

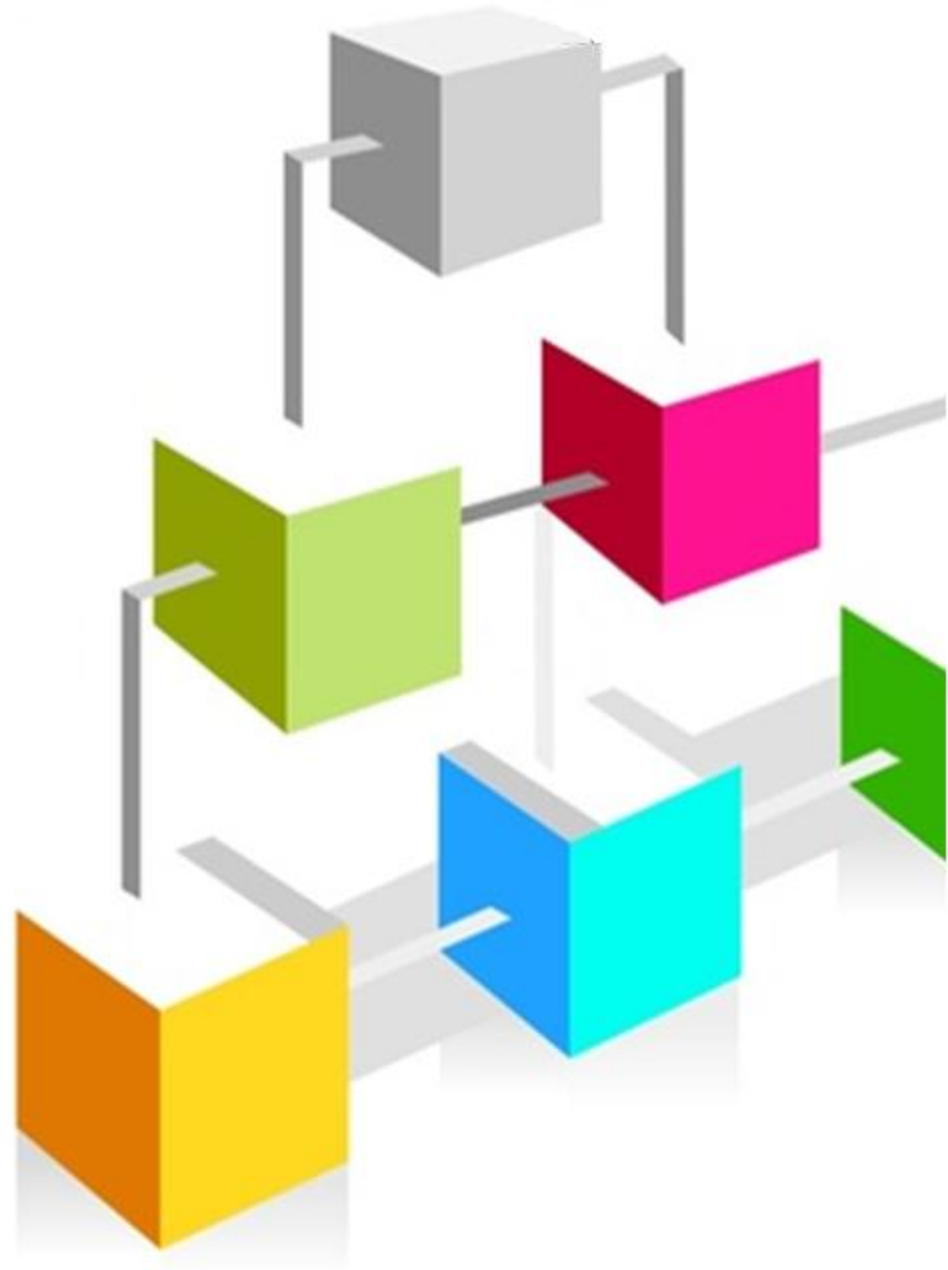


# COMCAST

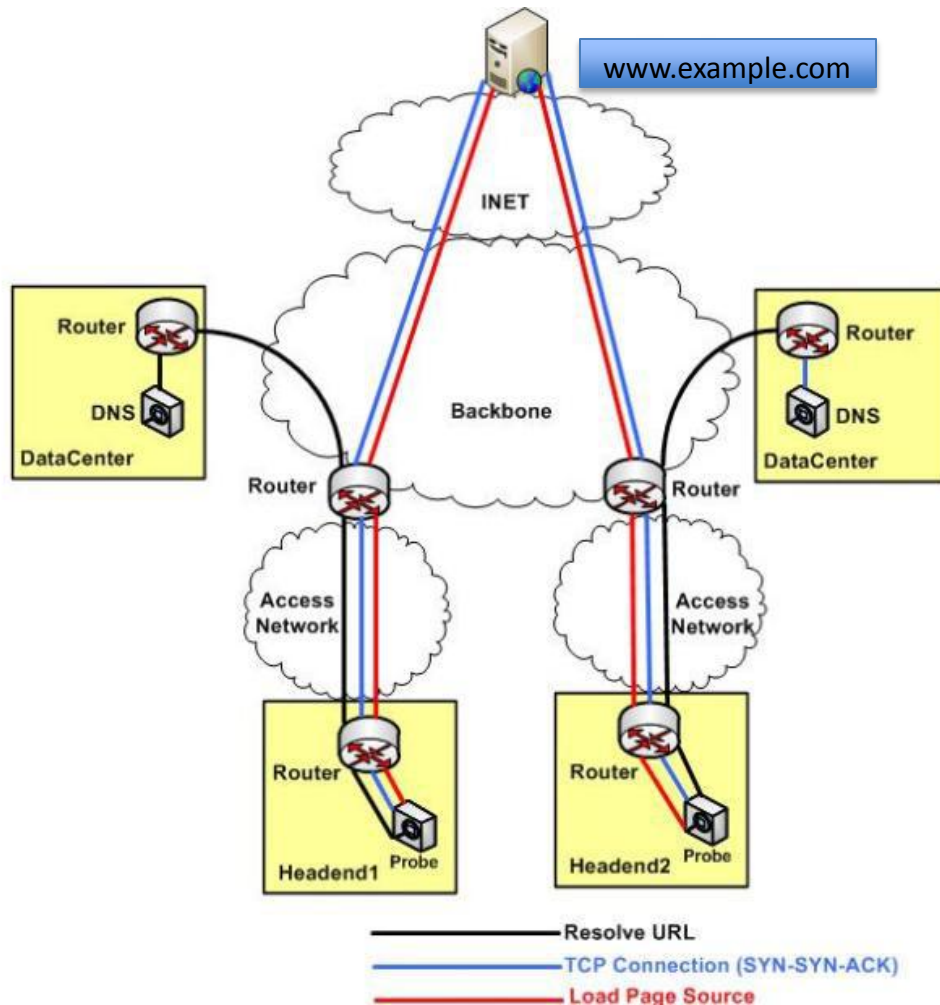
## IPV4 AND IPV6 LATENCY ANALYSIS

FOR  
ISOC LATENCY WORKSHOP, SEPT 25-26, 2013

SALIL BANERJEE  
COMCAST CABLE



# Comcast Latency Measurement Infrastructure



This chart shows the locations of the test probes in our network.

The probes run Unix Curl tool to initiate HTTP access to pre-configured websites.

The communications involved in the website access are shown separately in this diagram.

1. Black path for DNS resolution
2. Blue path for TCP 3-way handshake
3. Red path for web page load

Most of our focus is on TCP RTT

# Latency Monitoring Diagnostic Systems

## Website Latency Analysis (WLA) System

- Database and analysis system for probe-website RTTs
- RTT data every 5 minutes from 21 probes to several hundred websites
- Visual representations for high level and detailed views
- Provides thresholding/alerts for troubleshooting

## Traceroute Analysis System

- Detailed traceroute (every hop) data for all probe-website pairs
- Traceroute data every 15 minutes; data retained for 2 weeks
- WLA identifies high RTT cases; Traceroute Analysis system helps troubleshoot

# RTT Monitoring and Analysis Systems

## WLA Screen

Website Metrics Analysis DASHBOARD V2.0

Options:  IPv4  IPv6  IPv4 & IPv6

Prev 5 Min Next 5 Min 2013/09/17 14:40 UTC All

Home Top N Websites Add Sites Custom Reports Legend LOG OUT

BEAVERTON BROCKTON FAGAN ELMHURST GRANDRAPIDS HATTIESBURG MURFREESBORO OLATHE PANAMACITY PIMACO PITTSBURGH POMPANOBEACH ROCKVILLE ROYALTON SACRAMENTO SALTLAKECITY SANDIA SEVENACRESR STERLING TACOMA WALLINGFORD

