Performance Assessment Tool (PAT) v 2.1.

1 PAT

The Performance Assessment Tool, or PAT for short, is Acceleration Systems built in benchmarking tool for determining the results of optimization on the attached WAN connection of an RBA. PAT determines the difference in throughput between the WAN and LAN connections and shows the effects of optimization on the "Last Mile" of a network connection. This provides a simple, easy to read tool that shows you exactly how much data is passing over your WAN connection and what affects our system is having on it. You get to see the immediate effect on your data, your file transfers, and your application performance in real time so there is no question of the benefits of Acceleration Systems WAN optimization.

The "Last Mile" terminology refers to the Internet connection between your ISP and the location of the RBA. This is where our RBA works for your connection. Test result will vary from connection to connection, especially depending on the quality of the connection provided by your ISP. Although our RBA can help poor quality connections through the optimization protocols it runs, it cannot make a poor connection run well. Lost, out of order, or retransmission of packets due to interference on the connection can only be helped so much. We want our clients to be able to evaluate the value of our systems as effectively as possible. So let's look at the quality of your network as it stands and then let's apply PAT to give you real world result measures.

1.1 NETWORK QUALITY REPORT (PRE-TEST EVALUATION)

You need to login to your RBA to see the Network Quality Report. Enter this URL in the address bar on your browser: localrba.accelerationsystems.com/ Login to the RBA with user "localadmin" and password = RBA Serial Number. The Network Quality Report is near top center of the RBA Dashboard page, as shown below.

acceleration*systems*

Status: Dashboard

System ☑	
Interfaces ☑	
Firewall ☑	
Services ☑	
VPN ☑	
Status ☐	
CARP (failover)	
Dashboard	
DHCP Leases	
DHCPv6 Leases	
Email Reports	
Filter Reload	
Gateways	

Acceleration Systems Tools ☐ ☒
Serial Number: LR201405011523
Performance Assessment Tool

Network Quality Report ☐ ☒
Last Test Datetime: November 02 2015 18:48:27.

MTR: Installed	Loss	Latency	Status
Local Network	0.0 %	23.70ms	PASSED
Last Mile	0.0 %	20.00 ms	PASSED
Internet	15.4 %	37.07 ms	UNKNOWN
Destination	0.0 %	52.30 ms	PASSED

View Report   Run Test

Cumulative Offload Statistics ☐ ☒

Acceleration: On	Received	Sent

SMART Status ☐ ☒

Drive	Ident	SMART Status
ada0	20140715AA0000000048	PASSED

Thermal Sensors ☐ ☒

Core 0: 25.0 °C   100°
Core 1: 25.0 °C   100°
Core 2: 23.0 °C   100°
Core 3: 24.0 °C   100°

Traffic Graphs ☐ ☒
Current WAN Traffic

As stated, Network Quality can and will impact the results seen by using the AS's WAN Optimization so it is very crucial to know what is happening on your network prior to looking at our numbers. Many connections are challenged by distance, reliability of connections, etc. So before we look at performance numbers let's find out if there are issues to address before we take measurements of acceleration.

The "Network Quality Report" is based on data collected with MTR. MTR (My TraceRoute) is a computer program which combines the functionality of the traceroute and ping programs in a single network diagnostic tool. (See https://en.wikipedia.org/wiki/MTR_(software) for additional information.)

MTR probes routers on the route path by limiting the number of hops individual packets may traverse, and listening to responses of their expiry. It will regularly repeat this process, usually once per second, and keep track of the response times of the hops along the path.

Network Quality Report performs an analysis of the MTR data and breaks the data into 4 network segments, as follows:

Local Network: These are the devices between the RBA and a public router.

Last Mile: These are the ISP devices connecting the local network to the public Internet.

Internet: Routers in the public Internet that connect the ISP to the destination. This is typically the largest number of routers in one segment.

Destination: Routers between the public Internet and the target SPOC.

Network Quality Report shows Packet Loss percentage, Latency, and Status for each of the 4 segments. Latency is reported as average Round Trip Time (RTT) for the segment being evaluated, in milliseconds. Status is reported as one of three color coded values: **PASSED**, **UNKNOWN**, and **FAILED**.

> **PASSED**: indicates that this network segment is operating correctly.

> **UNKNOWN**: indicates that this network segment has issues such as pack loss that may impact test results.

> **FAILED**: indicates that this network segment is has major issues or is not operational. Troubleshoot your connection or contact your network support or ISP for assistance.

