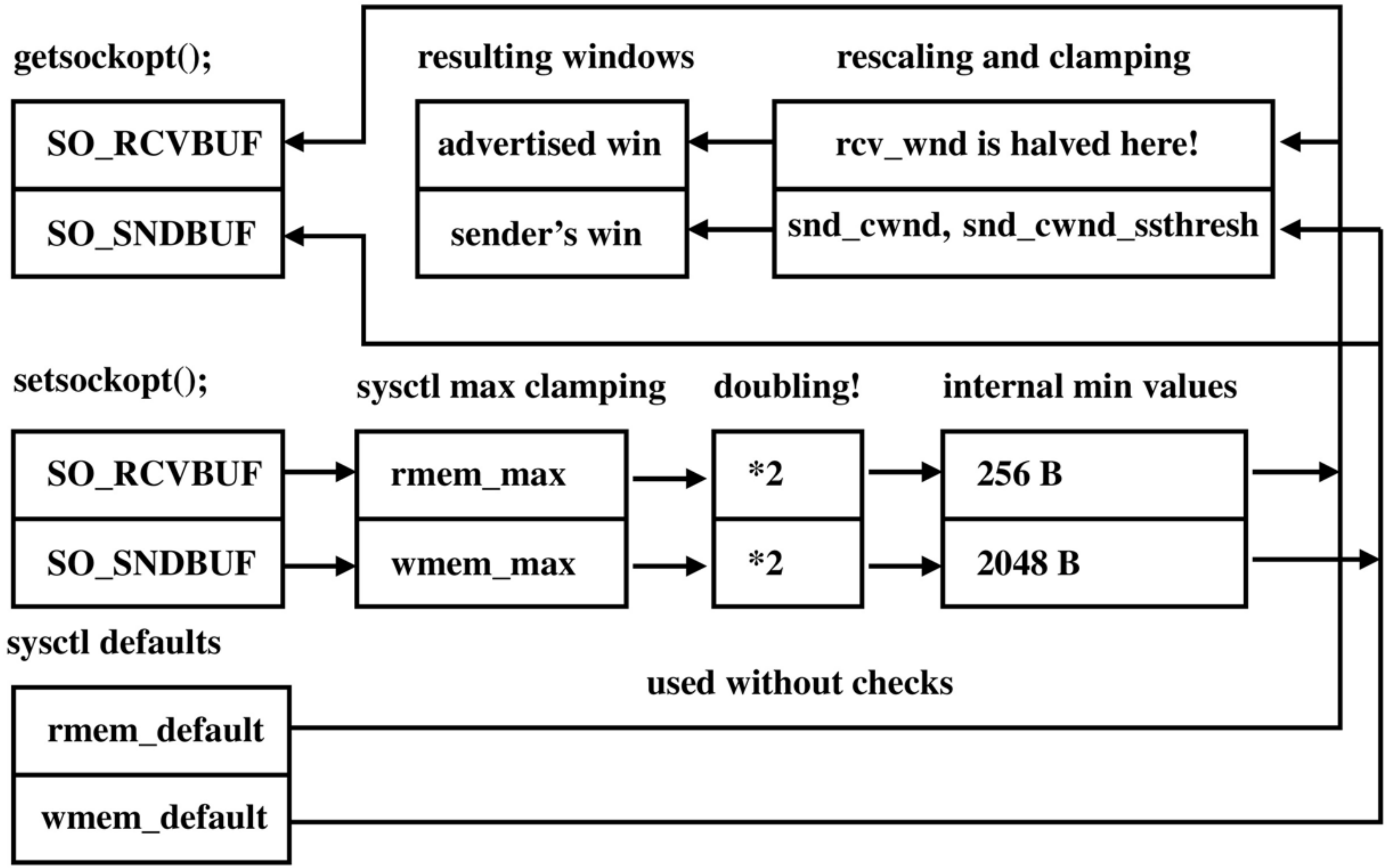
End-to-end performance

- Protective QoS -> proactive QoS
- Interaction of all computer system components (applications, operating system, network adapter, network)
- Decided to concentrate on E2E performance on Linux PCs
- Need to increase TCP windows, how much?
- What „autoconfiguration“ do we need?

