ORIGINAL

INTERNAL ANALYSIS

Description: Review Of Performance Issues In Specific U.S. Test Nodes During The Month Of March 2012

PROJECT REF: MEASURING BROADBAND AMERICA

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ORIGINAL

Overview

INTRODUCTION

NOTE 1: This spreadsheet was produced in April 2012 shortly after the issue was identified and the root cause discovered. Any subsequent discoveries are not documented here.

NOTE 2: ISP names have been redacted in this spreadsheet. In some cases specific ISPs' products were used here because they normally exhibited extremely consistent performance, and this changed noticably when testing to the unhealthy servers. This is by no means the fault of the ISP though.

The contents of this spreadsheet are an attempt at analysing the impact of the issues experienced at mlab1.lga02, mlab3.lga02, mlab3.lax01, mlab1.lga01 and mlab3.lga01 during March. This is by no means an exhaustive analysis.

This spreadsheet focuses on downstream throughput and packet loss. Other metrics may or may not be affected - these have not been studied here. Each chart shows the results for "healthy" servers (those unaffected by the issue) and "unhealthy" servers (those affected by the issue) for comparative purposes.

The packet loss charts show a very large increase in packet loss on the affected servers. The downstream throughput charts show that multiple products from multiple providers were affected, at different headline speeds. Higher speed products were affected more than lower speed ones.

Each case analysed is presented as a separate sheet in this spreadsheet. For each case, the data used to produce the graph is included. The data was derived directly from the raw, unfiltered data that will be published on the FCC website.

This spreadsheet does not include comparison of off-net (MLab) versus on-net (ISP-provided) test node performance. This may be performed later once the on-net data is released.

CHRONOLOGY

March 1st - Measurement period begins

March 23rd - SK begins to observe some significant differences between on-net and off-net performance in New York. Reintroduces mlab1.lga01 into testing (in an attempt to spread load), but does not reintroduce mlab2.lga01 and mlab3.lga01 as these failed health-checks (they could not reach more than ~90Mbps). MLab notified.
March 23rd - SK begins to observe some significant differences between on-net and off-net performance in Los Angeles. Introduces mlab4.nuq01 into testing (in an attempt to spread load).
March 30th - SK identifies wider issue with mlab3.lax01, mlab1.lga02 and mlab3.lga02. Issue is the same one affecting mlab2.lga01 and mlab3.lga01.
March 31st - Issue resolved by rebooting servers.
April 5th - MLab identified and resolved root cause of problem (slow resource leak on servers).

SERVERS INVOLVED

mlab1.lga01 - Healthy, reintroduced into service in March
mlab2.lga01 - Unhealthy. Not covered here as SK healthcheck prior to March determined there was some problem, so it was excluded from testing.
mlab3.lga01 - Unhealthy. Not covered here as SK healthcheck prior to March determined there was some problem, so it was excluded from testing.
mlab1.lga02 - Unhealthy, used throughout March.
mlab2.lga02 - Heathly, used throughout March.
mlab3.lga02 - Unhealthy, used throughout March.
mlab1.lax01 - Offline due to disk failures.
mlab2.lax01 - Offline due to disk failures.
mlab3.lax01 - Unhealthy, used throughout March.
mlab1.nuq01 - Healthy, used throughout March.
mlab2.nuq01 - Healthy, used throughout March.
mlab3.nuq01 - Healthy, used throughout March.
mlab4.nuq01 - Healthy, reintroduced into service in March

NOTE: 'Unhealthy' denotes a server that was subsequently discovered to have been affected by a resource leak.

Packet Loss to New York servers, across all ISPs and products

What this shows

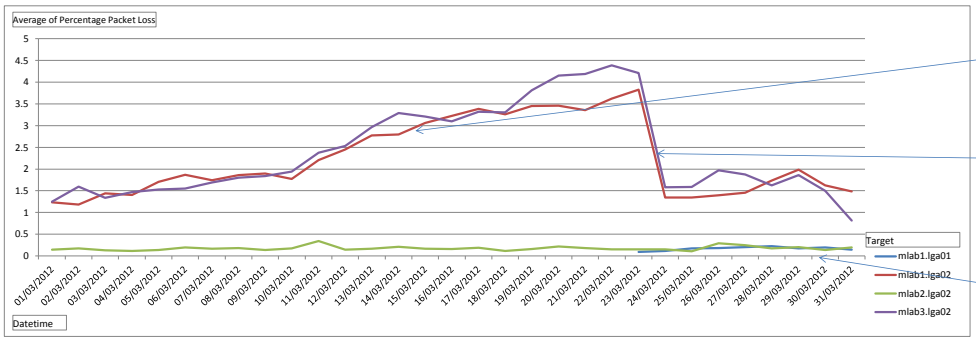
The below graph depicts packet loss against the various New York servers during March, across all ISPs and products. Measurements to mlab1.lga01, mlab2.lga01 and mlab3.lga01 were disabled at the start of the month due to various disk failures. Unrelated to the issue at hand, mlab1.lga01 was reintroduced later in the month following testing. We declined to reintroduce mlab2.lga01 and mlab3.lga01 as we identified throughput issues to them (this was the first hint that something was amiss, and we reported the issue at this time).

Packet loss to mlab2.lga02 is consistently low (~0.2%), which is similar to values reported in last year's FCC study. Packet loss to mlab1.lga02 and mlab3.lga02 starts at ~1.3% and increases to 4% during the month. This is presumably increasing as resources are draining on the M-Lab servers (due to the subsequently discovered resource leak).

Once mlab1.lga01 was introduced, a sharp drop in packet loss was observed. This was due to a large amount of the test volume moving to mlab1.lga01. Note though that the test volume to mlab1.lga01 and mlab2.lga02 (the healthy servers) was far higher than mlab1.lga02 and mlab3.lga02, yet these healthy servers experienced far lower and more stable packet loss.

This graph also shows that it is very likely that the packet loss (and thus the issue) was occurring before March, as loss to mlab1.lga02 and mlab3.lga02 was already high at the beginning of the month.

Graph



Packet loss increased quickly during the month, presumably as resources drained on the servers

mlab1.lga01 was introduced into active service, resulting in many probes switching to use the new server (which was unaffected by the issue). This resulted in a lower amount of tests to mlab1.lga02 and mlab3.lga02, lowering average packet loss. The sample sizes in the data below corroborate this. Note also that although levels have dropped, they're still far higher than the

Even though the healthy servers (mlab1.lga01 and mlab2.lga02) had a far higher traffic volume to them, probes testing against them saw almost no packet loss.