Let's take a look at this data. Log in to the RBA using the "localadmin" user and the unit's serial number as the password. On the Dashboard at the top left you will see this represented data.
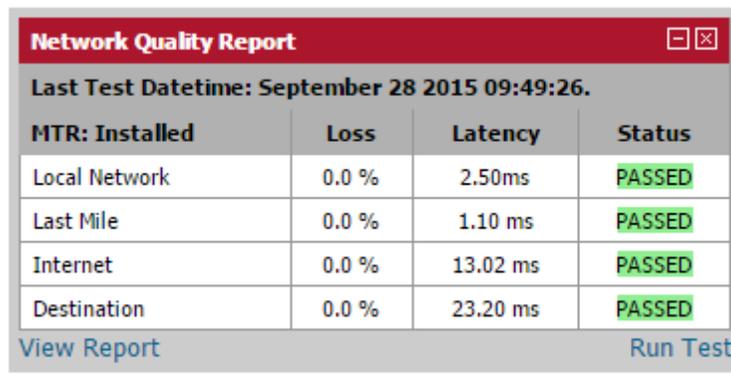
Network Quality Report ☐☒

Last Test Datetime: September 28 2015 09:49:26.

MTR: Installed	Loss	Latency	Status
Local Network	0.0 %	2.50ms	PASSED
Last Mile	0.0 %	1.10 ms	PASSED
Internet	0.0 %	13.02 ms	PASSED
Destination	0.0 %	23.20 ms	PASSED
View Report			Run Test

Network Quality Report results are saved by the RBA for a short period of time. To be sure you are looking at current network information click the "Run Test" link at the bottom right corner of this box.

To see a detailed view let's click on the "View Report" link on the bottom left.

```
September 28 2015 09:49:26.

Start: Mon Sep 28 09:49:07 2015
HOST: 2t82j1t-i28nw11-jvced11-vbf  Loss%   Snt   Last    Avg   Best   Wrst  StDev
  1.|-- RO1-DSL-74-215-218-1.fuse   0.0%    10    0.8    2.5    0.8    7.8    2.4
  2.|-- 172.17.122.34               0.0%    10    1.2    1.3    1.0    2.0    0.0
  3.|-- WS-ZT-1.CIN1.core.fuse.ne   0.0%    10    1.0    1.1    0.9    2.3    0.3
  4.|-- te0-0-2-0.nr11.b016343-1.   0.0%    10    2.2    1.9    1.7    2.2    0.0
  5.|-- te0-0-1-1.rcr12.cvg02.atl   0.0%    10    2.0    2.2    1.7    4.2    0.7
  6.|-- te0-7-0-0.rcr21.cmh02.atl   0.0%    10    3.9    4.0    3.7    4.0    0.0
  7.|-- te0-7-0-35.ccr21.cle04.at   0.0%    10   10.2    7.6    7.1   10.2    0.9
  8.|-- be2482.ccr41.jfk02.atlas.   0.0%    10   19.4   19.3   19.1   19.6    0.0
  9.|-- be2324.ccr21.jfk04.atlas.   0.0%    10   19.4   19.5   19.2   20.4    0.0
 10.|-- telia.jfk04.atlas.cogentc   0.0%    10   19.4   19.5   19.4   19.6    0.0
 11.|-- digitalocean-ic-306497-ny   0.0%    10   23.0   23.0   22.9   23.1    0.0
 12.|-- 162.243.188.242             0.0%    10   20.0   20.2   20.0   20.4    0.0
 13.|-- 104.131.123.138             0.0%    10   23.6   23.2   22.7   23.9    0.0
```

1.1.1 Raw MTR Data

As we see from this Network Quality Report, we have 0.0% packet loss on this connection at this time. This states that, overall, this connection is performing normally, though this may vary from time to time depending on a multitude of variables that can affect your ISP or destination. Some variables that can come into play at any given point of time include, traffic saturation and demand, failed or flapping infrastructure from various ISP's, line interference or "noise" on a connection, distance of connection, or even weather can create negative impacts on a connection at any given point and time.

Sometimes we see some of these glitches in our report and the connection may return a test result of "Unknown". Typically this result will show packet loss at a particular hop along the route of the traffic but then we will see that all further hops are still showing clean. This type of result shows us that somewhere along the route there was a failure to respond to the ping because the operator of that system has ping response blocked. These result don't typically have an impact on our traffic tests so we can proceed with our testing. Should we see packet loss begin at one hop and then continue over multiple hops then we need to take a more in depth look at the quality of our connections and typically engage troubleshooting with our ISP.

