

# End to End Methods for Measuring and Improving Internet Performance

Cross Industry Working Team  
Plenary Meeting  
Palo Alto, CA  
February 4, 1997

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# Overview

- ❑ Motivation for Measuring Internet Performance
- ❑ Basic Methodology
- ❑ Implementation Details:
  - ❑ Iometer
  - ❑ Timeit
- ❑ Issues
- ❑ Future
- ❑ Conclusion

# Motivation for Measuring Internet Performance

- ❑ The Internet is becoming an important business tool (approaching the phone).
- ❑ Without objective measurements, there is little hope for management or improvement.
- ❑ To manage and improve the Internet experience, Internet performance must be measured.
- ❑ Once measurements are made, actions must follow.

# Basic Methodology

- ▣ Goals of End to End Monitoring
- ▣ Performance Control Algorithm
- ▣ Key Metrics
- ▣ Determining Action Limits
- ▣ Measurement Methodology

# Goals of End to End Monitoring

- ❑ End to end performance monitored to hosts selected by an IP Provider's customer.
- ❑ Immediately implementable metrics not requiring IP Provider or target intervention.
- ❑ Detection of assignable causes for departure from expected performance.
- ❑ Identification of probable causes from departure from expected performance.

# Performance Control Algorithm

- ❑ Collect data.
- ❑ Apply analysis algorithm on data.
- ❑ Generate knowledge from algorithm.
- ❑ Take actions based on knowledge.

# Measurement Methods Used for Data Collection

## ❑ ICMP Echo (Imeter)

- ❑ Delay

- ❑ Packet loss

- ❑ Unreachable

## ❑ HTTP Get (Timeit)

- ❑ Time to perform DNS

- ❑ Time to connect

- ❑ Rate of delivery

- ❑ Errors

# Summary Statistics Applied to Data Collected

- ☐ Median (50th percentile)
- ☐ Interquartile Range (IQR) or 75th percentile
- ☐ Error Percentages



# Determining Action Limits - Three Action Limit Algorithms

- ❑ Action limits need to objectively indicate when something has changed.
- ❑ Action limits need to value detected change against cost to act.
- ❑ Types of action limits:
  - ❑ Static Value: compare to static value; well controlled environment
  - ❑ Delta Fraction: % change; poorly controlled environment.
  - ❑ Delta Shift: change of constant amount; moderately controlled environment.

# Take Action When “Important” Change Detected

- ❑ Traceroute from multiple egress points to host or group of hosts showing problem.
- ❑ Open trouble ticket(s) with IP provider(s) including traceroute information.
- ❑ Fix internal network infrastructure.
- ❑ Keep internal network services groups informed to address customer/employee calls.
- ❑ Maintain database of trouble spots or providers.

# Implementation Details

- ☐ Discussed general performance control method.
- ☐ Implementation details on production use of ICMP Echo and HTTP Get data.

Note: these methods are applied to intranets, too.

# Imeter

- ▣ Implementation overview
- ▣ Examples of Imeter use

# Imeter Implementation

- ❑ Ping set of Internet “landmarks”
- ❑ Plot on intranet graph the following:
  - ❑ Delay (round trip)
  - ❑ Percentage unreachable
  - ❑ Packet loss
- ❑ Source available at:
  - ❑ <ftp://ftp.intel.com/pub/ietf/ippm/Imeter-1.1.tar.Z>