Pivot Table

Average of Percentage Packet Loss	Column Labels				
Row Labels	**mlab1.lga01**	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**Grand Total**
01/03/2012		1.230641	0.143209	1.2474692	0.873773067
02/03/2012		1.181617	0.1765667	1.5927042	0.9836293
03/03/2012		1.4408864	0.1267171	1.3355951	0.967732867
04/03/2012		1.3999552	0.1137794	1.4711112	0.9949486
05/03/2012		1.7021628	0.1367689	1.5321805	1.123704067
06/03/2012		1.8656458	0.1994241	1.5481826	1.2044175
07/03/2012		1.7431672	0.1693257	1.6934618	1.2019849
08/03/2012		1.8634885	0.1845405	1.798771	1.282266667
09/03/2012		1.897639	0.1363511	1.8383378	1.290775967
10/03/2012		1.7742046	0.1719709	1.9418903	1.296021933
11/03/2012		2.2047449	0.3408587	2.3782416	1.641281733
12/03/2012		2.4469696	0.1443591	2.5281925	1.706507067
13/03/2012		2.7724749	0.1653855	2.9631762	1.9670122
14/03/2012		2.7942871	0.2081122	3.2859591	2.096119467
15/03/2012		3.0599297	0.1694033	3.208957	2.146096667
16/03/2012		3.2196836	0.1568797	3.1003421	2.158968467
17/03/2012		3.3813568	0.1905899	3.3197846	2.297243767
18/03/2012		3.2562127	0.1149855	3.3032307	2.224809633
19/03/2012		3.4506932	0.1573726	3.813972	2.4740126
20/03/2012		3.4560694	0.2166759	4.1524679	2.6084044
21/03/2012		3.3543339	0.18015	4.184266	2.572916633
22/03/2012		3.6183978	0.1511789	4.3893946	2.7196571
23/03/2012	0.0944501	3.8240493	0.1538645	4.2091058	2.070367425
24/03/2012	0.1177296	1.3432245	0.1528042	1.5769142	0.797668125
25/03/2012	0.1723956	1.3474993	0.1085779	1.589357	0.80445745
26/03/2012	0.1818754	1.3955296	0.2878681	1.9687403	0.95850335
27/03/2012	0.2055426	1.4544061	0.2455723	1.8719644	0.94437135
28/03/2012	0.2229856	1.7360138	0.1715709	1.6275364	0.939526675
29/03/2012	0.1736675	1.9821176	0.2030591	1.8598274	1.0546679
30/03/2012	0.1932912	1.6221273	0.1340122	1.5028778	0.863077125
31/03/2012	0.1428874	1.4874647	0.1947612	0.8168894	0.660500675
Grand Total	**0.167202778**	**2.235709461**	**0.174409519**	**2.375835506**	**1.469307981**

Downstream throughput for ISP-1, 35x35 product in New York

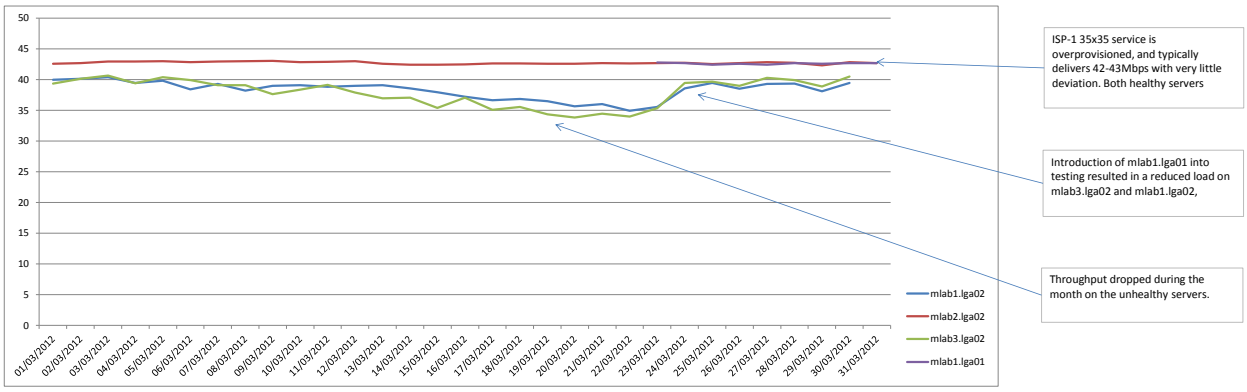
What this shows

ISP-1, 35x35 Mbps service commonly delivers 42-43 Mbps (it is overprovisioned), and this is evidenced below for traffic to mlab2.lga02 and (later) mlab1.lga01.

Throughput to the unhealthy servers began the month lower at ~40Mbps, and continued to drop during the month to ~35Mbps. When another healthy server was introduced (mlab1.lga01), throughput to the unhealthy ones increased again - presumably due to load falling on them.

Note though that the test volume to the unhealthy servers at the start of the month was double what it was at the end of the month. This suggests that traffic volume alone was not the cause of the load issues.

Graph



Pivot Table

Average of Mean Throughput	Column Labels				
Row Labels	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**mlab1.lga01**	**Grand Total**
01/03/2012	39.96335394	42.57209791	39.35849607		40.63131597
02/03/2012	40.11911881	42.67260513	40.10044214		40.96405536
03/03/2012	40.365104	42.95765713	40.67020997		41.33099037
04/03/2012	39.46089368	42.93515797	39.38348		40.59317722
05/03/2012	39.78894973	42.97340793	40.37145876		41.04460548
06/03/2012	38.40158509	42.83501022	39.92240177		40.38633236
07/03/2012	39.31464865	42.94755776	39.09976458		40.45399033
08/03/2012	38.22010684	42.96930677	39.07483884		40.08808415
09/03/2012	38.98962505	43.01838074	37.61269156		39.87356578
10/03/2012	39.09889036	42.81376962	38.36581919		40.09282639
11/03/2012	38.8356558	42.89948405	39.11843835		40.28452607
12/03/2012	38.99068533	42.97690519	37.89287234		39.95348762
13/03/2012	39.08855733	42.59529742	36.93946792		39.54110756
14/03/2012	38.56924062	42.39856108	37.0429815		39.33692774
15/03/2012	37.92974583	42.42280565	35.38317597		38.57857582
16/03/2012	37.23060973	42.4456527	37.05128706		38.90918316
17/03/2012	36.63950043	42.61955269	35.09835888		38.11913733
18/03/2012	36.8676479	42.6133693	35.53594193		38.33898638
19/03/2012	36.4535572	42.5502227	34.33929061		37.7810235
20/03/2012	35.63479368	42.56482523	33.80345327		37.3343574
21/03/2012	36.02698565	42.69628801	34.42316439		37.71547935
22/03/2012	34.92784159	42.60245565	33.97076915		37.16702213
23/03/2012	35.52667693	42.68632006	35.31938094	42.77894289	39.07783021
24/03/2012	38.57104369	42.7053518	39.46967174	42.67159439	40.8544154
25/03/2012	39.44144905	42.49465065	39.67693451	42.4140051	41.00675983
26/03/2012	38.48510617	42.69633373	38.99231315	42.57932236	40.68826885
27/03/2012	39.28438617	42.83352883	40.26159859	42.43909651	41.20465252
28/03/2012	39.33549866	42.74884388	39.93360351	42.68580912	41.17593879
29/03/2012	38.08041319	42.30187412	38.89035431	42.57755776	40.46254984
30/03/2012	39.45319971	42.80970679	40.49592648	42.68687332	41.36142657
31/03/2012		42.66047408		42.70044998	42.68046203
Grand Total	**38.30316236**	**42.71024048**	**37.91995292**	**42.61485016**	**39.94244565**

Downstream throughput for all ISP-2 panelists in New York

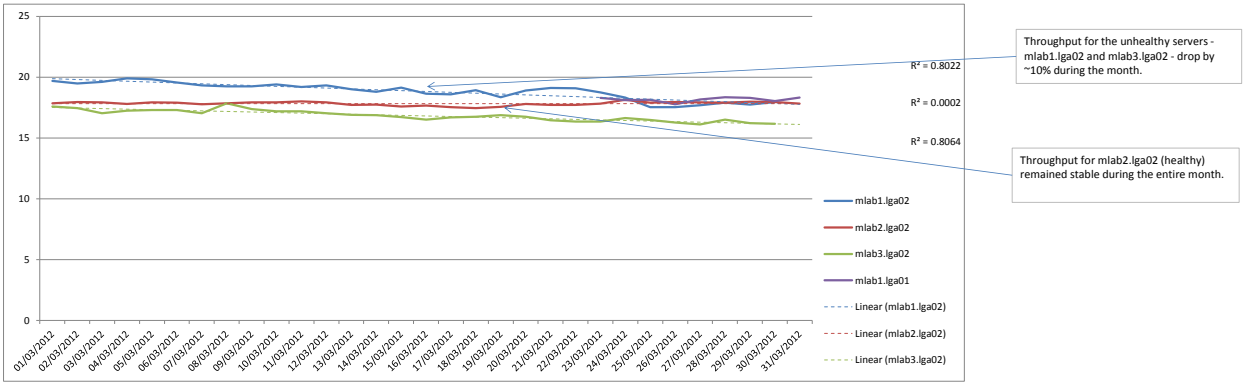
What this shows

The graph below depicts throughput results for all of ISP-2 customers using the New York servers. This includes products right across the broadband spectrum.