Data for time 09/17/2013 14:30:00 UTC to 09/17/2013 14:35:00 UTC

Copy CSV Excel PDF Search:

Test-Type	Code	Total Time	Connect Time	Lookup Time	Ratio total time (v6/v4)	Ratio connect time (v6/v4)	Ratio lookup time (v6/v4)	Ratio download speed (v6/v4)	Ratio connect time spark
curl4dns	200	69	12	1	1	1	2	1.0018	
curl6dns	200	69	12	2	1	1	0.5	0.8522	

## Traceroute Analysis Screen

TraceView

s...	ip	host	asname	asn	gmr
1	69.241.64.9	ge-3-38-ur01.wallingford.pa...	COMCAST-33287	33287	43.9
2	68.85.158.85	te-1-3-ur02.wallingford.pa...	COMCAST-33287	33287	43.9
3	68.86.208.189	xe-7-0-2-0-ar03.newcastle...	COMCAST-33287	33287	43.9
4	68.86.94.249	pos-5-15-0-0-cr01.ashburn...	COMCAST-7922	7922	43.9
5	4.26.6.25	xe-11-2-0-edge2.Washingto...	LEVEL3	3356	43.9
6	4.69.146.190	vlan51.ebr1.Washington12...	LEVEL3	3356	43.9
7	4.69.148.105	ae-6-6.ebr1.Atlanta2.Level3...	LEVEL3	3356	43.9
8	4.69.148.241	ae-6-3.ebr3.Atlanta2.Level...	LEVEL3	3356	43.9
9	4.69.134.21	ae-7-7.ebr3.Dallas1.Level3...	LEVEL3	3356	43.9
10	4.69.132.77	ae-3-3.ebr2.LosAngeles1.L...	LEVEL3	3356	43.9
11	4.69.137.26	ae-82-82.csw3.LosAngeles1...	LEVEL3	3356	43.9
12	4.69.144.202	ae-4-90.edge1.LosAngeles9...	LEVEL3	3356	43.9
13	4.33.228.134	TIME_WARNER.edge1.LosA...	LEVEL3	3356	43.9
14	157.166.241.10	157.166.241.10	ASN-TBS-1	3662	43.9

Histogram

last_hop_histo...	last_hop_host	last_hop_histogra...
17.7%	'157.166.249.11'	157.166.249.11
13.5%	'157.166.241.10'	157.166.241.10
12.5%	'157.166.249.10'	157.166.249.10
11.5%	'157.166.240.13'	157.166.240.13
10.4%	'157.166.241.11'	157.166.241.11
	'157.166.248.10'	157.166.248.10
	'157.166.248.11'	157.166.248.11