As stated before, this quality test only shows minimalistic data on the performance of a connection. Acceleration Systems assumes that qualified Network Engineers are capable of determining the Quality of their connection and typically have a variety of network monitoring and assessment tools. For those of you that are not as experienced in understanding your WAN link performance there are other tests that you can and should run to determine connection parameters and issues that may be affecting your network.

PingPlotter: https://www.pingplotter.com/ provides a downloadable lightweight network monitoring and troubleshooting tool. It can run in the background collecting data while you continue to run applications and then allow you to quickly look at the data in an intuitive

graphical format when you experience network problems. PingPlotter is great at allowing you to collect data over time to see trends.

Glasnost: ISP's often perform traffic shaping on the data connections to their customers. Traffic Shaping is a very effective tool for ISP's to limit or regulate the amount of traffic you can use. Glasnost from the Max Planck Institute can help you determine if your ISP is invoking traffic shaping on your data, you can test online here: http://broadband.mpi-sws.org/transparency/bttest.php.
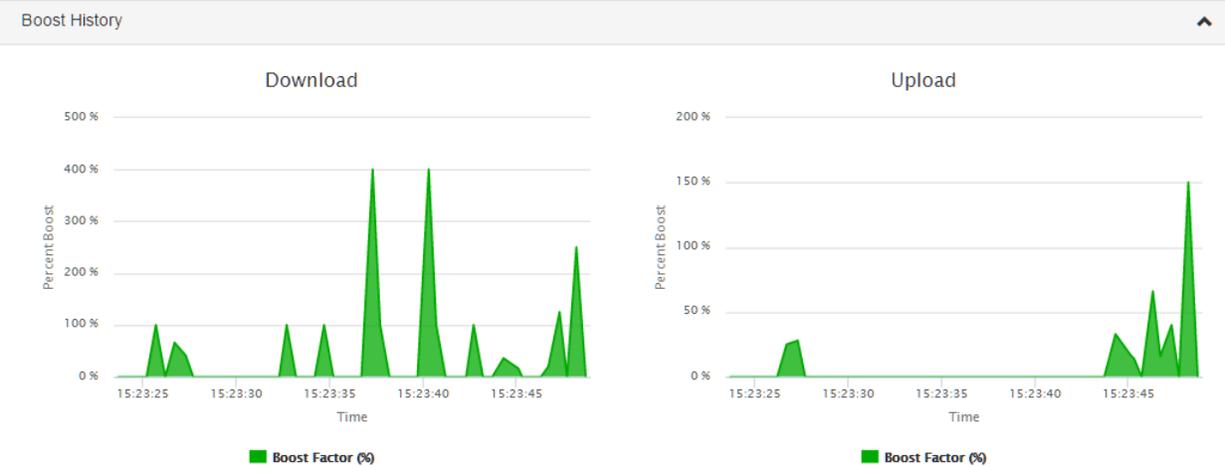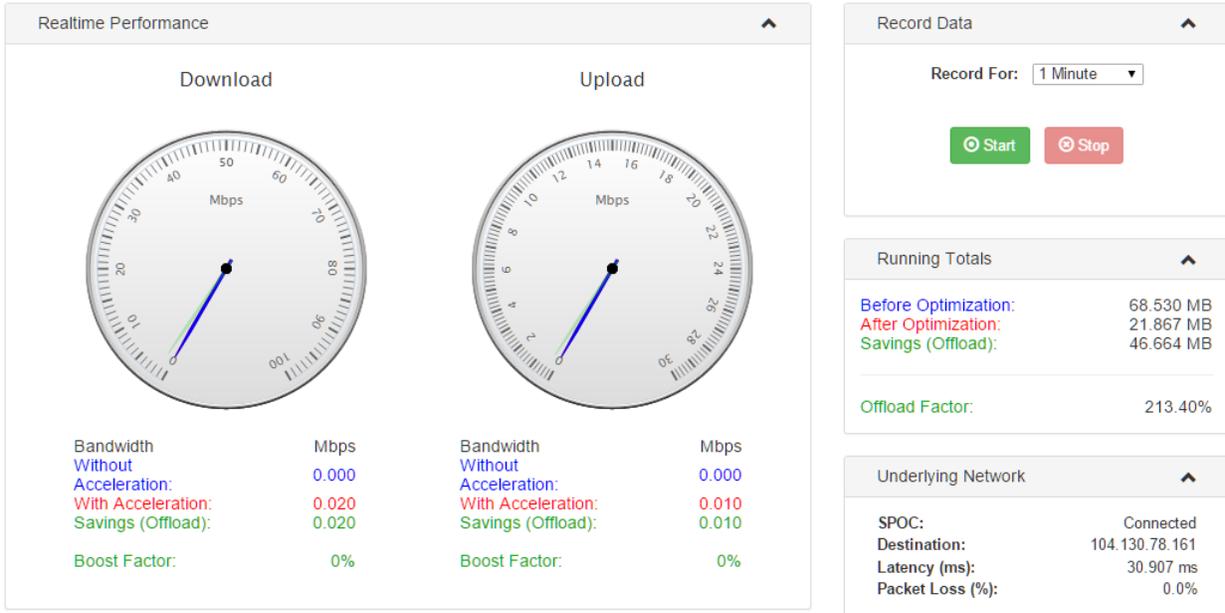
VisualWare: http://myspeed.visualware.com/ Running a network quality test from the myspeed server provides highly detailed information about packet loss issues.