# Examples of Imeter Use

## ☐ Detection of change

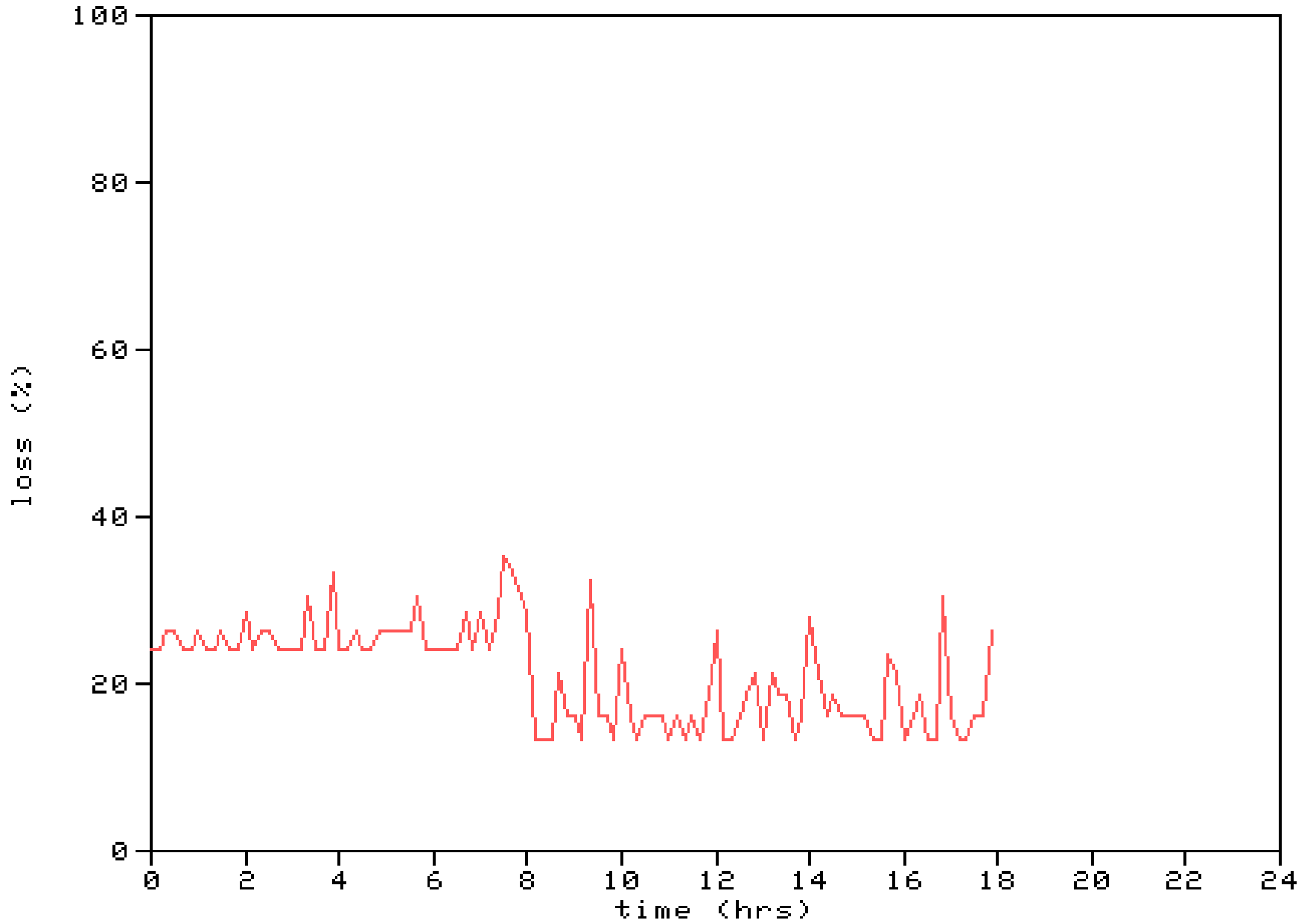
- ☐ repair of service component