source

dst

timeConvert  
Last 10 days

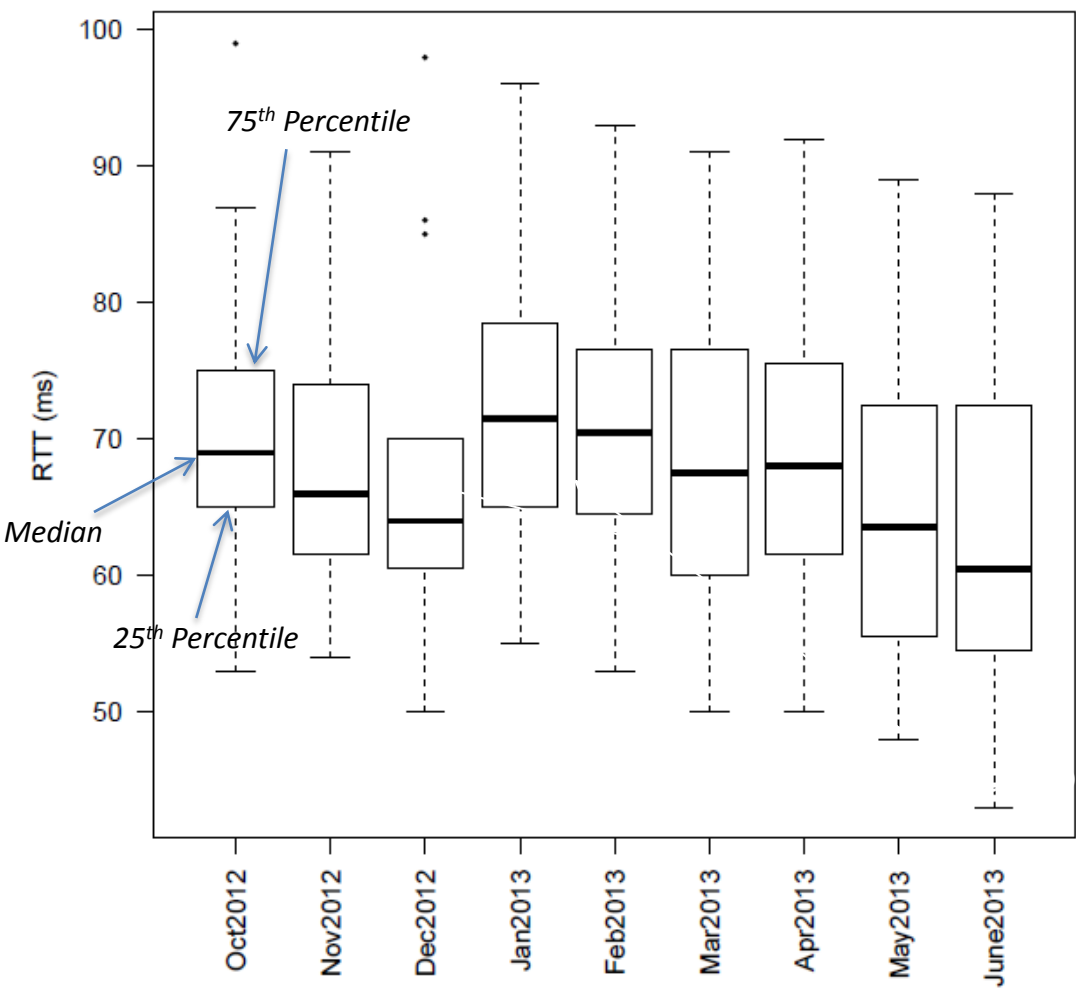
asname  
 ASN-TBS-1  
 CMCS  
 COMCAST-7922  
 LEVEL3

completed  
 (All)  
 -1  
 0  
 1

RTT Samples

# Characterization of Comcast RTTs – IPv4

IPv4 RTT Trends to Top websites from Entire Comcast Network



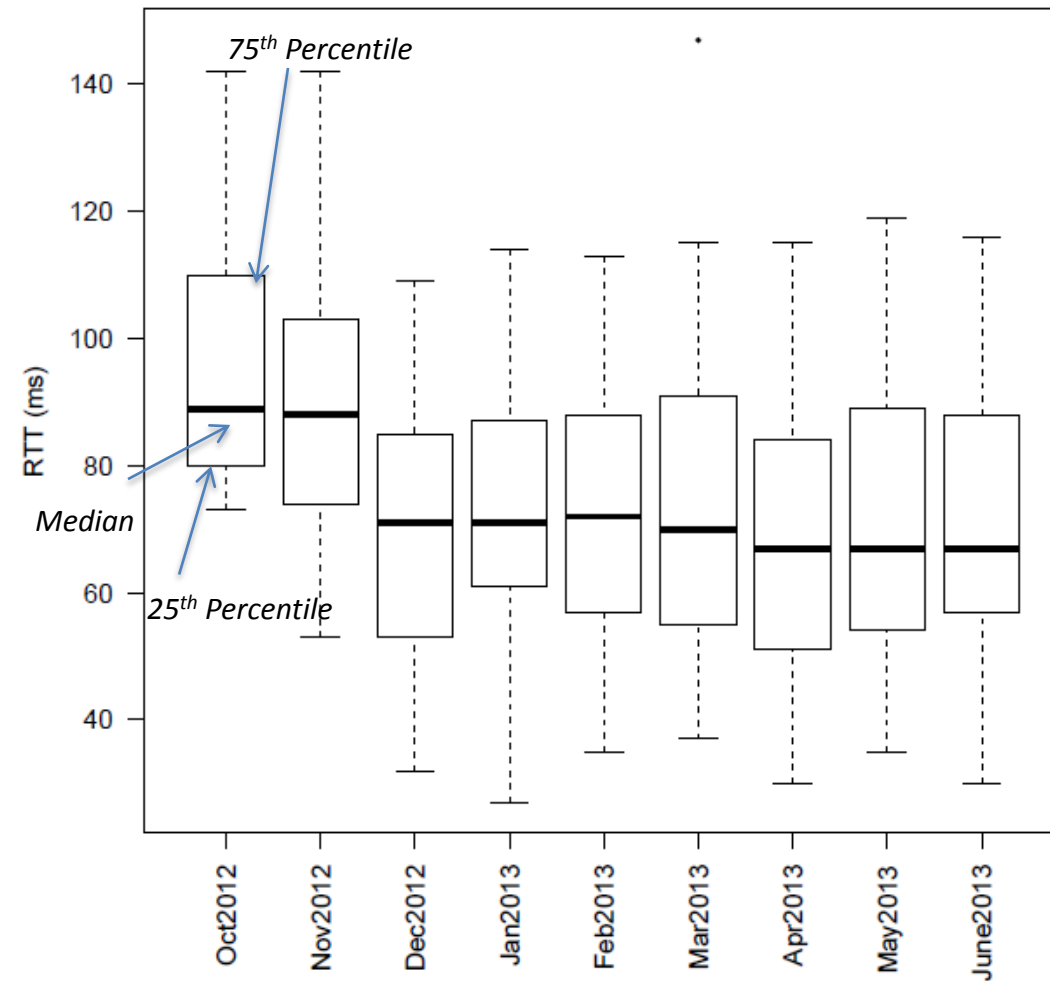
RTTs chart based on measurements for about top 25 websites