Once you have determined that your WAN connection does not have any issues that would affect the results of our testing we can move forward with a reasonable expectation that these parameters are going to hold true and that the numbers we will receive from PAT will provide us with an accurate measurement of the Accelerators true performance. Please remember to always check the Network Quality report prior to running testing to verify that this is always the state of the network so results can be evaluated fairly. If you are seeing packet loss along your WAN connections route please determine as much as possible what is happening to your connection and make remediation as necessary.

2   EXECUTING PAT

Now that we have determined our WAN link is functioning optimally let's run PAT. Enter this URL in the address bar on your browser: localrba.accelerationsystems.com/pat.php Or, login to the RBA with user "localadmin" and password = RBA serial Number and navigate to Services – PAT. -The following page is displayed.

***NOTE: Please make sure to close all other programs on your PC and run PAT exclusively as they can impact the traffic and caching of data that you see. Also when running specific performance tests be aware of what other users/devices on your network are doing. In some cases you want to perform your tests with normal business traffic going on. In other cases such as isolating a particular application performance you may need to schedule a window with other users and admins to verify that your test conditions remain constant during the test.

PAT
Performance Assessment Tool

Performance Assessment Tool

Realtime Performance ▲

Download

50
40   60
Mbps
30   70
20   80
10   90
0   100

Upload

14   16
12   18
Mbps
10   20
8   22
6   24
4   26
2   28
0   30

Bandwidth	Mbps	Bandwidth	Mbps
Without Acceleration:	0.000	Without Acceleration:	0.000
With Acceleration:	0.020	With Acceleration:	0.010
Savings (Offload):	0.020	Savings (Offload):	0.010
Boost Factor:	0%	Boost Factor:	0%

Record Data ▲

Record For: 1 Minute ▼

⊙ Start   ⊗ Stop

Running Totals ▲

Before Optimization:	68.530 MB
After Optimization:	21.867 MB
Savings (Offload):	46.664 MB
Offload Factor:	213.40%

Underlying Network ▲

|	
SPOC:	Connected
Destination:	104.130.78.161
Latency (ms):	30.907 ms
Packet Loss (%):	0.0%

Boost History ▲

Download

Upload

PAT is designed to measure the amount of network traffic across the LAN connection which represents the amount of data that would normally traverse the WAN without optimization. From there it measures the amount of traffic that traverses the WAN that is optimized and measures the amount of traffic that traverses the WAN that is not optimized. The delta difference represents the amount of optimization that has occurred.

PAT's speedometers for download and upload contain two needles the first is the blue needle, this needle represents total traffic across the WAN connection that is not optimized traffic. The red needle represents the optimized traffic and the green that is registered between the two needles represents the optimization savings you receive from our processes, this is known as

the "Boost Factor" and is shown in percent. PAT also has a third green needle that represents the maximum savings you have seen. The Green Needle will stay at the highest point of savings that your traffic has achieved. Resetting the needle back to zero can be done by refreshing the page in your browser as this clears all data.