## ☐ Start and end of planned service event

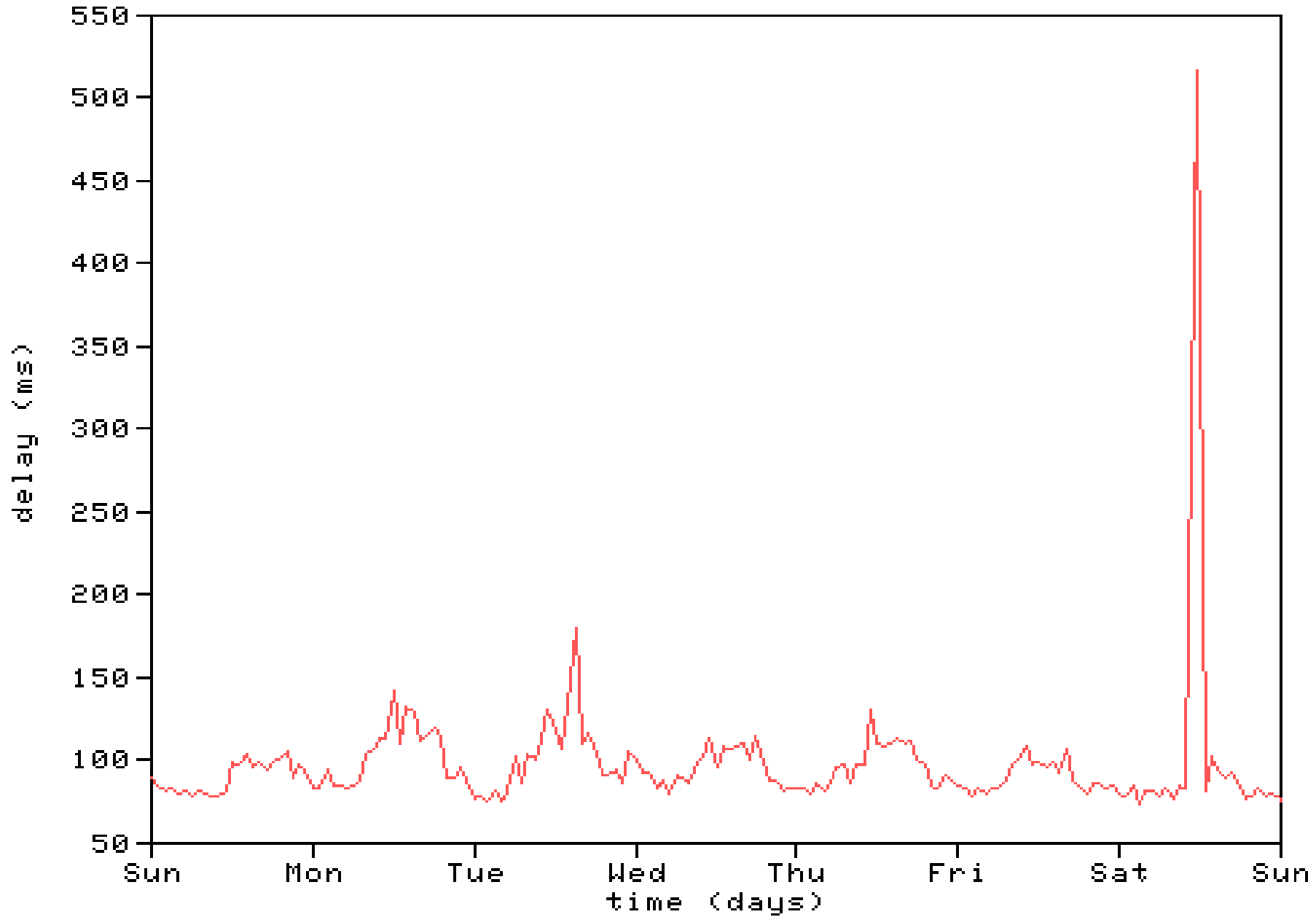
- ☐ relation of change in performance to exact time of event