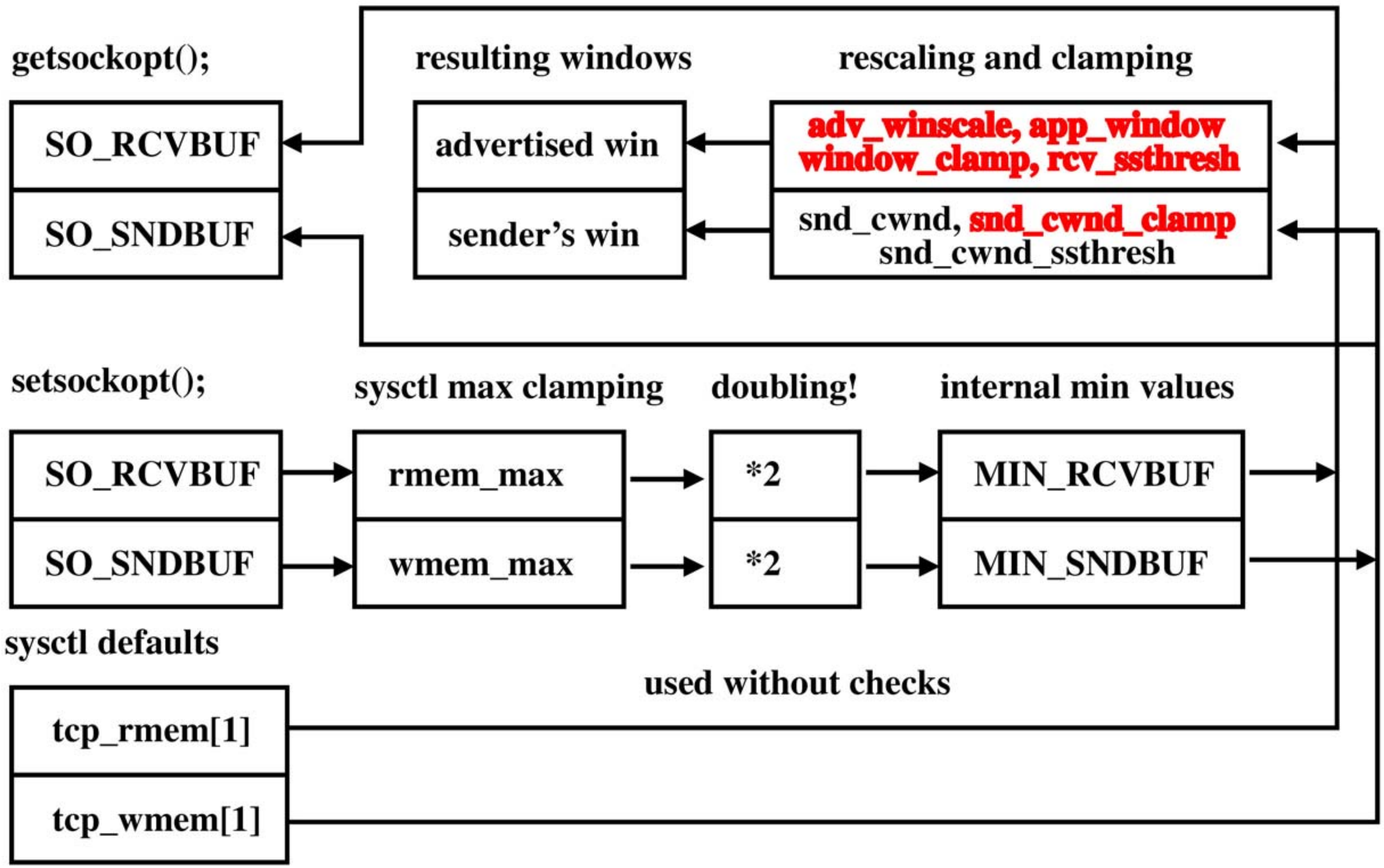
How big are my TCP windows?

Linux 2.2



How big are my TCP windows?

Linux 2.4



Is the bigger the better?

rwnd<=pipe capacity - bw=rwnd/rtt

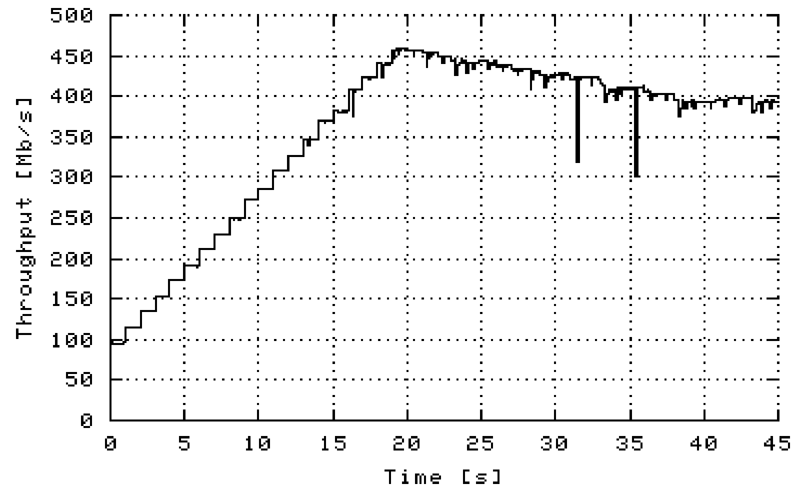
rwnd>pipe capacity - AIMD controlled, bw~(mss/rtt)*1/sqrt(p)

- Linux is not RFC standard slow start + congestion avoidance, includes a lot of modifications
- Interaction with network adapter must be considered
- TCP cache must be considered
- Router queues must be considered

Testing environment

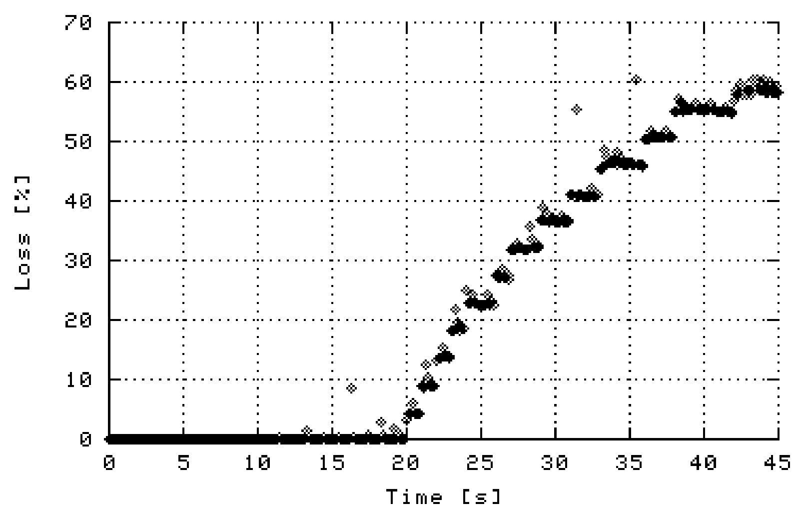
Cesnet (CZ) -> Uninett (NO)
12 hops, 1GE + OC-48, rtt=40 ms, wire pipe capacity<=5 MB
tcpdump on a mirrored port

pathload: 149 measurements
- 40 too low (50-70 Mb/s)
- 10 too high (1000 Mb/s)
- 99 realistic (750-850 Mb/s), but range sometimes too wide (150 Mb/s)