In the scenario below, I have started an application that downloads a cache of data that the system clearly has seen previously. Although some of the data has been changed the majority of the data has remained the same. This is clearly evident by the real time download Boost Factor of 563.64% on this segment. Yes over a 500% savings via Acceleration Systems Optimization techniques. A look at our "Running Totals" tells us that during this test I saw a Total Boost Factor of 134%
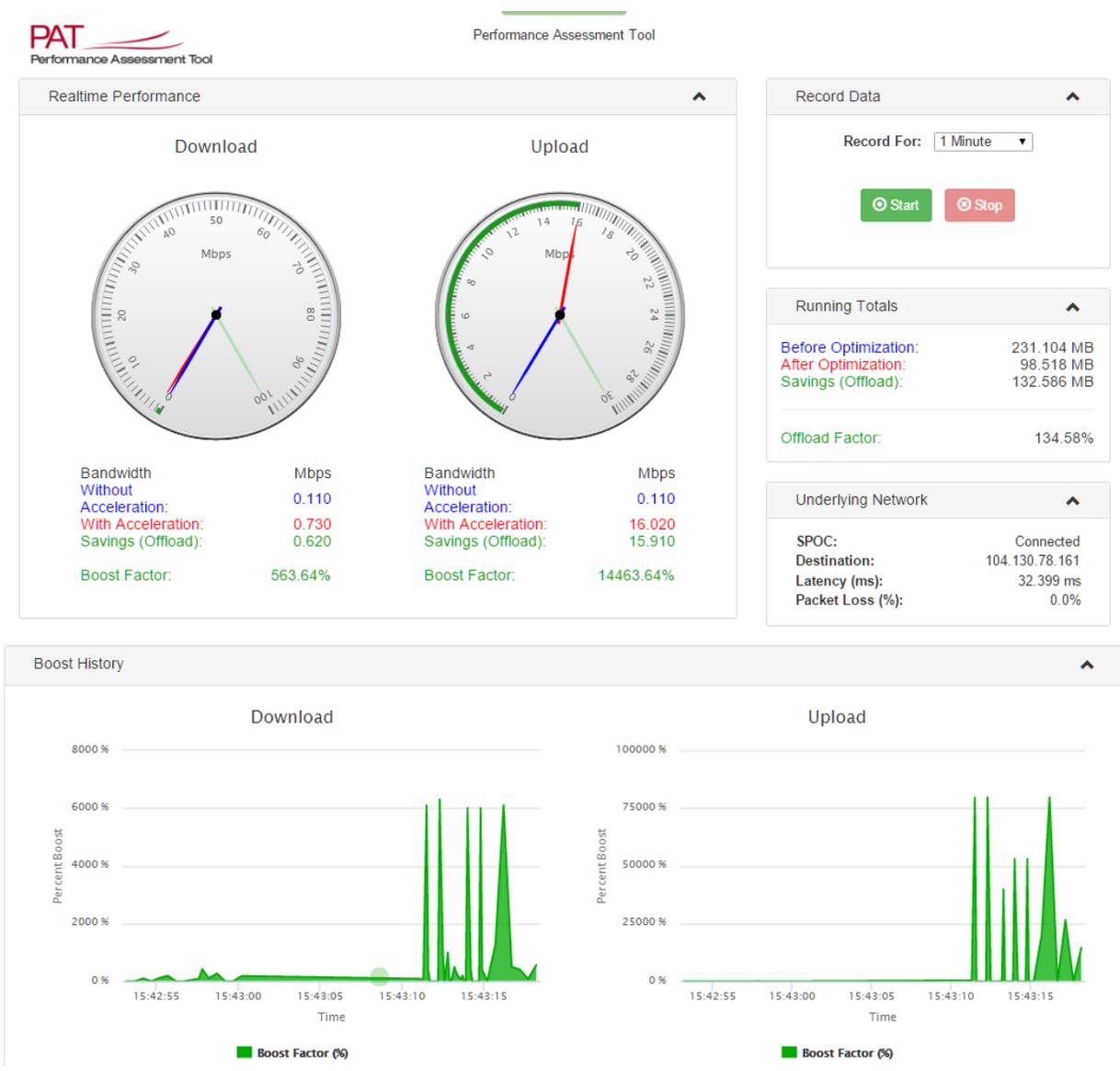
By using the PAT tool we are now able to watch typical WAN traffic uploads and downloads, application use and accurately measure the difference, or Boost Factor, that is obtained by using Acceleration Systems WAN Optimization. From there we can monitor the data flow in real time ½ second increments and perform any type of file data transfers over and over to recognize the value of the AS product lines. The results show the value that is obtained through our acceleration, optimization, and deduplication that is performed on the traffic. If we recognize the amount of data that we typically see over and over again in our WAN data streams we can see that as we continue to move data back and forth we actually continue a cumulative effect of getting faster and faster with every pass of similar traffic. This also means that data we have seen before does not need to traverse the wire again resulting in very substantial reduction or "offload" of actual data transferred across our WAN connections.

The graphs below the speedometers represent the Boost Factor. Along the vertical access in a dynamic format that changes in measuring units depending on the amount of savings, and the polling time is represented on the horizontal access and moves in half second increments.

2.1.1   Terms Defined
The following terms are used in PAT.

After Optimization is the total number of MegaBytes on the WAN ports.