Throughput to mlab2.lga02 and mlab1.lga01 (both healthy servers) remained stable during the month.

Throughput to mlab1.lga02 and mlab3.lga02 (unhealthy servers) fell by ~10% during the month. It is worth noting that although throughput to mlab1.lga02 (an unhealthy server) was higher than the healthy server at the start of the month, the fact that its throughput fell and the healthy one did not demonstrates that the issue affected measurements. Note the R^2 values for the trendlines for each server (the unhealthy servers show a clear decline, whilst the healthy one is almost completely flat).

Graph



Pivot Table

Average of Mean Throughput	Column Labels				
Row Labels	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**mlab1.lga01**	**Grand Total**
01/03/2012	19.67518994	17.83345114	17.5801262		18.36292243
02/03/2012	19.46820266	17.95583998	17.45057251		18.29153838
03/03/2012	19.60623566	17.92110791	17.01951315		18.18228557
04/03/2012	19.88964918	17.78419837	17.23817968		18.30400907
05/03/2012	19.8224377	17.92388256	17.30099758		18.34910594
06/03/2012	19.55261361	17.90166678	17.3049956		18.253092
07/03/2012	19.32942372	17.77715461	17.01903268		18.04187034
08/03/2012	19.25009563	17.84390333	17.84390078		18.31263325
09/03/2012	19.23034155	17.91713382	17.37441115		18.17396217
10/03/2012	19.40193104	17.92227729	17.17618621		18.16679818
11/03/2012	19.17474065	18.01545042	17.19539515		18.12852874
12/03/2012	19.32482087	17.92992323	17.01824934		18.09099781
13/03/2012	19.00885044	17.71694068	16.90809157		17.87796089
14/03/2012	18.79071635	17.72824929	16.8793807		17.79944878
15/03/2012	19.12440233	17.59197999	16.72427581		17.81355271
16/03/2012	18.63545602	17.65147359	16.50770963		17.59821308
17/03/2012	18.5836962	17.52956637	16.67560154		17.59628804
18/03/2012	18.93426962	17.45622052	16.73200592		17.70749869
19/03/2012	18.33268889	17.56768718	16.8736253		17.59133379
20/03/2012	18.90989125	17.78217343	16.73554559		17.80920342
21/03/2012	19.09923829	17.72538544	16.43867062		17.75443145
22/03/2012	19.06915956	17.70325337	16.33497497		17.70246263
23/03/2012	18.73878467	17.81437313	16.33643951	18.30495135	17.79863717
24/03/2012	18.31357515	18.14113518	16.64523896	18.09590166	17.79896274
25/03/2012	17.53850621	17.88519237	16.48098665	18.13181332	17.50912464
26/03/2012	17.53496054	17.96328717	16.26544203	17.76705418	17.38268598
27/03/2012	17.68991654	17.92133618	16.10153291	18.1566078	17.46734836
28/03/2012	17.89400524	17.89894868	16.49988257	18.33942482	17.65806533
29/03/2012	17.72977024	17.97718286	16.20969869	18.29209076	17.55218564
30/03/2012	17.94944336	17.95515362	16.16946591	18.02025643	17.52357983
31/03/2012		17.81544652		18.31571587	18.06558119
Grand Total	**18.85343377**	**17.824225**	**16.83467096**	**18.1582018**	**17.86617933**

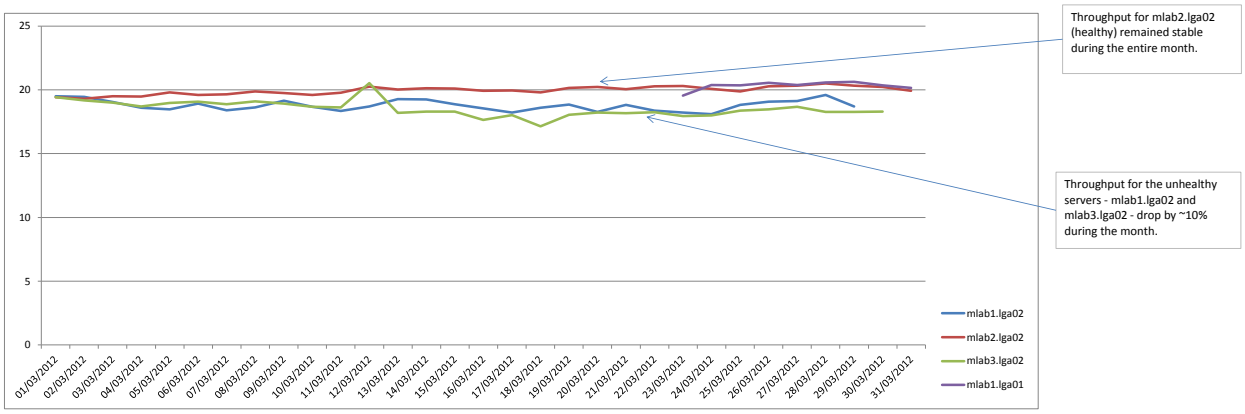
Downstream throughput for ISP-3, 15x2 product in New York

What this shows

The graph below depicts throughput for ISP-3, 15Mbps service (which is overprovisioned to ~21Mbps typically) to the New York servers in March.

During this time we see throughput for mlab2.lga02 and mlab1.lga01 remain stable. Throughput for the unhealthy servers (mlab1.lga02 and mlab3.lga02) fell by ~10%.

Graph



Pivot Table

Average of Mean Throughput	Column Labels				
Row Labels	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**mlab1.lga01**	**Grand Total**
01/03/2012	19.49179897	19.4178661	19.43432438		19.44799648
02/03/2012	19.45741992	19.30258204	19.1752508		19.31175092
03/03/2012	19.04603234	19.50328852	18.99654183		19.18195423
04/03/2012	18.60394353	19.48281714	18.69122269		18.92599445
05/03/2012	18.46593407	19.80972373	18.9773952		19.084351
06/03/2012	18.91328097	19.5938673	19.07187968		19.19300932
07/03/2012	18.38789626	19.64136179	18.87042229		18.96656011
08/03/2012	18.6267596	19.86615443	19.10143386		19.19811596
09/03/2012	19.1565531	19.75341267	18.91534157		19.27510244
10/03/2012	18.66066262	19.58718679	18.66532386		18.97105776
11/03/2012	18.34889369	19.77913387	18.61213785		18.91338847
12/03/2012	18.69826082	20.25609512	20.5167941		19.82371668
13/03/2012	19.27301896	20.0353696	18.20477242		19.17105366
14/03/2012	19.25570375	20.1366262	18.28089491		19.22440829
15/03/2012	18.8680513	20.1096874	18.2872433		19.08832733
16/03/2012	18.54505149	19.92867946	17.62870751		18.70081282
17/03/2012	18.21756078	19.93625413	18.01042037		18.72141176
18/03/2012	18.58186229	19.80676079	17.12853806		18.50572038
19/03/2012	18.83940469	20.15460997	18.05359667		19.01587044
20/03/2012	18.25965852	20.22246681	18.20766229		18.89659587
21/03/2012	18.82163824	20.05948621	18.16327798		19.01480081
22/03/2012	18.36421512	20.27437197	18.23107315		18.95655341
23/03/2012	18.22241618	20.29333819	17.93977117	19.55366971	19.00229881
24/03/2012	18.095974	20.07087571	17.99724191	20.37117884	19.13381762
25/03/2012	18.81325176	19.87722493	18.36234348	20.36111547	19.35348391
26/03/2012	19.06521273	20.27553569	18.48015909	20.56085875	19.59544156
27/03/2012	19.11621862	20.3305066	18.6738577	20.36989177	19.62261867
28/03/2012	19.59895884	20.50801848	18.259579	20.5703061	19.7342156
29/03/2012	18.68721572	20.32101606	18.27397206	20.63350256	19.4789266
30/03/2012		20.21848445	18.29888914	20.34671012	19.62136124
31/03/2012		19.92032532		20.15130314	20.03581423
Grand Total	**18.77527065**	**19.95074605**	**18.51700228**	**20.32428183**	**19.20590486**