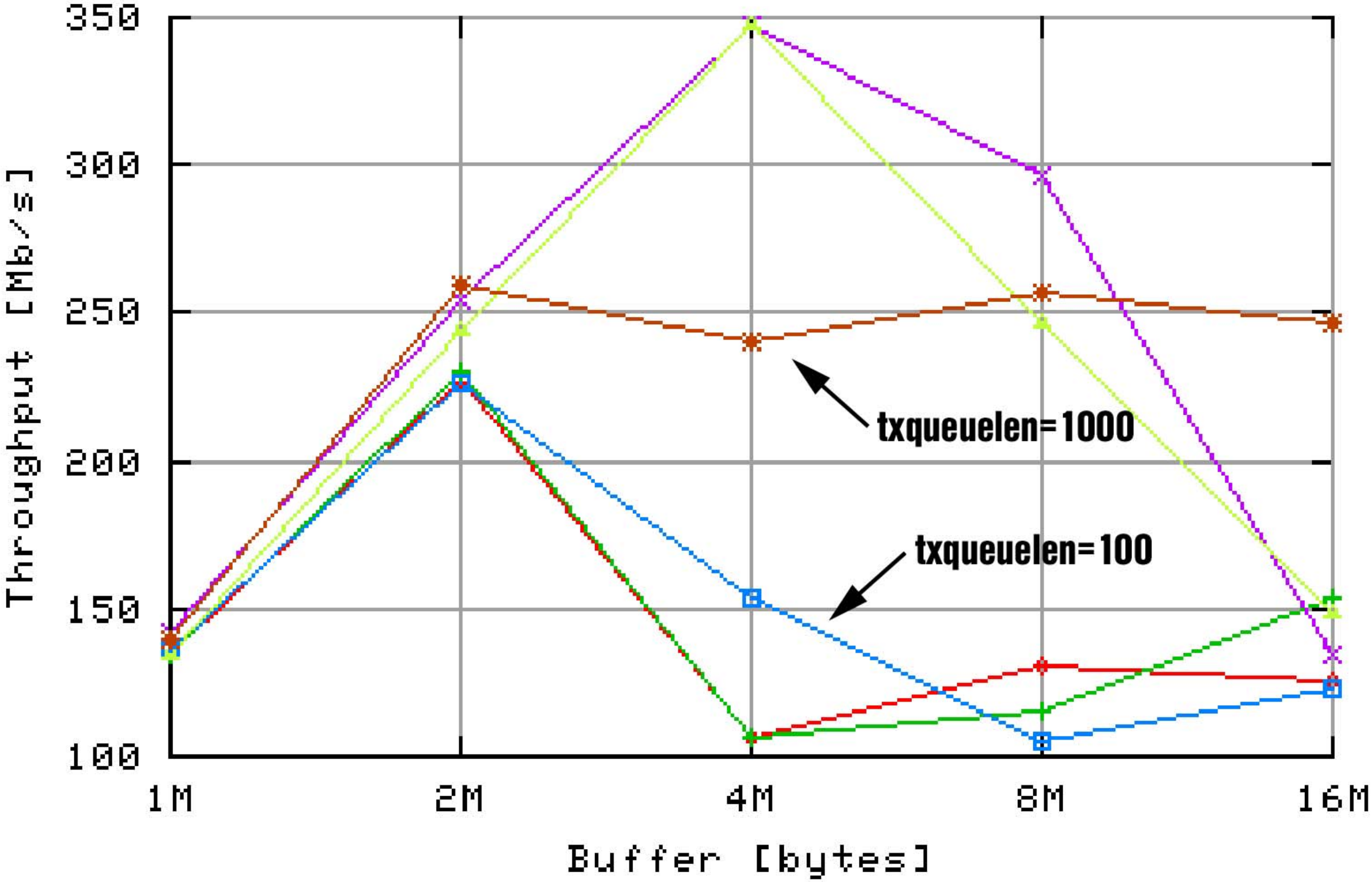
iperf: 50 measurements

1 MB	135 Mb/s
2 MB	227 Mb/s
4 MB	107 Mb/s
8 MB	131 Mb/s
16 MB	127 Mb/s



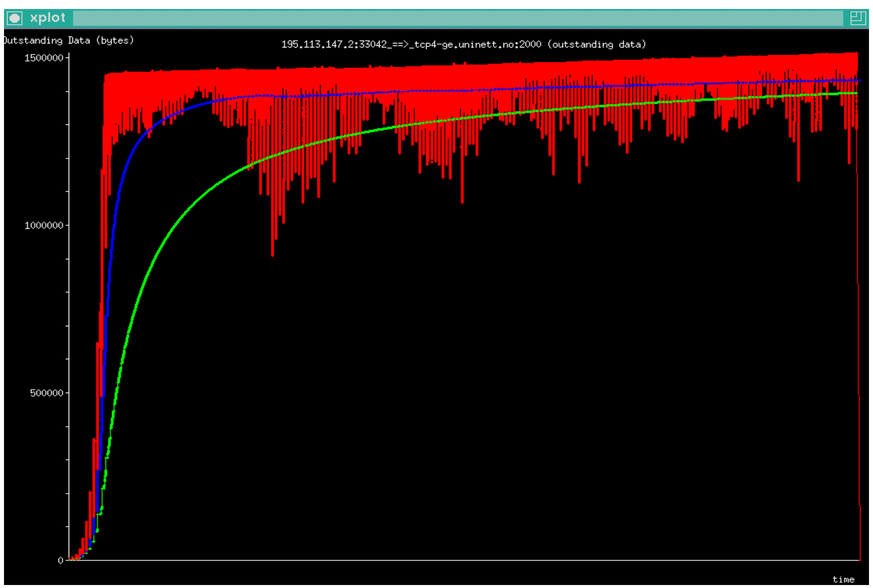
Gigabit interfaces and txqueuelen