**Before Optimization** is the total number of MegaBytes on the LAN ports.

Savings is the difference between Local and Internet

Offload Factor is Savings listed in a percentage format of the optimization achieved. Boost Factor = ((Local-Internet)/Internet) * 100.

2.2   RECORDING AND PRINTING PAT DATA
PAT has the ability to record performance data for a specified period and present the recorded data in a report page and as a down loadable .csv file that can be opened with any spreadsheet application. This means that you can start PAT recording, execute an application, then return to PAT and see the Savings for that application.

To access this function, use the Record Data box on the upper right of the PAT screen, and shown below.
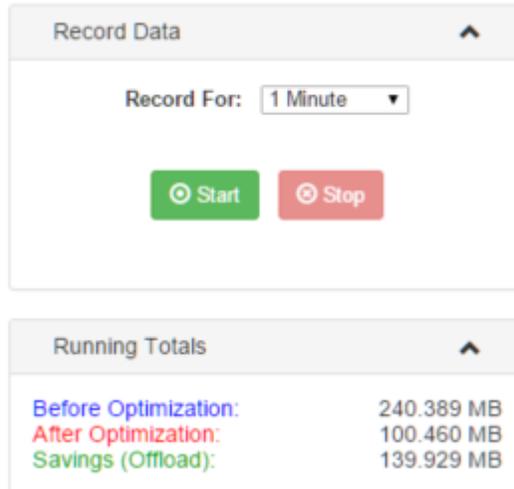
Use the dropdown to select a recording time (1, 5, 10, 30 minutes, or 1, 4, 8, 24 hours.) With the desired recording time selected, click the [Start] button to start recording. Notice that the values in the Running Totals box are reset to zero when the recording starts.

Execute your selected test applications. Two quick tests are http://www.speedtest.net/ and https://www.speakeasy.net/speedtest/. Run these tests at least twice to see the full impact of the deduplication cache that stores blocks of data for future reference.

You can stop recording at any time by clicking the [Stop] button or simply wait for the record time to run out. Notice that a countdown timer is displayed when recording is started, as shown below.
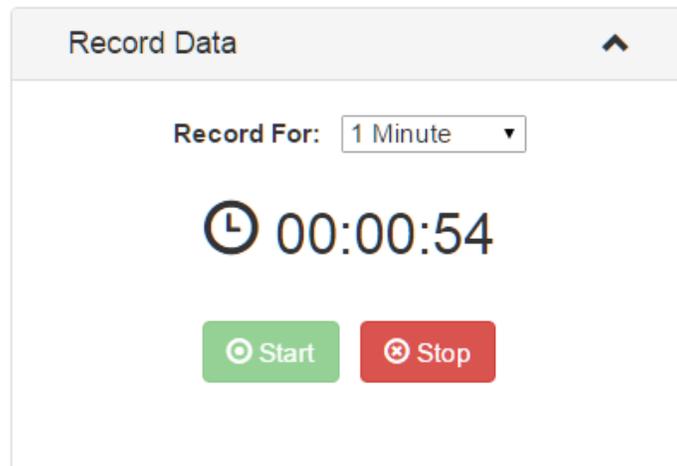
2.2.1   Viewing Results

Once a recording is complete, the Record Data box includes buttons to download the data, [Download CSV] and to view a report of the recorded data [View Results]. These buttons will appear when you open PAT when a previous recording is available on the system.
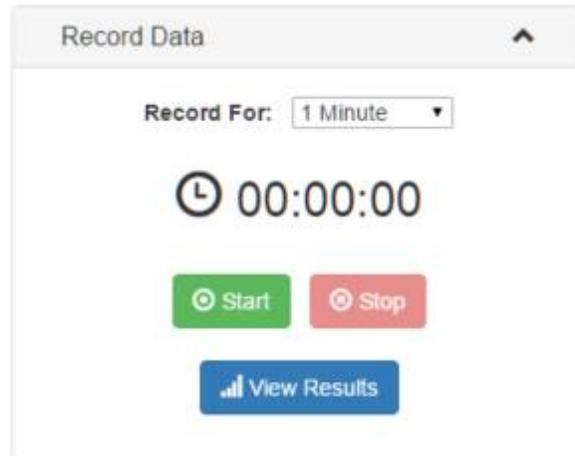
Click the [View Results] button to open a new browser page that displays the recorded data, as shown below.
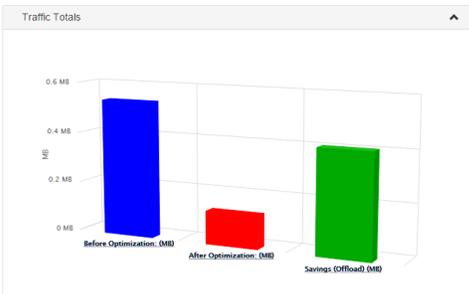
PAT
Performance Assessment Tool