- ☐ immediate communication of service restoration to network service personnel

# PACKET LOSS FOR TODAY



# NETWORK DELAY FOR LAST WEEK





# HTTP Get (or “Timeit”)

- ▣ Implementation overview
- ▣ Examples of Timeit use

# Timeit Implementation

- ❑ Complete automated HTTP Get to a set of URLs.
  - ❑ Aggregated by company type, country and/or geographic region.
- ❑ Plot on intranet graph for each Intel gateway.
  - ❑ DNS lookup time (seconds)
  - ❑ Connect time (seconds)
  - ❑ Delivery rate (bytes/second)
  - ❑ Fraction Error
- ❑ Source available at:
  - ❑ <ftp://ftp.va.pubnix.com/pub/uunet/timeit-2.1.tar.gz>
  - ❑ Intel modifies this code to our specific environment

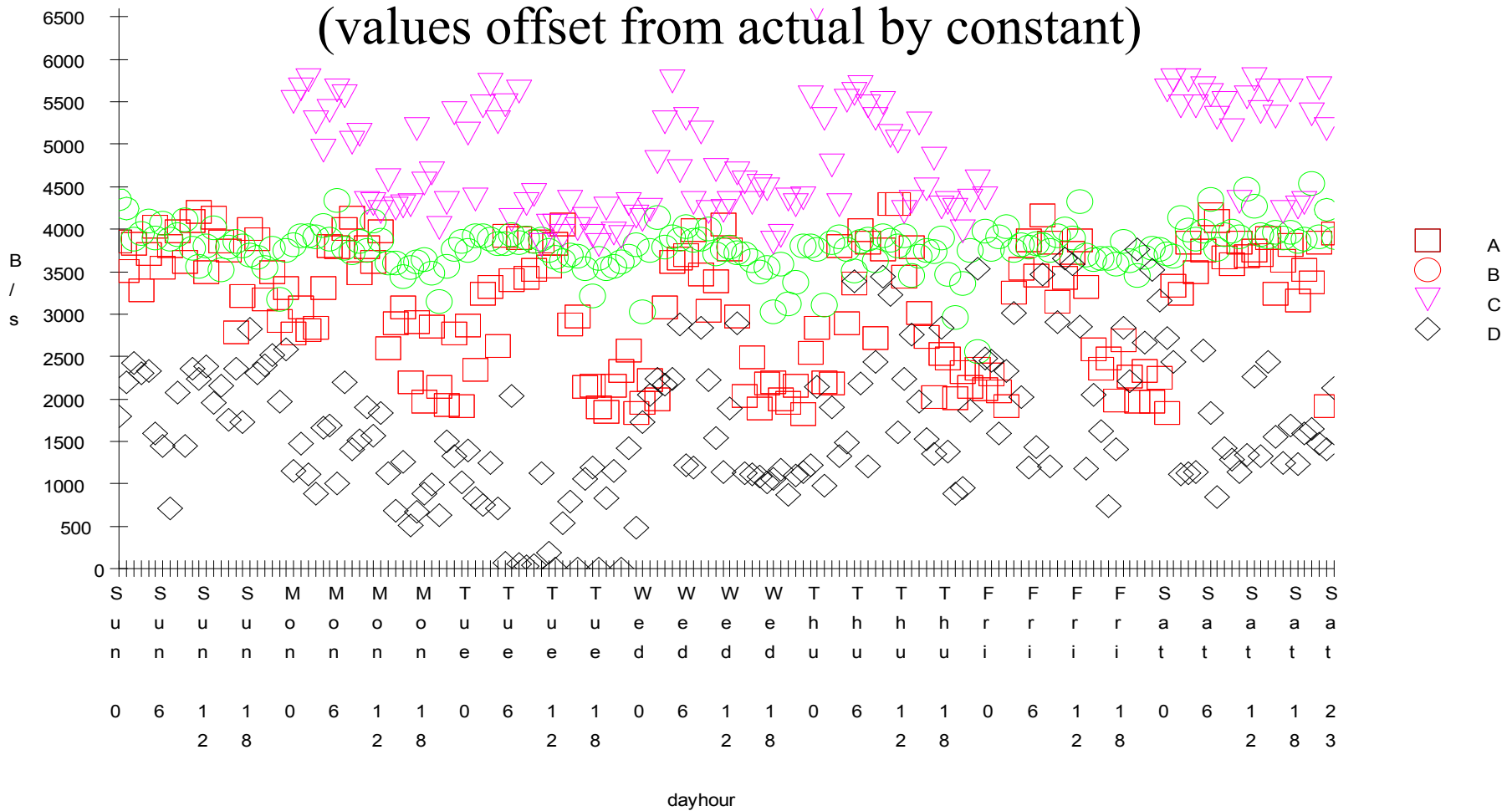
# Current Use of Timeit

- ☐ grep out errors esp. “no route” to detect ISP problems and fixes.