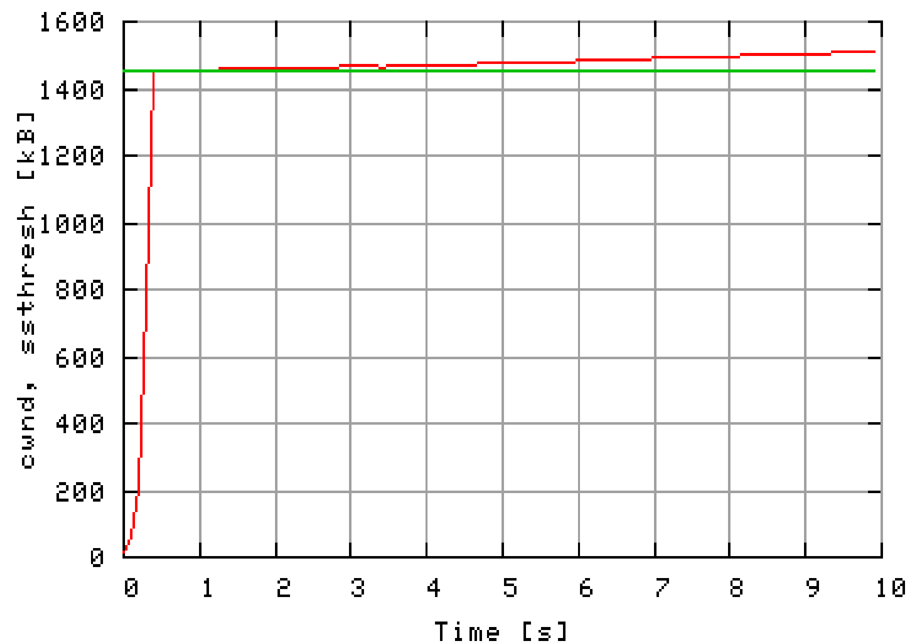
ifconfig eth0 txqueuelen 1000



TCP cache

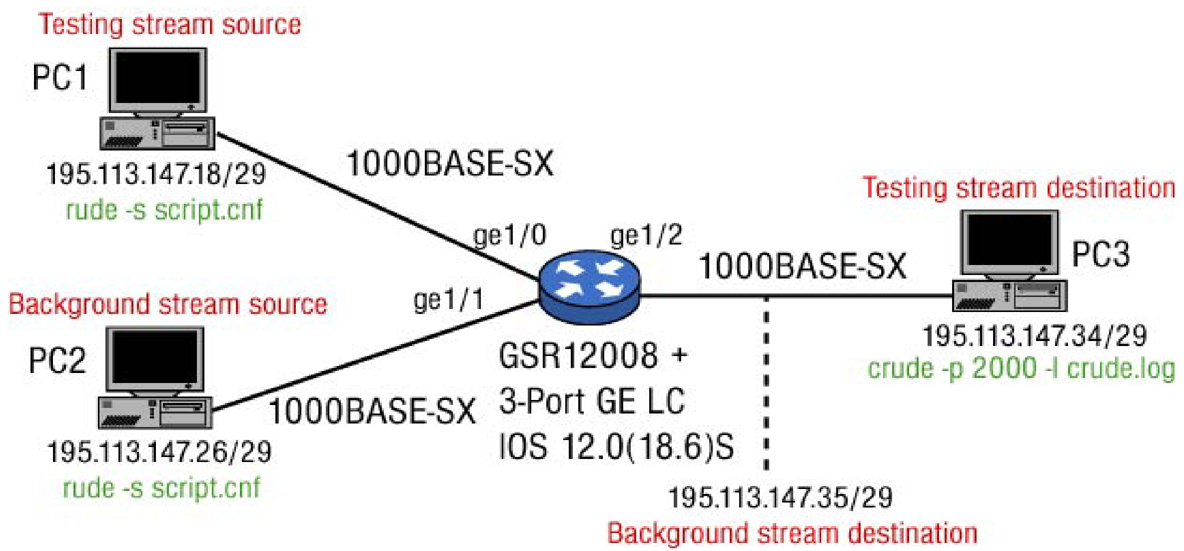
- initial ssthresh locked at 1.45 MB
- echo 1 > /proc/sys/net/ipv4/route/flush