Each box represents spread of measurements from our probes at different locations.

RTTs have not changed significantly since 4Q2012 although median is down by ~15%

# Characterization of Comcast RTTs – IPv6

IPv6 RTT Trends to Top websites from All Comcast Network



RTT data based on measurements of about 25 IPv6 websites

RTTs have come down by over 20% since last October

We attribute this reduction to Comcast's work with high RTT cases based on WLA analysis.

# Comcast Drivers for Reducing RTTs

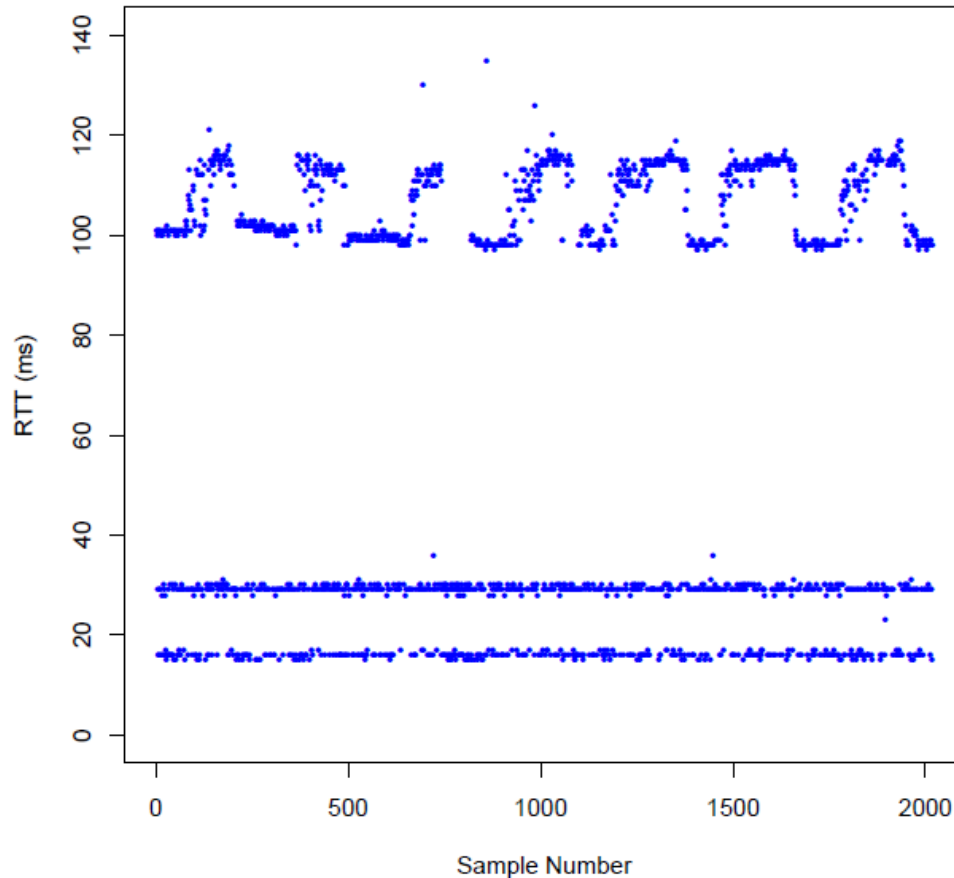
Comcast drivers for this project are:

- ❑ RTT is an important component of overall page download time; so reducing RTT would result in improved QoE for Comcast's internet service customers
- ❑ High RTT often indicates inefficient use of resources inside of Comcast or outside; reducing RTT would help fine-tune such inefficient configurations
- ❑ Website RTTs helped Comcast understand/compare CDN RTT performance changes

High RTT cases typically fell in the following categories:

- ❖ Website Provider's algorithm for assigning customers to servers not adequate
- ❖ Website providers use criteria (e.g., load) other than RTT in assigning customers
- ❖ Components involved in serving web content have inadequate resources or non-optimized configurations
- ❖ Smaller websites may not have multiple server locations
- ❖ Occasional mis-configurations

# Example of Multiple Server Locations



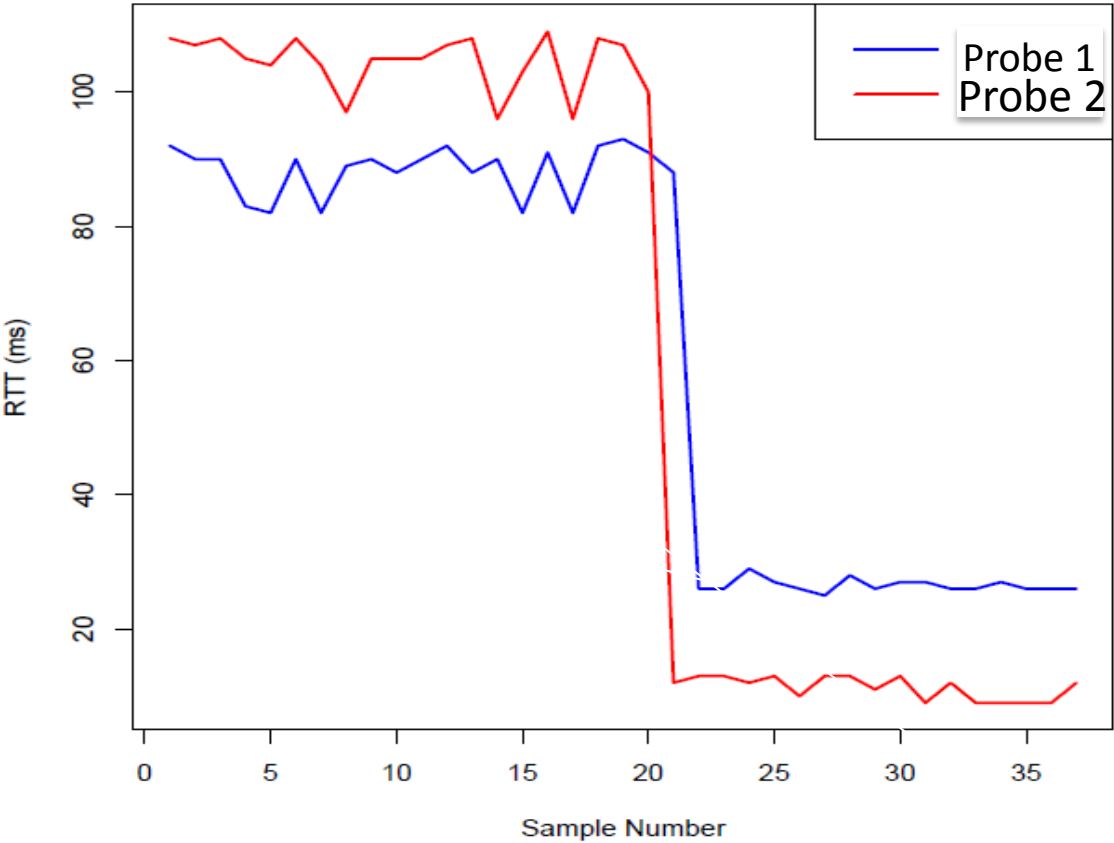
This website is served out of 3 different locations

RTTs from 2 locations quite low

But third location has high RTTs (>100ms) and a clear diurnal pattern indicating congestion during busy hours.