- ☐ combine with traceroute to determine cause of problem.
- ☐ Address specific internal customer complaints of performance problems to an important URL.
- ☐ Provide marketing assessment of performance.
- ☐ Select new and improve current ISPs.
- ☐ Justify expenditures to improve internal and external customer WWW performance.
- ☐ Experimental designs to compare configs of proxy, DNS, routers, etc.

# Examples of Timeit Use

- ❑ Comparison of performance at different IP.  
Providers' POP to the same URL list during the same time interval.
- ❑ Last weeks assessment of Internet health egressed from different Intel gateways.

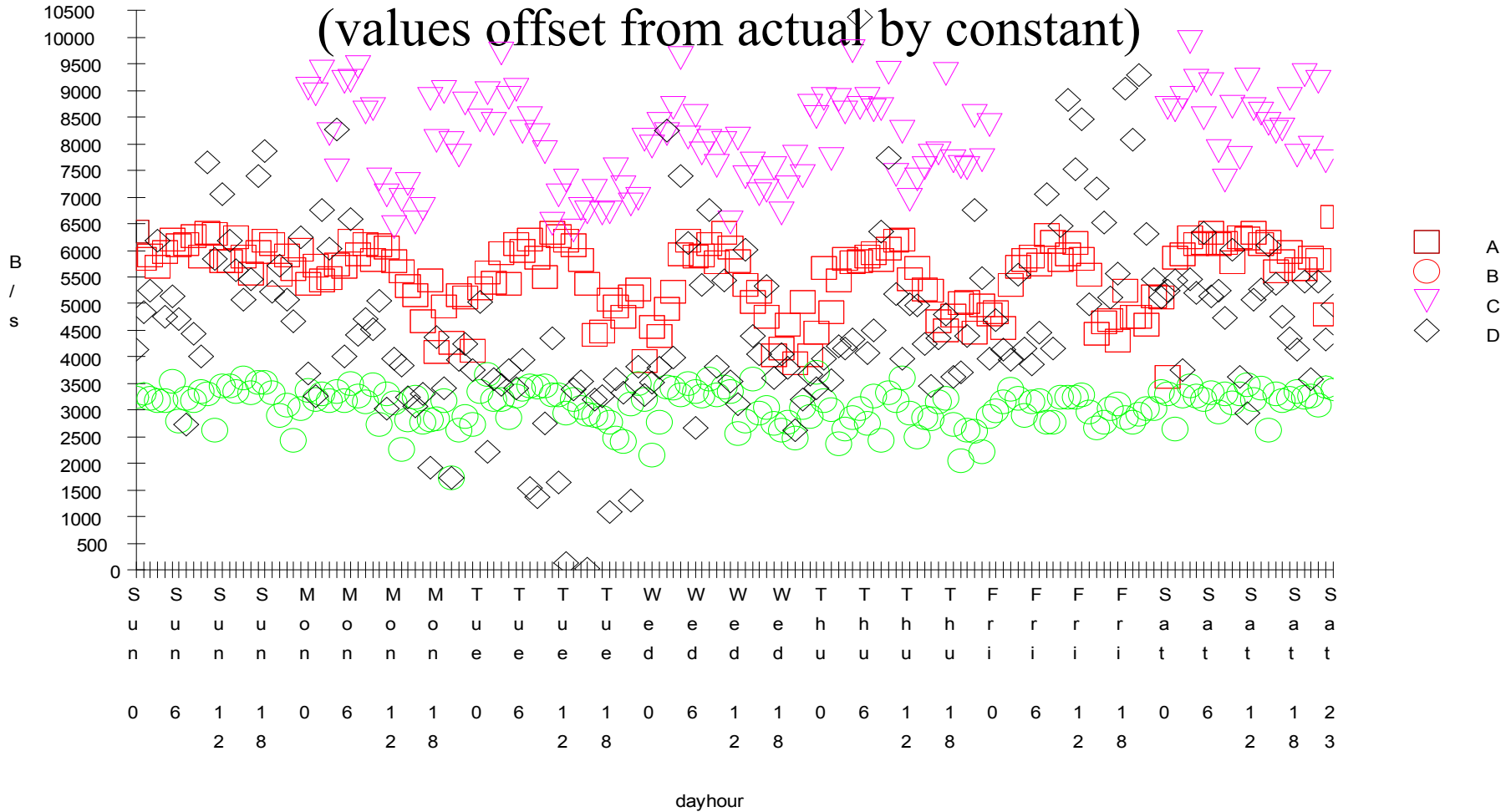
# 75% of URL requests are this fast or faster for US ISP list