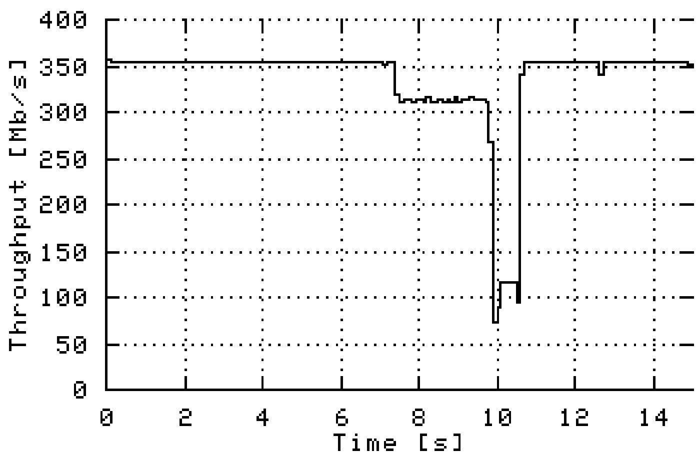


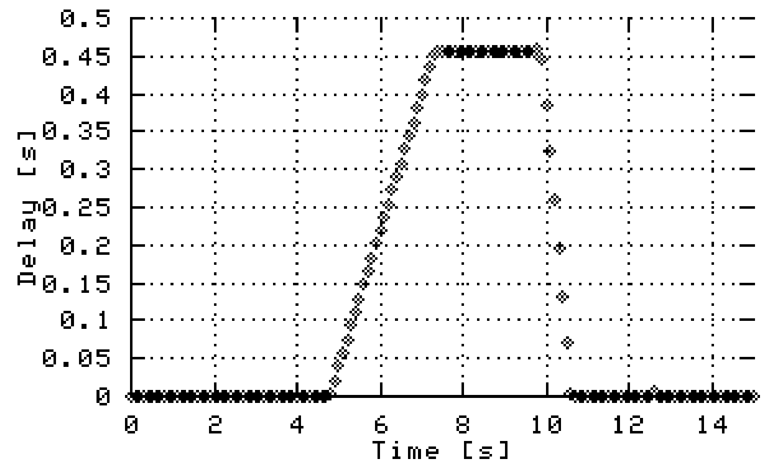


What is the right "pipe capacity"