Downstream throughput for all 10-20Mbps products, across all ISPs, in New York

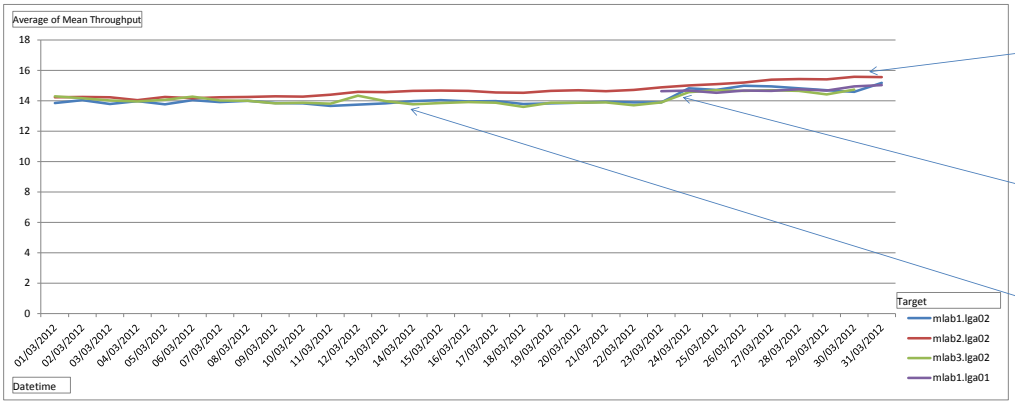
What this shows

The graph below depicts traffic across all users of 10-20Mbps broadband products which used the New York test servers.

Here we observe that throughput increased for mlab2.lga02 during March (which correlates with an increase in sample sizes).

Throughput for the unhealthy servers remained stable until mlab1.lga01 was introduced, when they jumped noticably. This was almost certainly due to reduced load on the unhealthy servers.

Graph



Throughput for mlab2.lga02 increased during the month (likely due to additional panelists - an increase in sample sizes below corroborates this).

When mlab1.lga01 was introduced (another healthy server), load on the unhealthy servers fell, and their average throughput increased.

Throughput for mlab1.lga02 and mlab3.lga02 (the unhealthy servers) remained stable during the majority of the month, but did not increase like mlab2.lga02

Pivot Table

Average of Mean Throughput	Column Labels				
Row Labels	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**mlab1.lga01**	**Grand Total**
01/03/2012	13.83785835	14.21181001	14.28674587		14.11213808
02/03/2012	14.03263519	14.24472796	14.154052		14.14380505
03/03/2012	13.78101368	14.22825425	14.01324974		14.00750589
04/03/2012	13.96296191	14.02517877	13.95019066		13.97944378
05/03/2012	13.76490552	14.23881126	14.05223602		14.01865093
06/03/2012	14.02325266	14.15893138	14.25791268		14.14669891
07/03/2012	13.90000361	14.22376202	14.00828393		14.04401652
08/03/2012	13.99215585	14.23879338	13.99804828		14.0763325
09/03/2012	13.83505001	14.2817272	13.82694258		13.98123993
10/03/2012	13.81120318	14.26604403	13.86074441		13.97933054
11/03/2012	13.64947196	14.38052982	13.80061679		13.94353952
12/03/2012	13.73756111	14.58232518	14.31843578		14.21277402
13/03/2012	13.81201494	14.55579576	13.97462732		14.11414601
14/03/2012	13.97140718	14.63719434	13.74885021		14.11915057
15/03/2012	14.03751321	14.662795	13.85071516		14.18367446
16/03/2012	13.95126856	14.64062958	13.90387117		14.16525644
17/03/2012	13.9593718	14.5268037	13.85923569		14.11513707
18/03/2012	13.7864836	14.51991204	13.58886154		13.96508572
19/03/2012	13.82808015	14.64476014	13.85776116		14.11020048
20/03/2012	13.8704378	14.68210337	13.85712342		14.13655486
21/03/2012	13.9331501	14.62358093	13.88039803		14.14570969
22/03/2012	13.88140055	14.711332	13.6947299		14.09582082
23/03/2012	13.89463476	14.86778631	13.89012775	14.61216521	14.31617851
24/03/2012	14.80302629	15.00123265	14.55654021	14.67014941	14.75773714
25/03/2012	14.70721081	15.09231278	14.68252599	14.51535947	14.74935226
26/03/2012	14.98577011	15.18839246	14.63350565	14.65928286	14.86673777
27/03/2012	14.92983242	15.38564236	14.68093216	14.63883213	14.90880977
28/03/2012	14.81987981	15.42532849	14.63356278	14.74693903	14.90642753
29/03/2012	14.6859126	15.40755897	14.42124862	14.65394468	14.79216622
30/03/2012	14.57654899	15.5736994	14.72661823	14.9412127	14.95451983
31/03/2012	15.17315053	15.53807719		15.01755211	15.24292661
Grand Total	**14.12694088**	**14.66986557**	**14.09895646**	**14.71727084**	**14.33787259**

Downstream throughput for all 20-30Mbps products, across all ISPs, in New York

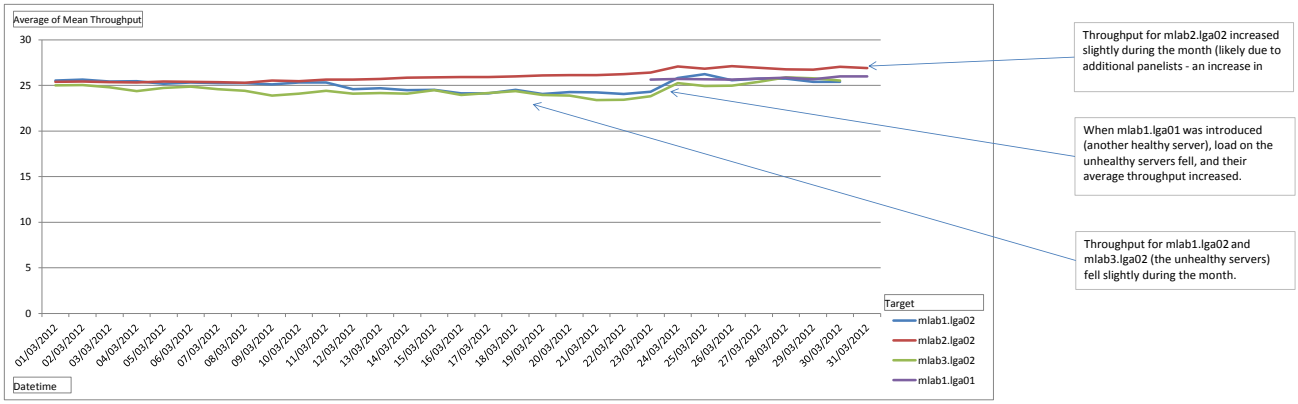
What this shows

The graph below depicts traffic across all users of 20-30Mbps broadband products which used the New York test servers.

Here we observe that throughput increased slightly for mlab2.lga02 during March (which correlates with an increase in sample sizes).

Throughput for the unhealthy servers remained stable until mlab1.lga01 was introduced, when they jumped noticably. This was almost certainly due to reduced load on the unhealthy servers.