# Example of RTT Reductions

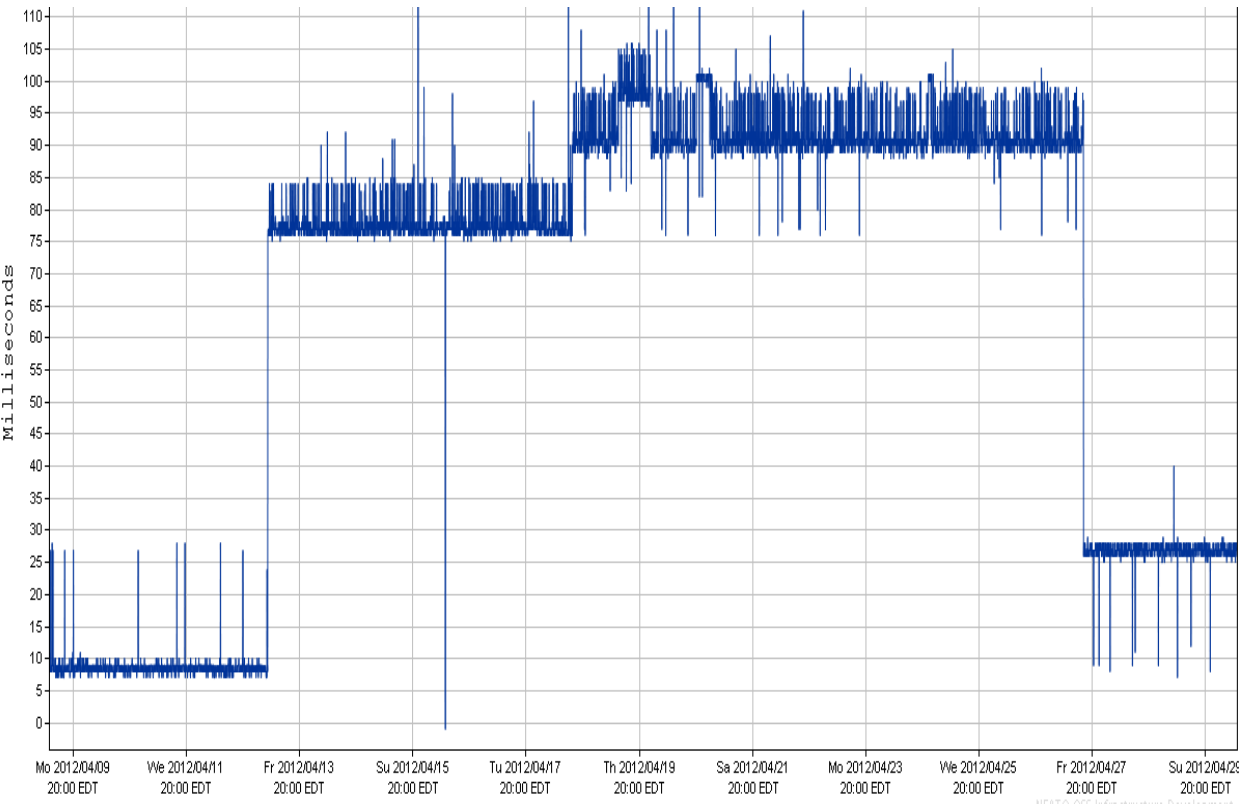


WLA system detected high RTTs to a popular website from several east coast probes. Traceroute analyses showed that east coast customers were being served out of west coast servers.

Inadequate user-server mapping algorithm. Website provider updated its mapping algorithm using information provided by Comcast.

Almost 80% reduction in RTTs

# Example of RTT Reductions



Comcast split an existing AS into two.

Website provider did not recognize new AS; so served those customers from a non-optimum default server.

WLA detected the issue

Comcast informed website provider and high RTT was quickly mitigated.