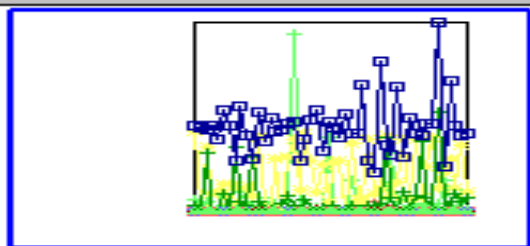
Data source: timeit prgm

Graphic: C. Bickerstaff

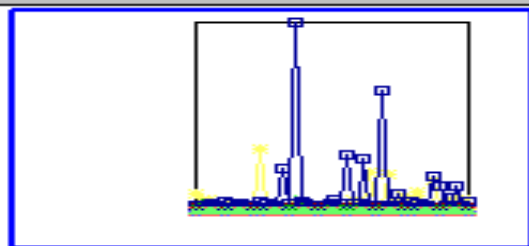
# 50% of URL requests are this fast or faster for US ISP list



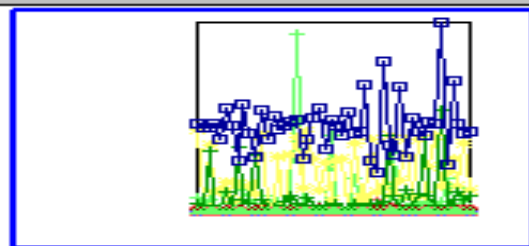
Data source: timeit prgm  
 Graphic: C. Bickerstaff