Graph



Pivot Table

Average of Mean Throughput	Column Labels				
Row Labels	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**mlab1.lga01**	**Grand Total**
01/03/2012	25.53858059	25.38509248	25.0128834		25.31218549
02/03/2012	25.63525814	25.42369848	25.03756991		25.36550884
03/03/2012	25.43868111	25.35904306	24.78776999		25.19516472
04/03/2012	25.44618333	25.30593581	24.37859117		25.0435701
05/03/2012	25.19137898	25.41600504	24.71567381		25.10768594
06/03/2012	25.31570529	25.37734145	24.8558167		25.18295448
07/03/2012	25.23941806	25.36760342	24.56687299		25.05796482
08/03/2012	25.24758217	25.29483523	24.39685815		24.97975852
09/03/2012	25.12189529	25.54587743	23.89592342		24.85456538
10/03/2012	25.31119339	25.4702702	24.08254076		24.95466811
11/03/2012	25.3173453	25.6405847	24.41234277		25.12342425
12/03/2012	24.58847699	25.64414341	24.0910115		24.77454397
13/03/2012	24.67426565	25.71776129	24.16506608		24.85236434
14/03/2012	24.48579518	25.84557214	24.07632387		24.80256373
15/03/2012	24.52257612	25.87567222	24.4702326		24.95616031
16/03/2012	24.12416504	25.92069655	23.94340073		24.66275411
17/03/2012	24.11865637	25.91341078	24.1448047		24.72562395
18/03/2012	24.52640631	25.97017325	24.38604128		24.96087361
19/03/2012	24.0588819	26.10394187	23.96395366		24.70892581
20/03/2012	24.25690165	26.12199908	23.87812548		24.75234207
21/03/2012	24.24401251	26.13494881	23.38462227		24.5878612
22/03/2012	24.05588619	26.23961399	23.44017253		24.57855757
23/03/2012	24.31444222	26.39127415	23.79785409	25.61845322	25.03050592
24/03/2012	25.81324145	27.0717313	25.23547202	25.69202424	25.95311725
25/03/2012	26.22088241	26.83338738	24.94474529	25.66599951	25.91625365
26/03/2012	25.57819477	27.1158289	24.97434262	25.63131827	25.82492114
27/03/2012	25.74553493	26.94680675	25.39264553	25.72716653	25.95303844
28/03/2012	25.7415762	26.77526155	25.86378747	25.85774721	26.05959311
29/03/2012	25.38852582	26.71079807	25.77972532	25.65962229	25.88466788
30/03/2012	25.39901549	27.0546492	25.51580018	25.98616638	25.98890781
31/03/2012		26.91433573		25.99942267	26.4568792
Grand Total	**25.02202196**	**26.02865464**	**24.51969901**	**25.75976893**	**25.24977843**

Downstream throughput for all 30-40Mbps products, across all ISPs, in New York

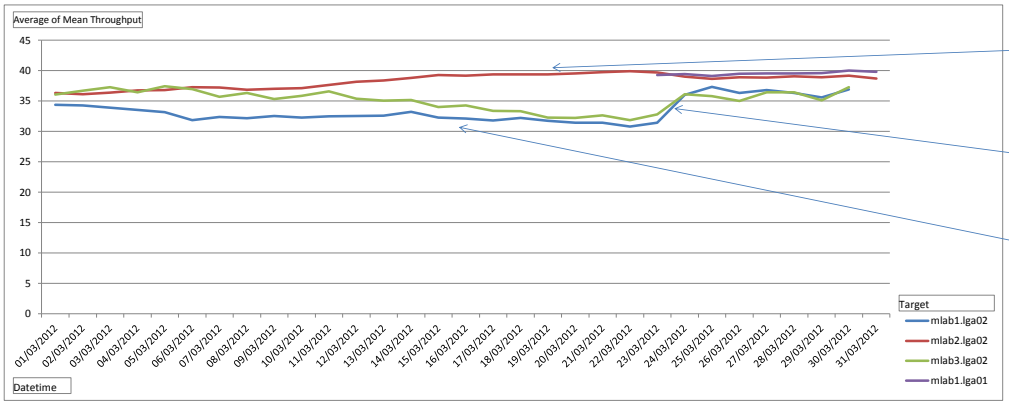
What this shows

The graph below depicts traffic across all users of 30-40Mbps broadband products which used the New York test servers.

Here we observe that throughput increased noticably for mlab2.lga02 during March (which correlates with an increase in sample sizes).

Throughput for the unhealthy servers fell during March, until mlab1.lga01 was introduced and load fell on the unhealthy servers.

Graph



Throughput for mlab2.lga02 increased during the month (likely due to additional panelists - an increase in sample sizes below corroborates this).

When mlab1.lga01 was introduced (another healthy server), load on the unhealthy servers fell, and their average throughput increased.

Throughput for mlab1.lga02 and mlab3.lga02 (the unhealthy servers) fell by ~ 10% during the

Pivot Table

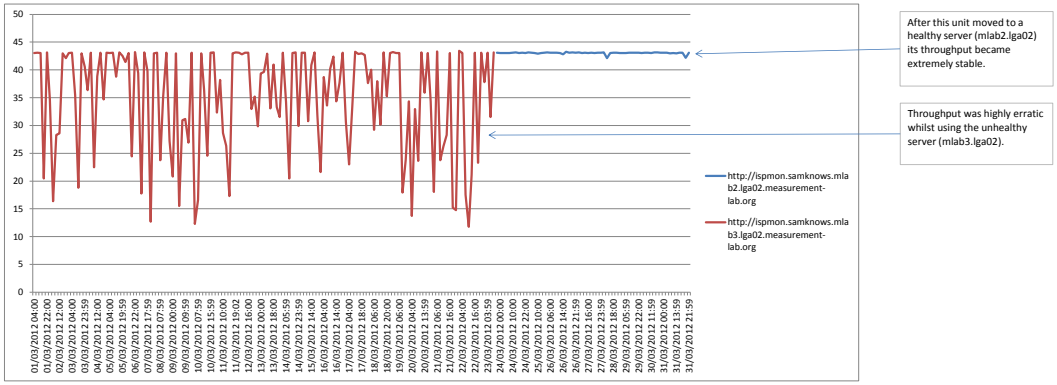
Average of Mean Throughput	Column Labels				
Row Labels	**mlab1.lga02**	**mlab2.lga02**	**mlab3.lga02**	**mlab1.lga01**	**Grand Total**
01/03/2012	34.3987644	36.3609649	36.09530023		35.61834318
02/03/2012	34.27830257	36.10739222	36.70502751		35.69690743
03/03/2012	33.91743144	36.39871557	37.26693973		35.86102891
04/03/2012	33.57356171	36.77820392	36.41828791		35.59001785
05/03/2012	33.15652991	36.81271055	37.41625901		35.79516649
06/03/2012	31.88628242	37.30641508	36.97515659		35.3892847
07/03/2012	32.38568668	37.24401757	35.69249818		35.10740081
08/03/2012	32.18947061	36.88269698	36.34090259		35.13769006
09/03/2012	32.53279086	37.02447542	35.31669717		34.95798782
10/03/2012	32.28846458	37.12789341	35.87232154		35.09622651
11/03/2012	32.51703988	37.65465898	36.58760065		35.58643317
12/03/2012	32.5479898	38.18215362	35.38201077		35.37071806
13/03/2012	32.61077317	38.39631064	35.09926934		35.36878438
14/03/2012	33.21112868	38.80453985	35.18649455		35.73405436
15/03/2012	32.28247722	39.29513581	34.04494656		35.20751986
16/03/2012	32.10612122	39.16378777	34.27168571		35.18053157
17/03/2012	31.82219788	39.4101042	33.39223468		34.87484559
18/03/2012	32.22460054	39.36454508	33.31123923		34.96679495
19/03/2012	31.74972665	39.40532456	32.28499521		34.48001547
20/03/2012	31.44735993	39.55981883	32.20522368		34.40413415
21/03/2012	31.46353734	39.78057191	32.66385		34.63598642
22/03/2012	30.82546398	39.91871422	31.87139321		34.20519047
23/03/2012	31.45591444	39.68886593	32.8135359	39.30917388	35.81687253
24/03/2012	36.03205124	39.02230411	36.15218403	39.46622056	37.66818998
25/03/2012	37.31733207	38.65133119	35.83457037	39.10076718	37.7260002
26/03/2012	36.34038608	38.89352764	34.9968243	39.4974971	37.43205878
27/03/2012	36.81585461	38.886773	36.45545286	39.53964157	37.92443051
28/03/2012	36.31660484	39.08042551	36.45821195	39.5321873	37.8468574
29/03/2012	35.61236081	38.91198677	35.12406012	39.61044909	37.3147142
30/03/2012	36.91723778	39.18844579	37.26213377	40.0392529	38.35176756
31/03/2012		38.72272632		39.81503441	39.26888037
Grand Total	**33.40744811**	**38.32340443**	**35.18324358**	**39.54558044**	**36.01656512**

Downstream throughput for Unit 8811 (ISP-1, 35x35) in New York

What this shows

Throughput measurements to mlab3.lga02 (one of the unhealthy servers) were highly erratic. Later in the month, the probe switched to use mlab2.lga02 and the measurements became extremely stable.