Gigabit routers have very big buffers



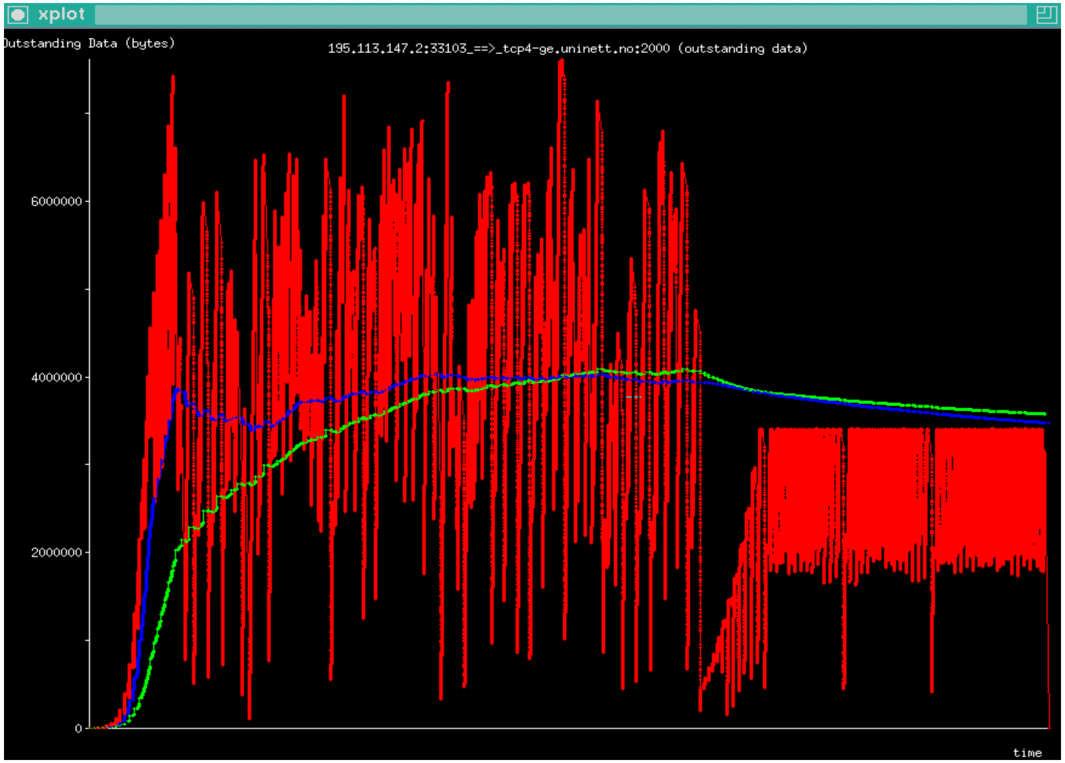




150 Mb/s overload buffered for 2 s => buffer=37.5 MB

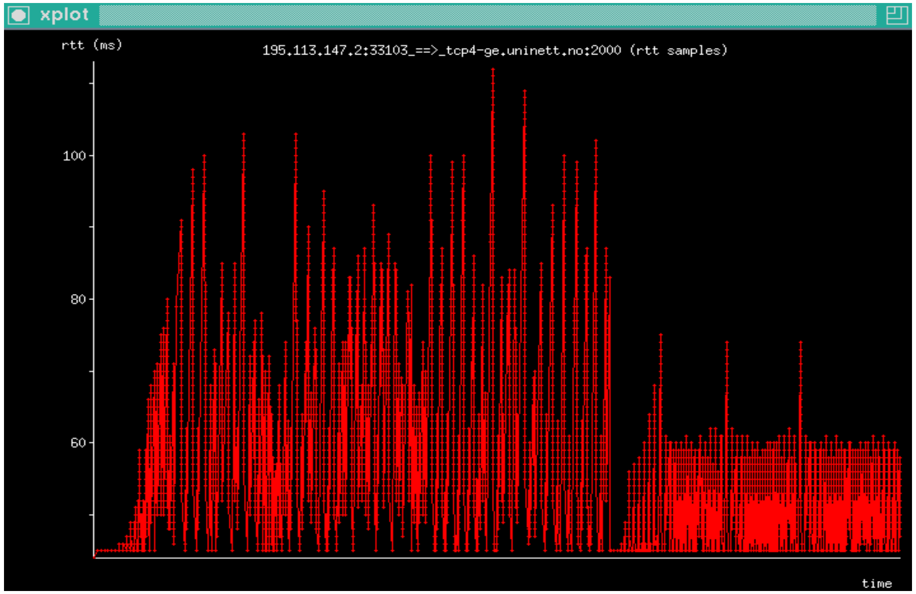
Using “buffered pipe” is not good

- No increase in throughput over using „wire pipe“ in long term
- Self-clocking adjusts sender to bottleneck speed, but does not stop sender from accumulating data in queues
- Filled-up queues are sensitive to losses caused by cross-traffic

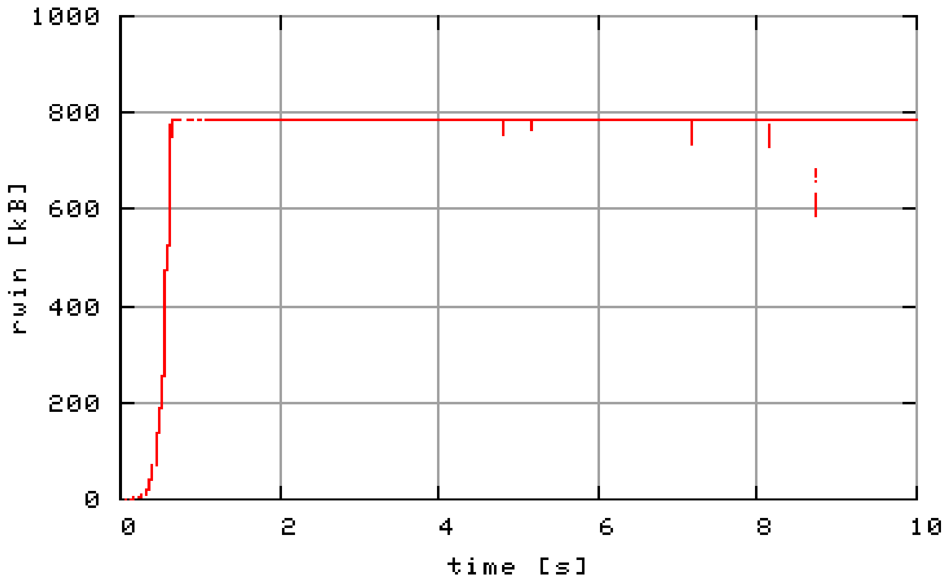


How to use not too much more than “wire pipe”

- Can sender control filling pipe by checking RTT ?