View Recorded Data

Site Specific Data ⌃

Hostname:	2t82j1t-i28nw11-uiqtsog-n4gtcgh-9qzv7oi-oz70hxi-y7fgulg
Serial:	LR201405011486
ISP:	Time Warner Cable Internet LLC
Location:	US-KY-Lexington

Recorded Data ⌃

Timezone: America/New_York

Start Time: 12/28/15, 15:55:44
Stop Time: 12/28/15, 15:56:43
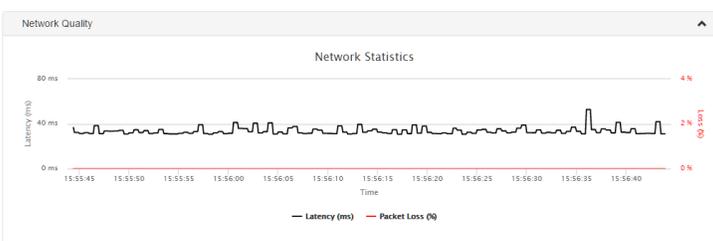
⬇ Download CSV

Traffic Totals ⌃

0.6 MB
0.4 MB
MB 0.2 MB
0 MB

Before Optimization: (MB)   After Optimization: (MB)   Savings (Offload) (MB)

Data Totals ⌃

Before Optimization:	0.537 MB
After Optimization:	0.130 MB
Savings (Offload):	0.407 MB
Offload Factor:	313.56%

Underlying Network ⌃

	Min	Avg	Max
Latency (ms)	30.68	33.57	52.75
Packet Loss (%)			0.00%

Savings (Boost) ⌃

Download

Boost Factor (%)

Upload

Boost Factor (%)

Throughput ⌃

Download

With Acceleration (Mbps)   Savings (Boost) (Mbps)   Without Acceleration (Mbps)

Upload

With Acceleration (Mbps)   Savings (Boost) (Mbps)   Without Acceleration (Mbps)

Network Quality ⌃

Network Statistics


Latency (ms)   Packet Loss (%)

2.2.2   Saving and Printing Reports

You can use any browser plugin that can capture pages for printing or storage in various file formats. We have used FireShot (available from http://getfireshot.com/) to capture the report shown above in Chrome. FireShot can save the page as an image (.png,) or a PDF, and can print the page.

2.2.3   Downloading Data

Click the [Download CSV] button to download a file of the data used for the report in CSV format. You can open the file with any spreadsheet program.
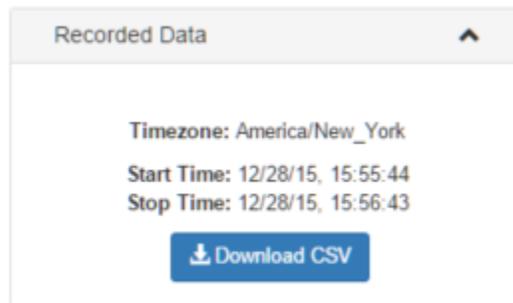
Here is a sample of the file as displayed by MS Excel.

timestamp	lan_down_MB	lan_down_Mbps	lan_up_MB	lan_up_Mbps	wan_down_MB	wan_down_Mbps
1.44657E+12	0.41	6.61	0.01	0.19	0.41	6.59
1.44657E+12	0.41	6.55	0.01	0.2	0.41	6.52
1.44657E+12	0.57	9.15	0.01	0.21	0.57	9.15
1.44657E+12	0.51	8.21	0.01	0.21	0.51	8.18
1.44657E+12	0.43	6.88	0.01	0.18	0.43	6.91
1.44657E+12	0.54	8.69	0.01	0.21	0.54	8.64
1.44657E+12	0.54	8.69	0.01	0.23	0.54	8.69
1.44657E+12	1.94	31.1	0.04	0.71	1.94	31.08
1.44657E+12	11.64	186.24	0.29	4.64	11.63	186.13

Data is normalized to 100 ms (0.1 second.) The full list of columns:

Timestamp is the Linux date/time value in milliseconds. It can be converted to MS Excel date/time using the formula = (A2/(86400000))+25569. This generates a time value in GMT.

lan_down_MB is the total number of MegaBytes delivered to local systems summed across all of the LAN ports for the time period.

lan_down_Mbps is the transmission speed in megabits per second for the data delivered to local systems summed across all of the LAN ports for the time period.