Graph



Pivot Table

Average of Throughput	Column Labels		
Row Labels	mlab2.lga02	mlab3.lga02	Grand Total
01/03/2012 04:00		43.052976	43.052976
01/03/2012 08:00		43.084216	43.084216
01/03/2012 12:00		43.063328	43.063328
01/03/2012 16:00		20.458464	20.458464
01/03/2012 22:00		43.130272	43.130272
02/03/2012 00:00		34.63632	34.63632
02/03/2012 04:00		16.374384	16.374384
02/03/2012 06:00		28.319344	28.319344
02/03/2012 12:00		28.60212	28.60212
02/03/2012 19:00		42.997096	42.997096
02/03/2012 22:00		42.103904	42.103904
03/03/2012 00:00		43.047416	43.047416
03/03/2012 04:00		43.089216	43.089216
03/03/2012 07:59		35.458152	35.458152
03/03/2012 18:00		18.780616	18.780616
03/03/2012 22:00		42.973816	42.973816
03/03/2012 23:59		40.579544	40.579544
04/03/2012 06:00		36.338	36.338
04/03/2012 07:59		43.095048	43.095048
04/03/2012 10:00		22.479744	22.479744
04/03/2012 12:00		38.841592	38.841592
04/03/2012 13:59		43.096392	43.096392
04/03/2012 22:00		34.686288	34.686288
05/03/2012 00:00		43.067704	43.067704
05/03/2012 04:00		43.053288	43.053288
05/03/2012 06:00		43.06852	43.06852
05/03/2012 13:59		38.760128	38.760128
05/03/2012 15:59		43.135728	43.135728
05/03/2012 19:59		42.546112	42.546112
06/03/2012 10:00		41.397208	41.397208
06/03/2012 12:00		43.057416	43.057416
06/03/2012 13:59		24.44716	24.44716
06/03/2012 22:00		43.198408	43.198408
07/03/2012 08:00		39.400752	39.400752
07/03/2012 12:00		17.75308	17.75308
07/03/2012 16:00		43.1684	43.1684
07/03/2012 17:59		39.834304	39.834304
07/03/2012 20:00		12.704408	12.704408
08/03/2012 03:59		42.966888	42.966888
08/03/2012 06:00		43.093144	43.093144
08/03/2012 07:59		23.740136	23.740136
08/03/2012 12:00		35.208744	35.208744
08/03/2012 16:00		43.091976	43.091976
08/03/2012 21:59		27.210448	27.210448
09/03/2012 00:00		20.7926	20.7926
09/03/2012 04:00		42.977232	42.977232
09/03/2012 06:00		15.50996	15.50996
09/03/2012 07:59		30.962216	30.962216
09/03/2012 09:59		31.162944	31.162944
09/03/2012 14:00		26.896744	26.896744
09/03/2012 15:59		43.094904	43.094904
09/03/2012 23:59		12.282936	12.282936
10/03/2012 07:59		16.62172	16.62172
10/03/2012 10:00		42.952864	42.952864
10/03/2012 11:59		36.377168	36.377168
10/03/2012 14:00		24.56824	24.56824
10/03/2012 15:59		43.117032	43.117032
10/03/2012 17:59		43.1618	43.1618
10/03/2012 22:00		32.348024	32.348024
11/03/2012 06:00		38.193416	38.193416
11/03/2012 10:00		28.625744	28.625744
11/03/2012 11:59		26.365488	26.365488
11/03/2012 16:00		17.29824	17.29824
11/03/2012 17:59		42.98908	42.98908
11/03/2012 19:02		43.177824	43.177824
11/03/2012 21:59		43.067832	43.067832
12/03/2012 08:00		42.831208	42.831208
12/03/2012 13:59		43.112528	43.112528
12/03/2012 16:00		43.06832	43.06832
12/03/2012 17:59		32.96104	32.96104
12/03/2012 20:00		35.185808	35.185808
12/03/2012 22:00		29.879072	29.879072
13/03/2012 00:00		39.367792	39.367792
13/03/2012 03:59		39.655328	39.655328
13/03/2012 05:59		42.899008	42.899008
13/03/2012 10:00		33.089952	33.089952
13/03/2012 18:00		40.99084	40.99084
13/03/2012 20:00		33.317144	33.317144
13/03/2012 23:59		31.52248	31.52248
14/03/2012 03:59		43.067688	43.067688
14/03/2012 05:59		34.227216	34.227216
14/03/2012 10:00		20.458464	20.458464
14/03/2012 19:01		43.031928	43.031928