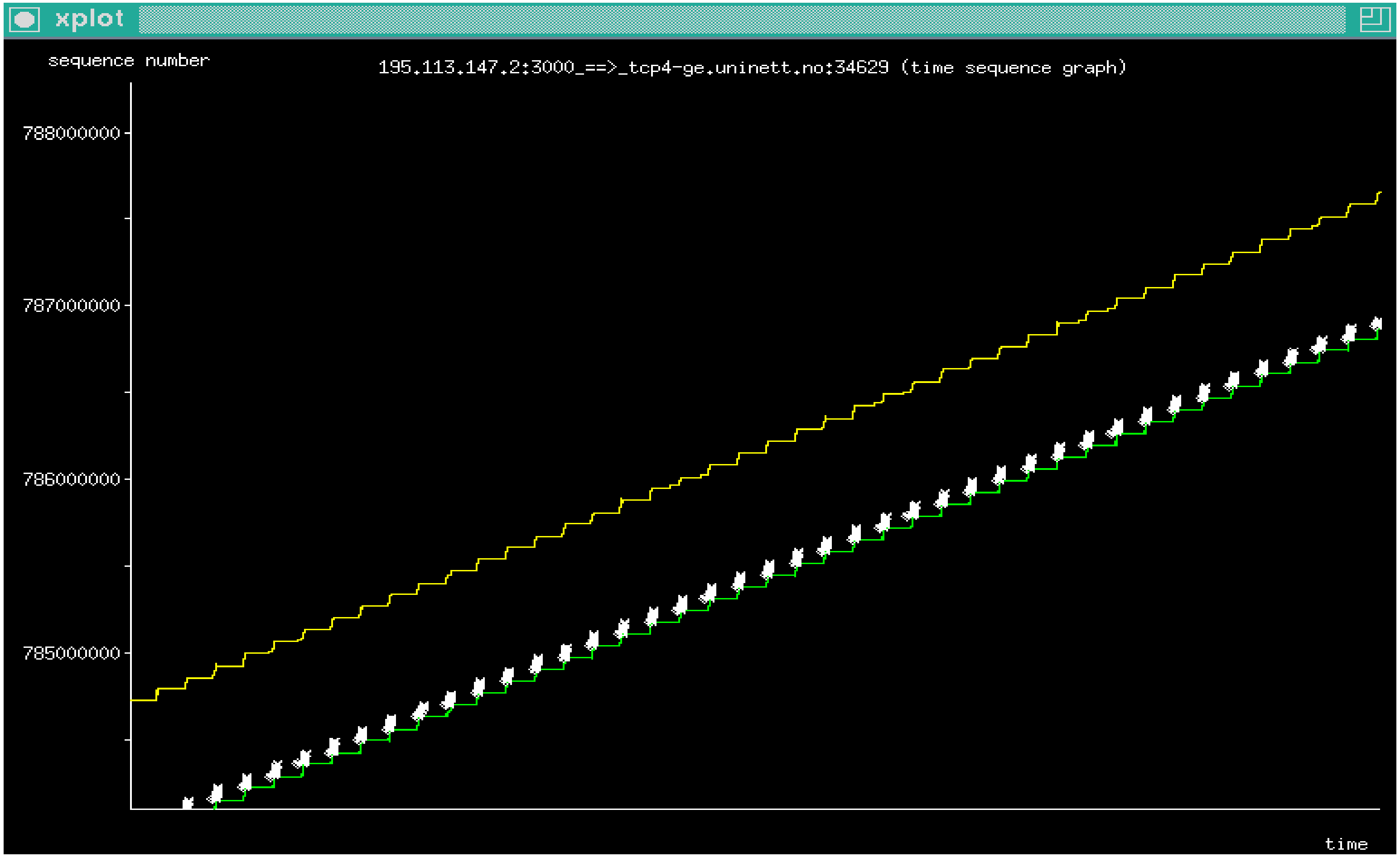


- Can receiver better moderate its advertised window?



scp

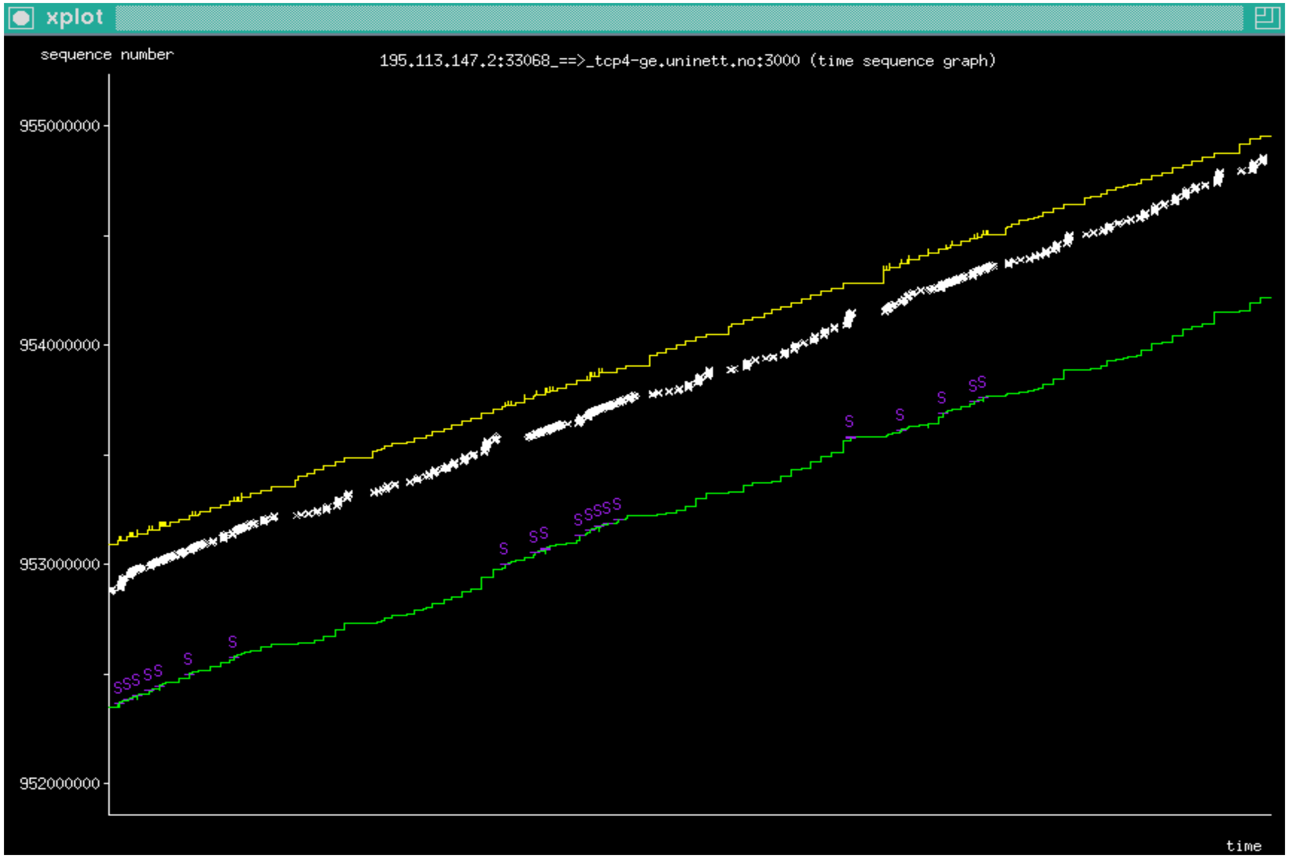
Cesnet -> Uninett, 1.5 MB window, 10.4 Mb/s, 9% load CPU



scp, cont.

