

CLI Testing and Troubleshooting

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perfSONAR is developed by a partnership of

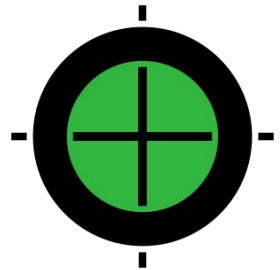


ESnet



INDIANA UNIVERSITY





Commands and Syntax



pscheduler – The Secret Sauce

- pscheduler is the engine that drives perfSONAR
 - Coordinates timeslots and schedules tests between nodes
 - Creates a common syntax that all tools use
 - Handles the storage of results
- This approach to test management ensures that:
 - Tests that could impact each other's performance, like throughput, are never run simultaneously
 - Simplified coordination, where you don't need an engineer at the other end to start a daemon, open a port, etc.
 - Access control is maintained and test limits are enforced



Basic syntax

pscheduler task [options] test-type [test-options]

- *task* is what you want pscheduler to do
- *test-type* is how you want pscheduler to do it

There's more than one tool to run many of these tests, and pscheduler gives you the option to choose that tool:

- *iperf2/iperf3/nuttcp* for bandwidth
- *traceroute/tracepath/paris-traceroute* for routing
- *--help is your friend!*



Remote Commands, AKA, Your Best Friends

- --source and --dest flags do what you expect they would, but neither end has to be your node
 - You can run most tests between two remote nodes
 - This includes perfSONAR's built-in self-diagnostic tools
- This core piece of functionality is what makes perfSONAR useful in day-to-day troubleshooting activities and makes it more than just a simple performance data collector



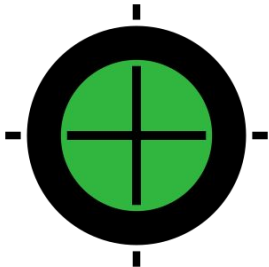
```
[ps-iniu@thrpt10ge-1 ~]$ pscheduler task throughput --source perf.newy32aoa.neaar.net --dest test.seat.transpac.org
Submitting task...
Task URL:
https://perf.newy32aoa.neaar.net/pscheduler/tasks/666b16fc-c32d-4960-a8ac-ef66b2eca183
Running with tool 'iperf3'
Fetching first run...

Next scheduled run:
https://perf.newy32aoa.neaar.net/pscheduler/tasks/666b16fc-c32d-4960-a8ac-ef66b2eca183/runs/31b57ed0-c39c-4533-8654-60e8a2137d64
Starts 2021-05-26T14:18:53Z (~6 seconds)
Ends 2021-05-26T14:19:12Z (~18 seconds)
Waiting for result...

* Stream ID 5
Interval      Throughput      Retransmits      Current Window
0.0 - 1.0     4.67 Gbps       1                148.25 MBytes
1.0 - 2.0     9.89 Gbps       0                148.39 MBytes
2.0 - 3.0     9.90 Gbps       0                148.39 MBytes
3.0 - 4.0     9.90 Gbps       2                152.96 MBytes
4.0 - 5.0     9.90 Gbps       0                152.96 MBytes
5.0 - 6.0     9.89 Gbps       0                152.96 MBytes
6.0 - 7.0     9.90 Gbps       0                152.96 MBytes
7.0 - 8.0     9.90 Gbps       0                152.96 MBytes
8.0 - 9.0     9.90 Gbps       0                152.96 MBytes
9.0 - 10.0    9.89 Gbps       0                152.96 MBytes

Summary
Interval      Throughput      Retransmits      Receiver Throughput
0.0 - 10.0    9.37 Gbps       3                9.20 Gbps

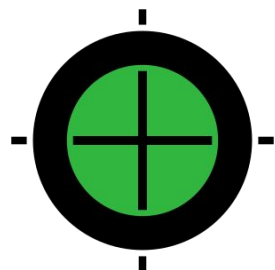
No further runs scheduled.
```



```
[ps-iniu@thrpt10ge-1 ~]$ pscheduler task --tool tracepath trace --source perf.newy32aoa.neaar.net --dest test.seat.transpac.org
Submitting task...
Task URL:
https://perf.newy32aoa.neaar.net/pscheduler/tasks/a447400a-125a-46cb-9e78-020ab537cca1
Running with tool 'tracepath'
Fetching first run...

Next scheduled run:
https://perf.newy32aoa.neaar.net/pscheduler/tasks/a447400a-125a-46cb-9e78-020ab537cca1/runs/19416479-28b0-40a3-9844-2bd9c4f93a70
Starts 2021-05-26T14:30:25Z (~1 seconds)
Ends 2021-05-26T14:32:06Z (~100 seconds)
Waiting for result...
```

```
1      vlan-150.rtr.newy32aoa.neaar.net (192.203.116.32) AS396390 0.142 ms mtu 9000 bytes
      INDIANA-UNIVERSITY-NEAAR, US
2      et-2-1-5.127.rtsw.newy32aoa.net.internet2.edu (198.71.45.192) AS11537 0.789 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
3      ae-3.4079.rtsw.wash.net.internet2.edu (162.252.70.138) AS11537 6.192 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
4      ae-0.4079.rtsw2.ashb.net.internet2.edu (162.252.70.137) AS11537 6.62 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
5      ae-2.4079.rtsw.ashb.net.internet2.edu (162.252.70.74) AS11537 6.54 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
6      ae-20.4079.rtsw.clev.net.internet2.edu (162.252.70.129) AS11537 13.544 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
7      ae-3.4079.rtsw3.eqch.net.internet2.edu (162.252.70.131) AS11537 20.07 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
8      ae-5.4079.rtsw.eqch.net.internet2.edu (162.252.70.162) AS11537 26.237 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
9      ae-0.4079.rtsw.minn.net.internet2.edu (162.252.70.107) AS11537 27.898 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
10     ae-1.4079.rtsw.seat.net.internet2.edu (162.252.70.172) AS11537 59.964 ms mtu 9000 bytes
      INTERNET2-RESEARCH-EDU, US
11     207.231.240.24 AS53965 59.659 ms mtu 9000 bytes
      CCSEBGP, US
12     test.seat.transpac.org (192.203.115.2) AS22388 59.635 ms mtu 9000 bytes
      TRANSPAC, US
```