lan_up_MB is the total number of MegaBytes received from local systems summed across all of the LAN ports.

lan_up_Mbps is the transmission speed in megabits per second for the data received from local systems summed across all of the LAN ports.

wan_down_MB is the total number of MegaBytes received from remote systems summed across all of the WAN ports.

wan_down_Mbps is the transmission speed in megabits per second for the data received from remote systems summed across all of the WAN ports.

wan_up_MB is the total number of MegaBytes delivered to remote systems summed across all of the WAN ports.

wan_up_Mbps is the transmission speed in megabits per second for the data delivered to remote systems summed across all of the WAN ports.

boost_down_absolute is the number of megabytes of Boost for data received on the WAN from remote servers and delivered to local users on all LAN. Calculated as (Local Down –Internet Down) for the measurement period.) Not currently used.

boost_down_factor is the percent Boost for data received on the WAN from remote servers and delivered to local users on all LAN. Calculated as ((Local Down –Internet Down)/Internet Down)*100 for the measurement period.)

boost_up_absolute is the number of megabytes of Boost for data received on the LAN from all local users and delivered on the WAN to remote servers. Calculated as (Local Up –Internet Up) for the measurement period.) Not currently used.

boost_up_factor is the percent Boost for data received on the LAN from all local users and delivered on the WAN to remote servers. Calculated as ((Local Up –Internet Up)/Internet Up)*100 for the measurement period.)

boost_down_MB is the number of megabytes of Boost for data received on the WAN from remote servers and delivered to local users on all LAN. Calculated as (Local Down – Internet Down) for the measurement period.)

boost_down_Mbps is the accelerated transmission speed in megabits per second for the data received from remote systems summed across all of the WAN ports.

boost_up_MB is the number of megabytes of Boost for data received on the LAN from all local users and delivered on the WAN to remote servers. Calculated as (Local Up – Internet Up) for the measurement period.)

boost_up_Mbps is the accelerated transmission speed in megabits per second for the data delivered to remote systems summed across all of the WAN ports.

latency is the delay in milliseconds for the link between the RBA and the supporting SPOC as measured by a one packet ping during the data collection period.

loss is the packet loss for the link between the RBA and the supporting SPOC as measured by a one packet ping during the data collection period.

So now all you need to do is create your own tests by opening your applications or running your downloads and uploads and by watching PAT, the evidence becomes quite clear as to just how much our systems optimizes your connection.

2.3 SPEEDTEST.NET COMPARISON

SpeedTest.net uses a set of 10 predefined files for the test. Each file is actually a jpeg image with random colors in each pixel. SpeedTest.net downloads a file to the browser running the test, then sends that file back to the SpeedTest.net server for the upload test.

The first time the RBA processes a SpeedTest.net file it has to build a deduplication cache for blocks of data in the file. This is termed a cold pass. The next time the RBA sees this file all of the data is in the cache so that only references to the sequence of cache blocks needs to be transmitted. This is termed a hot pass. Since SpeedTest.net uploads the file that was just downloaded, the upload test is always a hot pass, showing significant acceleration, often over 3x.

SpeedTest.net collects data movement measurements (throughput in bytes per unit of time) as the test is executed. SpeedTest.net executes the following process to calculate the reported speed result:

- Throughput samples are received at up to 30 times per second.
- These samples are then aggregated into 20 slices (each being 5% of the samples).
- The fastest 10% and slowest 30% of the slices are then discarded.
- The remaining slices are averaged together to determine the final result.

Reference: See https://support.speedtest.net/hc/en-us/articles/203845400-How-does-the-test-itself-work-How-is-the-result-calculated-.

2.4 TROUBLESHOOTING

A final word on testing. For many of you, it is obvious what this data means to you and your network, for some it may seem like a mish-mash of numbers that really don't explain to you why you are seeing what you are seeing. We understand this. Network assessments can be tricky and troubleshooting varying results can sometimes feel like you are searching for the proverbial needle in the haystack.

If you are experiencing wide variations of results, the first thing we always recommend is an examination of your WAN connection without the RBA, run the tests that check your WAN connections Network Quality, check with your ISP to determine the causes of any major degraded traffic issues you may be experiencing. Once you have determined that your WAN connection is running trouble free then perform the Optimization tests. You should be able to return consistent testing results and see the actual benefit of the RBA. If for some reason you still get numbers that you think are erroneous, please feel free to open a ticket with us so we can help you assess the numbers you're seeing While we can't assume responsibility for failures in your WAN connection, we are always willing to look and see if the results you are seeing are to be attributed to your RBA or not.