14/03/2012 20:00		43.140032	43.140032
14/03/2012 23:59		29.892416	29.892416
15/03/2012 06:00		43.091808	43.091808
15/03/2012 08:00		43.071776	43.071776
15/03/2012 10:00		30.798208	30.798208
15/03/2012 14:00		40.868568	40.868568
15/03/2012 15:59		43.13472	43.13472
15/03/2012 20:00		31.750384	31.750384
15/03/2012 22:00		21.597704	21.597704
16/03/2012 04:00		38.717496	38.717496
16/03/2012 06:00		33.567808	33.567808
16/03/2012 08:00		40.225408	40.225408
16/03/2012 12:00		42.377912	42.377912
16/03/2012 14:00		34.359752	34.359752
16/03/2012 15:59		37.617552	37.617552
16/03/2012 18:00		43.071872	43.071872
16/03/2012 21:59		30.653112	30.653112
17/03/2012 04:00		22.982936	22.982936
17/03/2012 10:00		33.347912	33.347912
17/03/2012 12:00		43.276768	43.276768
17/03/2012 14:00		42.890616	42.890616
17/03/2012 18:00		42.981256	42.981256
17/03/2012 22:00		42.690224	42.690224
17/03/2012 23:59		37.636968	37.636968
18/03/2012 04:00		40.070816	40.070816
18/03/2012 06:00		29.208616	29.208616
18/03/2012 10:00		37.970936	37.970936
18/03/2012 12:00		30.118528	30.118528
18/03/2012 18:00		43.166016	43.166016
18/03/2012 20:00		35.261584	35.261584
18/03/2012 22:00		43.022	43.022
19/03/2012 00:00		43.211928	43.211928
19/03/2012 04:00		43.05272	43.05272
19/03/2012 06:00		43.025096	43.025096
19/03/2012 08:00		17.919736	17.919736
19/03/2012 10:00		23.826192	23.826192
19/03/2012 20:00		34.356296	34.356296
20/03/2012 04:00		13.729736	13.729736
20/03/2012 05:59		32.93928	32.93928
20/03/2012 10:00		23.629048	23.629048
20/03/2012 12:00		43.153248	43.153248
20/03/2012 13:59		35.89608	35.89608
20/03/2012 16:00		43.055344	43.055344
20/03/2012 18:00		34.328376	34.328376
21/03/2012 04:00		18.072576	18.072576
21/03/2012 06:00		43.328048	43.328048
21/03/2012 07:59		23.739184	23.739184
21/03/2012 10:00		26.282376	26.282376
21/03/2012 14:00		28.276272	28.276272
21/03/2012 16:00		43.029232	43.029232
21/03/2012 18:00		15.238072	15.238072
21/03/2012 20:00		14.752304	14.752304
21/03/2012 21:59		43.446264	43.446264
22/03/2012 04:00		43.051912	43.051912
22/03/2012 08:00		17.524352	17.524352
22/03/2012 10:00		11.781256	11.781256
22/03/2012 14:00		21.16628	21.16628
22/03/2012 16:00		43.07308	43.07308
22/03/2012 17:59		23.279984	23.279984
22/03/2012 20:00		43.103472	43.103472
22/03/2012 23:59		37.795024	37.795024
23/03/2012 03:59		43.081312	43.081312
23/03/2012 16:00		31.520032	31.520032
23/03/2012 18:00		43.127392	43.127392
23/03/2012 21:03	43.074472		43.074472
24/03/2012 00:00	43.05816		43.05816
24/03/2012 04:00	43.02404		43.02404
24/03/2012 06:00	43.055688		43.055688
24/03/2012 07:59	43.050096		43.050096
24/03/2012 10:00	43.095112		43.095112
24/03/2012 12:00	43.131976		43.131976
24/03/2012 14:00	43.04316		43.04316
24/03/2012 18:00	43.108072		43.108072
24/03/2012 22:00	43.0356		43.0356
25/03/2012 00:00	43.180072		43.180072
25/03/2012 05:59	43.082848		43.082848
25/03/2012 08:00	43.03364		43.03364
25/03/2012 10:00	42.943616		42.943616
25/03/2012 11:59	43.0594		43.0594
25/03/2012 14:00	43.078944		43.078944
25/03/2012 15:59	43.13092		43.13092
26/03/2012 06:00	43.078992		43.078992
26/03/2012 08:00	43.068712		43.068712
26/03/2012 10:00	43.10276		43.10276
26/03/2012 12:00	43.056072		43.056072
26/03/2012 14:00	42.7946		42.7946
26/03/2012 16:00	43.286936		43.286936
26/03/2012 18:00	43.089728		43.089728
26/03/2012 20:00	43.137576		43.137576
26/03/2012 21:59	43.074496		43.074496
27/03/2012 04:00	43.128856		43.128856
27/03/2012 08:00	43.049672		43.049672
27/03/2012 12:00	43.092424		43.092424
27/03/2012 16:00	43.026448		43.026448
27/03/2012 17:59	43.069928		43.069928
27/03/2012 20:00	43.04204		43.04204
27/03/2012 22:00	43.10672		43.10672
27/03/2012 23:59	43.080288		43.080288
28/03/2012 03:59	43.155528		43.155528
28/03/2012 08:00	42.119584		42.119584
28/03/2012 12:00	43.0628		43.0628
28/03/2012 18:00	43.079552		43.079552
28/03/2012 22:00	43.071072		43.071072
28/03/2012 23:59	43.021728		43.021728
29/03/2012 04:00	43.0628		43.0628
29/03/2012 05:59	43.0562		43.0562
29/03/2012 07:59	43.083256		43.083256
29/03/2012 09:59	43.088584		43.088584
29/03/2012 20:00	43.083112		43.083112
29/03/2012 22:00	43.0824		43.0824
30/03/2012 06:00	43.06064		43.06064
30/03/2012 07:59	43.099664		43.099664
30/03/2012 10:00	43.107064		43.107064
30/03/2012 11:59	43.012976		43.012976
30/03/2012 13:59	43.131088		43.131088
30/03/2012 15:59	43.164448		43.164448
30/03/2012 20:00	43.088848		43.088848
31/03/2012 00:00	43.087		43.087
31/03/2012 04:00	43.1166		43.1166
31/03/2012 06:00	42.957712		42.957712
31/03/2012 12:00	43.029256		43.029256
31/03/2012 13:59	42.981824		42.981824
31/03/2012 15:59	43.102512		43.102512

31/03/2012 17:59	43.089		43.089
31/03/2012 20:00	42.175768		42.175768
31/03/2012 21:59	43.079136		43.079136
Grand Total	**43.04390671**	**34.91670226**	**37.32764329**

Packet Loss to Los Angeles & Mountain View servers, across all ISPs and products

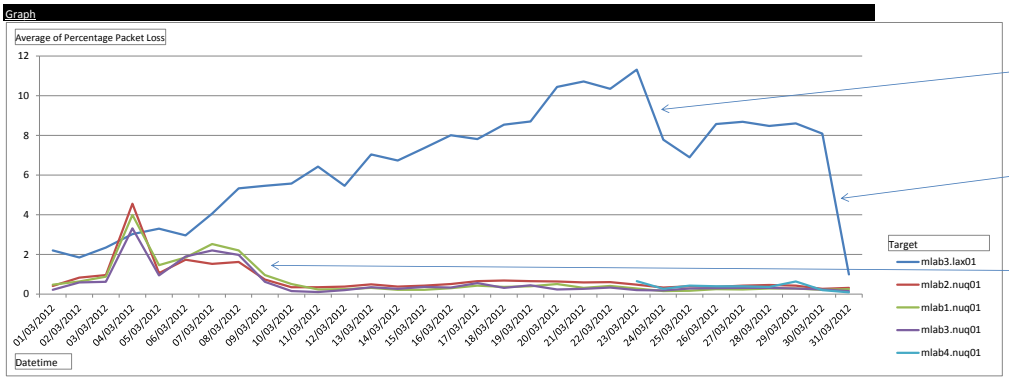
What this shows

The below graph depicts packet loss against the Los Angeles and Mountain View servers during March, across all ISPs and products. The Mountain View (nuq01) servers were healthy and are included here for comparison against the unhealthy Los Angeles server (mlab3.lax01). Measurements to mlab1.lax01 and mlab2.lax01 were disabled, as these servers were offline with disk issues. Measurements were also disabled to mlab4.nuq01 until later in the month.

Packet loss to mlab3.lax01 increases steadily throughout the month, eventually exceeding 11%. Loss dropped down to ~8% following the introduction of mlab4.nuq01 (and a subsequent reduction in measurements to mlab3.lax01). Loss to mlab3.lax01 dropped significantly on March 31 as (a) the issue was resolved and (b) we moved all measurement traffic away from the faulty server.

This graph also shows that it is very likely that the packet loss (and thus the issue) was occurring before March, as loss to mlab3.lax01 was already at 2%.

Graph



mlab4.nuq01 was introduced into active service, resulting in someprobes switching to use the new server. This meant a lower amount of tests to mlab3.lax01 lowering average packet loss. The sample sizes in the data below corroborate this.

All traffic was moved away from this server, and the server was rebooted (resolving the issue) around the same time.