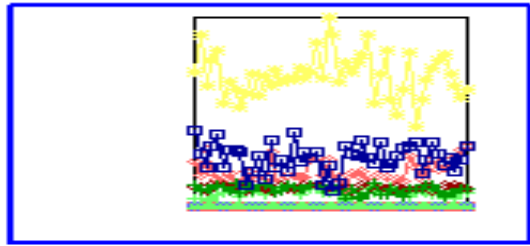
DNS IQR



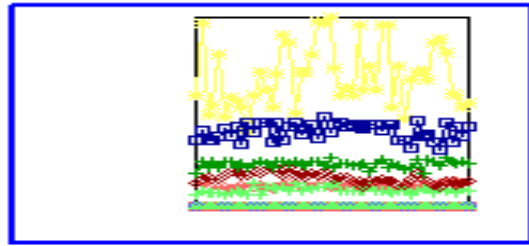
DNS median



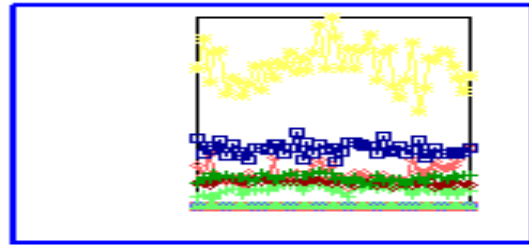
DNS p75



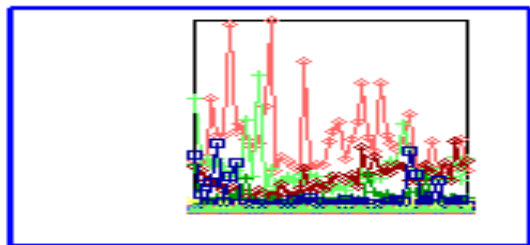
Rate IQR



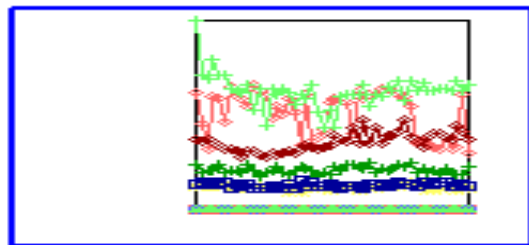
Rate median



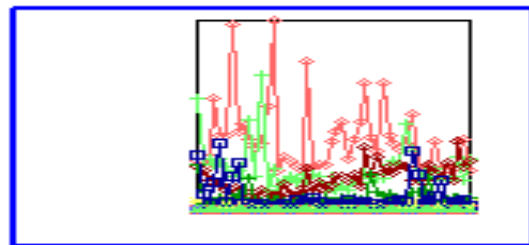
Rate p75



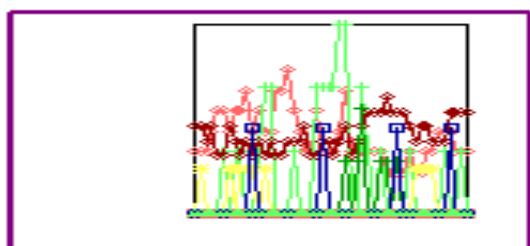
Setup IQR



Setup median

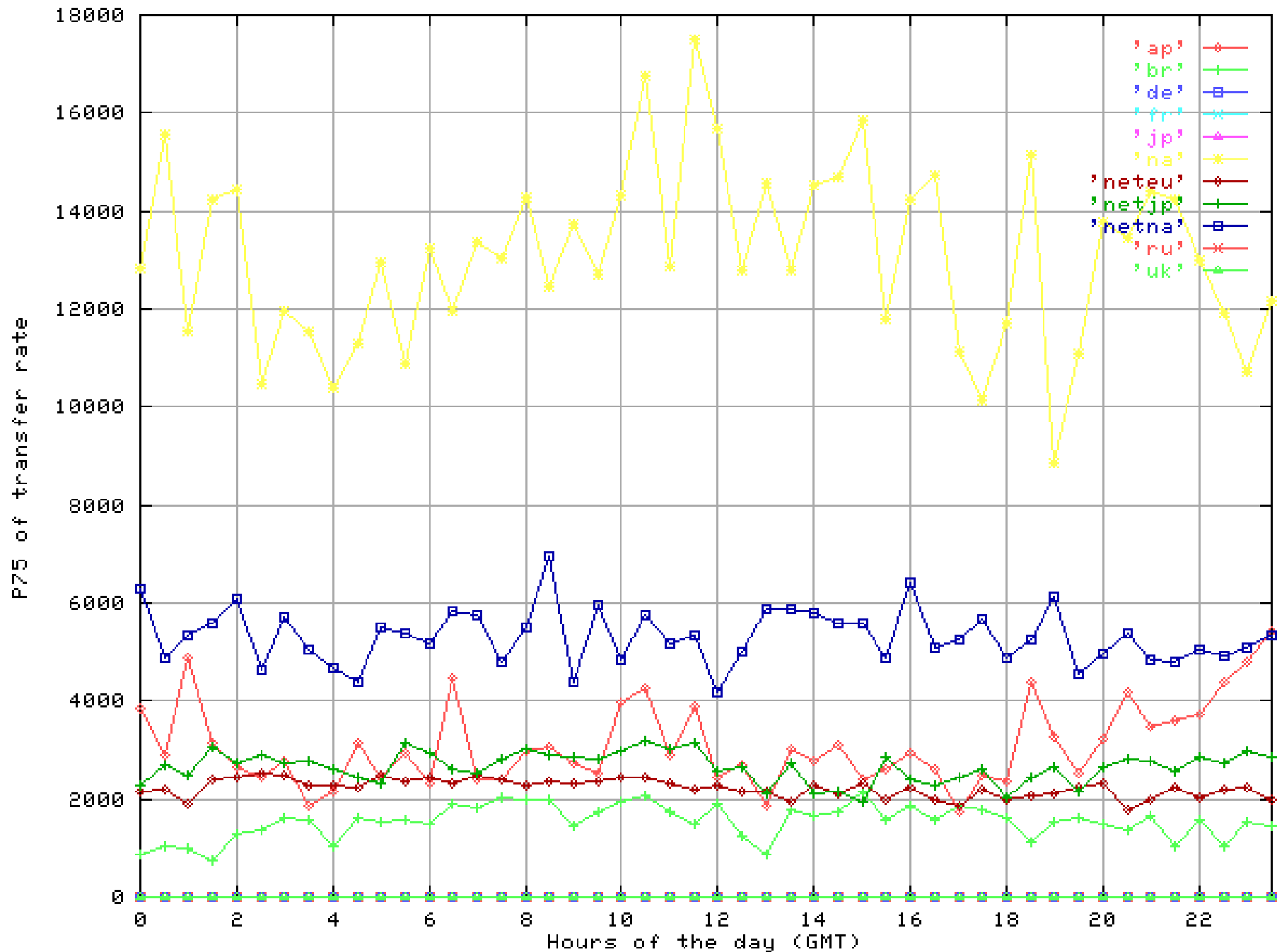


Setup p75



Percent Error

P75 of transfer rate over time





# Issues

- ❑ Firewalls blocking ICMP (Imeter).
- ❑ Need to modify timeout for those servers wanting a browser type.
- ❑ Need to implement automatic algorithmic processing of data.
- ❑ Refinement of landmark selection.
- ❑ Be aware of maintaining sampling frequency below annoyance levels.
- ❑ Be aware that these measurements add traffic load and are non-value added.

# Futures

- ❑ Algorithmic detection of action limits and automated alerts.
  - ❑ including regular monthly review of time trends by gateway by engineering staff.
- ❑ Analysis of outliers.
- ❑ Aggregation by geographies of interest for Imeter.
- ❑ Analysis of internal proxy data for performance results (in-situ measurement) in lieu of additional Imeter/Timeit.

# Outcome of IP Performance Data Collection

- ☐ ISPs cooperated and were interested in results interpretation.
- ☐ ISPs used data to detect, debug and fix problems then demonstrated improvement.
- ☐ ISPs we've worked with plan to continue using data for problem solving.
- ☐ Results used and believed by internal customers who sign and authorize \$\$ expenditure for Internet services.

# Conclusions

- ❑ The generic performance control algorithm (data/algorithm/knowledge/action) can be and has been applied to the Internet performance space.
- ❑ The measurement methods described for data collection require no additional Internet infrastructure.
- ❑ The tools and algorithms described are available and can be implemented by any company with Internet access.  
(also applicable to intranets.)