Patched scp, with increased CHAN_SES_WINDOW_DEFAULT:

set to 20, rwnd=1.5 MB 48 Mb/s, 45% CPU load
set to 40, rwnd=1.5 MB 88 Mb/s, 85% CPU load



PERT

- Performance Enhancement and Response Team
- TF-NGN initiative (TERENA, DANTE, so far 6 NRENs)
- Comparable to CERT
- A support structure for users to help solve performance issues when using applications over a computer network
  - hierarchical structure
  - accepting and resolving performance cases
  - knowledge dissemination
  - measurement and monitoring infrastructure
- Relations with other organizations
- Pilot project in 2003

Conclusion

- Configuration and interaction of existing components (application, TCP buffers, OS, network adapter, router buffers) may have greater influence on E2E performance than new congestion control algorithms

- Use „wire pipe“ rather than „buffered pipe“

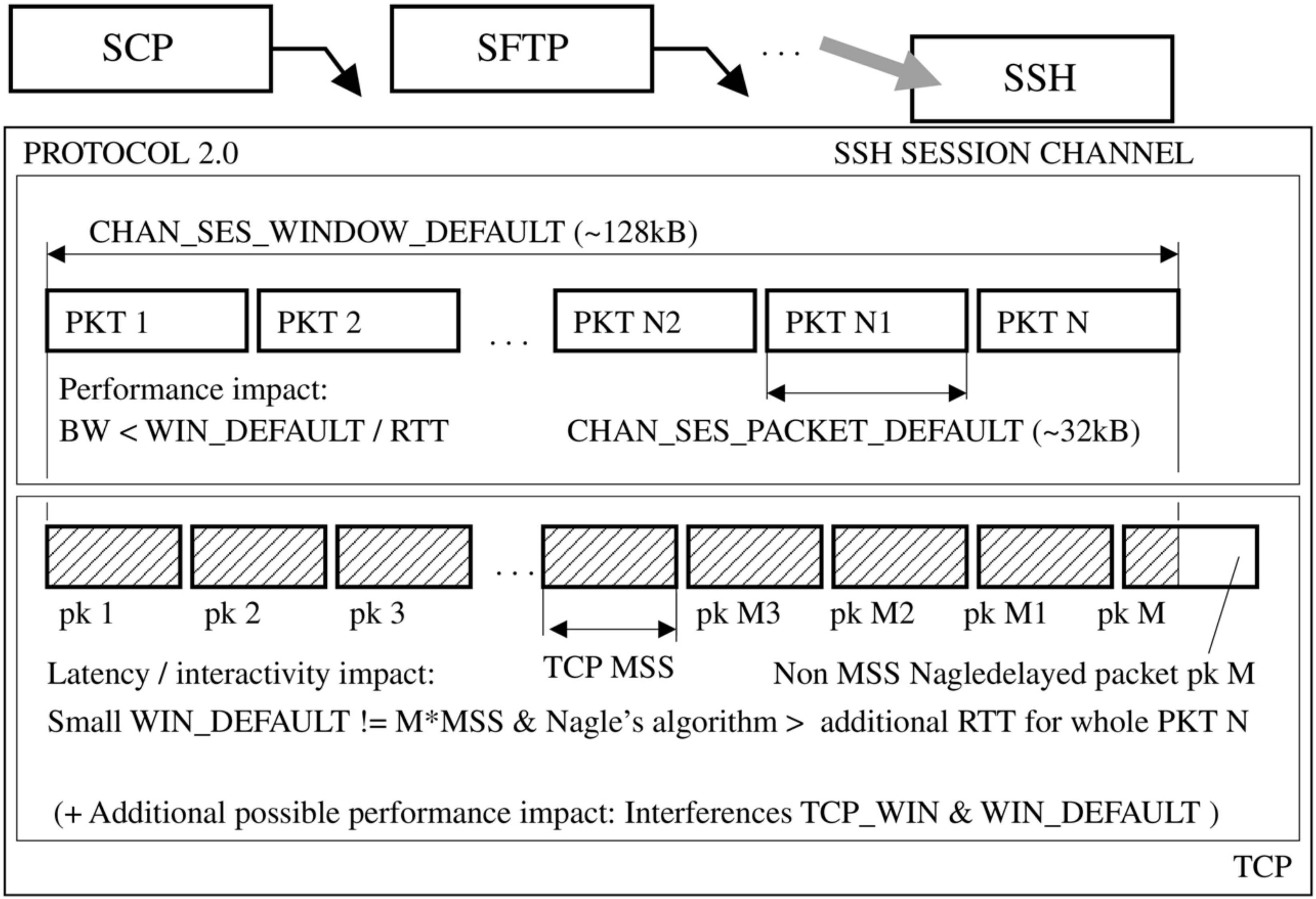
- Autoconfiguration should not just save memory and set buffers „large enough“, but also „small enough“

http://www.cesnet.cz/english/project/qosip

http://staff.cesnet.cz/~ubik

Backup slides

scp, cont.


SCP
SFTP
SSH
PROTOCOL 2.0
SSH SESSION CHANNEL
CHAN_SES_WINDOW_DEFAULT (~128kB)
PKT 1
PKT 2
PKT N2
PKT N1
PKT N
Performance impact:
BW < WIN_DEFAULT / RTT
CHAN_SES_PACKET_DEFAULT (~32kB)
pk 1
pk 2
pk 3
pk M3
pk M2
pk M1
pk M
TCP MSS
Latency / interactivity impact:
Non MSS Nagledelayed packet pk M
Small WIN_DEFAULT != M*MSS & Nagle's algorithm > additional RTT for whole PKT N
(+ Additional possible performance impact: Interferences TCP_WIN & WIN_DEFAULT)
TCP

SCAMPI

- Scaleable Monitoring Platform for the Internet
- 2 1/2 year project since April 2002
- To provide high-level monitoring API (MAPI) for monitoring applications
- To overcome gap between network speed and processor speed
- Will run on top of a commodity network adapter and a specialized network adapter
- Proposed initial monitoring applications:
  - packet capture
  - QoS monitoring
  - netflow statistics
  - intrusion and DoS attempts detection