The reason for this spike at the start of March for all of nuq01 is unknown, but certainly unrelated to the issues highlighted here (we know this because loss falls back to very low levels again, without a server reboot, so it was likely some upstream network issue, or an issue affecting a single ISP)

Pivot Table

Average of Percentage Packet Loss	Column Labels					
Row Labels	**mlab3.lax01**	**mlab2.nuq01**	**mlab1.nuq01**	**mlab3.nuq01**	**mlab4.nuq01**	**Grand Total**
01/03/2012	2.1971062	0.4220689	0.4770295	0.2217811		0.829496425
02/03/2012	1.8572385	0.8326654	0.6357356	0.5861231		0.97794065
03/03/2012	2.3474286	0.9633101	0.8753469	0.6174409		1.200881625
04/03/2012	3.0330995	4.5563777	3.9936586	3.3160813		3.724804275
05/03/2012	3.3033446	1.0571127	1.4580454	0.9524975		1.69275005
06/03/2012	2.9696856	1.74263	1.8510805	1.8938473		2.11431085
07/03/2012	4.0641053	1.5250147	2.5334884	2.1992061		2.580453625
08/03/2012	5.3323205	1.6255013	2.1985109	1.9715247		2.78196435
09/03/2012	5.4649961	0.7321287	0.9582525	0.6170887		1.9431165
10/03/2012	5.5748033	0.3474086	0.5065508	0.1629196		1.647920575
11/03/2012	6.4223162	0.3537226	0.2423886	0.1151932		1.78340515
12/03/2012	5.4564555	0.3878545	0.2470722	0.2102863		1.575417125
13/03/2012	7.0399052	0.4899102	0.3215814	0.3473153		2.049678025
14/03/2012	6.7420444	0.3861818	0.215963	0.2673423		1.902882875
15/03/2012	7.3563946	0.432326	0.2285243	0.3704698		2.096928675
16/03/2012	8.0012288	0.5060069	0.3058333	0.3265973		2.284916575
17/03/2012	7.8097967	0.6565063	0.4352617	0.5621178		2.365920625
18/03/2012	8.5438363	0.6866984	0.3584833	0.3213346		2.47758815
19/03/2012	8.6990133	0.6481236	0.3968806	0.4537311		2.54943715
20/03/2012	10.4504965	0.6326612	0.5175718	0.2427234		2.960863225
21/03/2012	10.7221126	0.5984642	0.3128265	0.2673746		2.975194475
22/03/2012	10.3532811	0.6080789	0.4119717	0.338411		2.927935675
23/03/2012	11.3136976	0.48061	0.2873279	0.207313	0.6490963	2.58760896
24/03/2012	7.7775476	0.3337986	0.1638642	0.1841661	0.2681488	1.74550506
25/03/2012	6.8889706	0.3918214	0.1739265	0.2915211	0.4333288	1.63591368
26/03/2012	8.576069	0.3704383	0.2494479	0.2977244	0.4015994	1.9790558
27/03/2012	8.6926856	0.435696	0.2363309	0.3212287	0.3976169	2.01671162
28/03/2012	8.4742872	0.4584164	0.2803375	0.3182471	0.3720238	1.9806624
29/03/2012	8.6034194	0.4353374	0.2901718	0.2785794	0.6437945	2.0502605
30/03/2012	8.0932768	0.2610947	0.2156705	0.2326524	0.2124938	1.80303764
31/03/2012	0.992036	0.3133549	0.2499048	0.1590122	0.093504	0.36156238
Grand Total	**6.553322555**	**0.763590981**	**0.697710952**	**0.601672626**	**0.385734033**	**2.034412156**

Downstream throughput for all 20-30Mbps products, across all ISPs, in Los Angeles

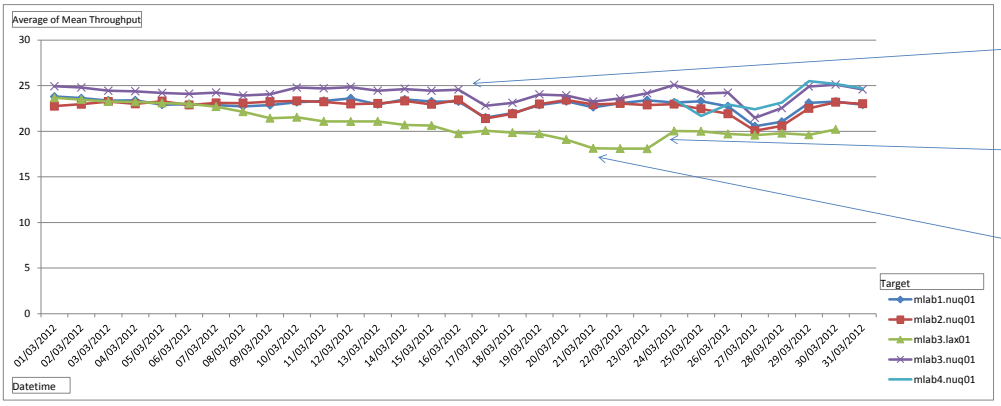
What this shows

The graph below depicts traffic across all users of 20-30Mbps broadband products which used the Los Angeles and Mountain View test servers.

Here we observe that throughput remained largely stable for the healthy servers (mlab*.nuq01) during March.

Throughput for mlab3.lax01 (unhealthy) fell considerably during the month - by as much as 20%.

Graph



Throughput for the healthy nuq01 servers was largely stable during the month.

The introduction of mlab4.nuq01 took some load off mlab3.lax01, increasing throughput slightly.

Throughput for mlab3.lax01 (unhealthy) dropped significantly during the month, falling by as much as 20%.

Pivot Table

Average of Mean Throughput	Column Labels					
Row Labels	**mlab1.nuq01**	**mlab2.nuq01**	**mlab3.lax01**	**mlab3.nuq01**	**mlab4.nuq01**	**Grand Total**
01/03/2012	23.8036671	22.74212448	23.66337593	24.92487908		23.78351165
02/03/2012	23.6186587	22.95342888	23.47377809	24.78963033		23.708874
03/03/2012	23.37169431	23.24829094	23.25073845	24.43706477		23.57694712
04/03/2012	23.39634244	22.99352153	23.22444486	24.38797729		23.50057153
05/03/2012	22.9097948	23.29910483	23.08596467	24.18226217		23.36928162
06/03/2012	22.96150229	22.87343003	23.01692244	24.09567519		23.23688249
07/03/2012	22.86073903	23.09515631	22.69342188	24.23514408		23.22111532
08/03/2012	22.71883893	23.08259816	22.14245564	23.90497133		22.96221602
09/03/2012	22.84918929	23.23515624	21.43316861	24.04684442		22.89108964
10/03/2012	23.18532618	23.32494389	21.53019339	24.77941684		23.20497008
11/03/2012	23.33142117	23.21955086	21.0762576	24.70406834		23.08282449
12/03/2012	23.61381663	22.97715505	21.06460832	24.84555025		23.12528256
13/03/2012	22.93908129	23.0433729	21.08075401	24.45054062		22.8784372
14/03/2012	23.47828037	23.32123887	20.69075086	24.63403446		23.03107614
15/03/2012	23.26308242	22.94732929	20.62539539	24.43618703		22.81799853
16/03/2012	23.26084279	23.43820855	19.73004176	24.5635478		22.74816023
17/03/2012	21.50478447	21.38323955	20.06869147	22.79851819		21.43880842
18/03/2012	21.99494656	21.91434806	19.84046347	23.09658309		21.7115853
19/03/2012	22.87305093	22.98321486	19.71942123	24.03226318		22.40198755
20/03/2012	23.27373637	23.42577292	19.08741442	23.92715686		22.42852014
21/03/2012	22.63276334	22.92571412	18.13013008	23.25370757		21.73557878
22/03/2012	23.06609094	23.04236235	18.09849029	23.59495548		21.95047477
23/03/2012	23.40696073	22.8773788	18.08418439	24.16334917		22.13296827
24/03/2012	23.1467922	22.97183004	20.02116971	25.06906729	23.48907319	22.93958649
25/03/2012	23.27867212	22.44784615	19.9947481	24.12607691	21.66715825	22.30290031
26/03/2012	22.73624031	21.91244743	19.6940269	24.22662015	22.91813721	22.2974944
27/03/2012	20.53787381	20.06138563	19.57364536	21.45394786	22.4113887	20.80764827
28/03/2012	21.04009413	20.5740974	19.77927065	22.53550854	23.12676479	21.4111471
29/03/2012	23.1160803	22.50355156	19.59623996	24.90143546	25.48392675	23.1202468
30/03/2012	23.25617175	23.17391187	20.20375052	25.11484691	25.17469463	23.38467514
31/03/2012	22.90421901	23.00900302		24.57768073	24.68783494	23.79468442
Grand Total	**22.91389531**	**22.74195854**	**20.78913062**	**24.13837133**	**23.61987231**	**22.71949525**