Wait, did you say built-in diagnostics??

- *pscheduler troubleshoot*
 - See if your node has the basic, necessary services running, if PMTUD is working, if the clock is synched to an NTP source, etc.
- *pscheduler troubleshoot \$remote_node1*
 - Same as above, but adds in the same tests on a remote node to ensure your two nodes can successfully complete a test
- *pscheduler troubleshoot --host=\$remote_node1 \$remote_node2*
 - Same as the first two, but checking two remote nodes against each other




```
[ps-iniu@thrpt10ge-1 ~]$ pscheduler troubleshoot --host perf.newy32aoa.neaar.net test.seat.transpac.org
Performing basic troubleshooting of perf.newy32aoa.neaar.net and test.seat.transpac.org.
```

```
perf.newy32aoa.neaar.net:
```

```
Measuring MTU... 9000+
Looking for pScheduler... OK.
Fetching API level... 4
Checking clock... OK.
Exercising API... Status... Tests... Tools... OK.
Fetching service status... OK.
Checking services... ticker... scheduler... runner... archiver... OK.
Idle test.... 4 seconds.... Checking archiving... OK.
```

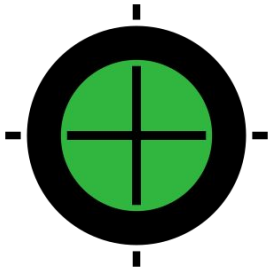
```
test.seat.transpac.org:
```

```
Measuring MTU... 9000+
Looking for pScheduler... OK.
Fetching API level... 4
Checking clock... OK.
Exercising API... Status... Tests... Tools... OK.
Fetching service status... OK.
Checking services... ticker... scheduler... runner... archiver... OK.
Idle test.... 4 seconds.... Checking archiving... OK.
```

```
perf.newy32aoa.neaar.net and test.seat.transpac.org:
```

```
Checking IP addresses... IPv4
Measuring MTU... 9000+
Checking timekeeping... OK.
Simple stream test.... 11 seconds.... OK.
```

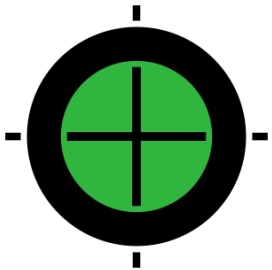
```
pScheduler on both hosts appears to be functioning normally.
```



Yeah, but what about pscheduler monitor?

Yep, that works too.

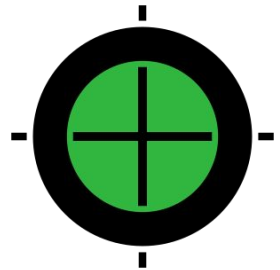
pscheduler monitor --host=\$remote_host



You can even plot a host's schedule:

```
pscheduler plot-schedule --host=$remote_host
```

[illegible]



In The Wild

Examples from real world scenarios

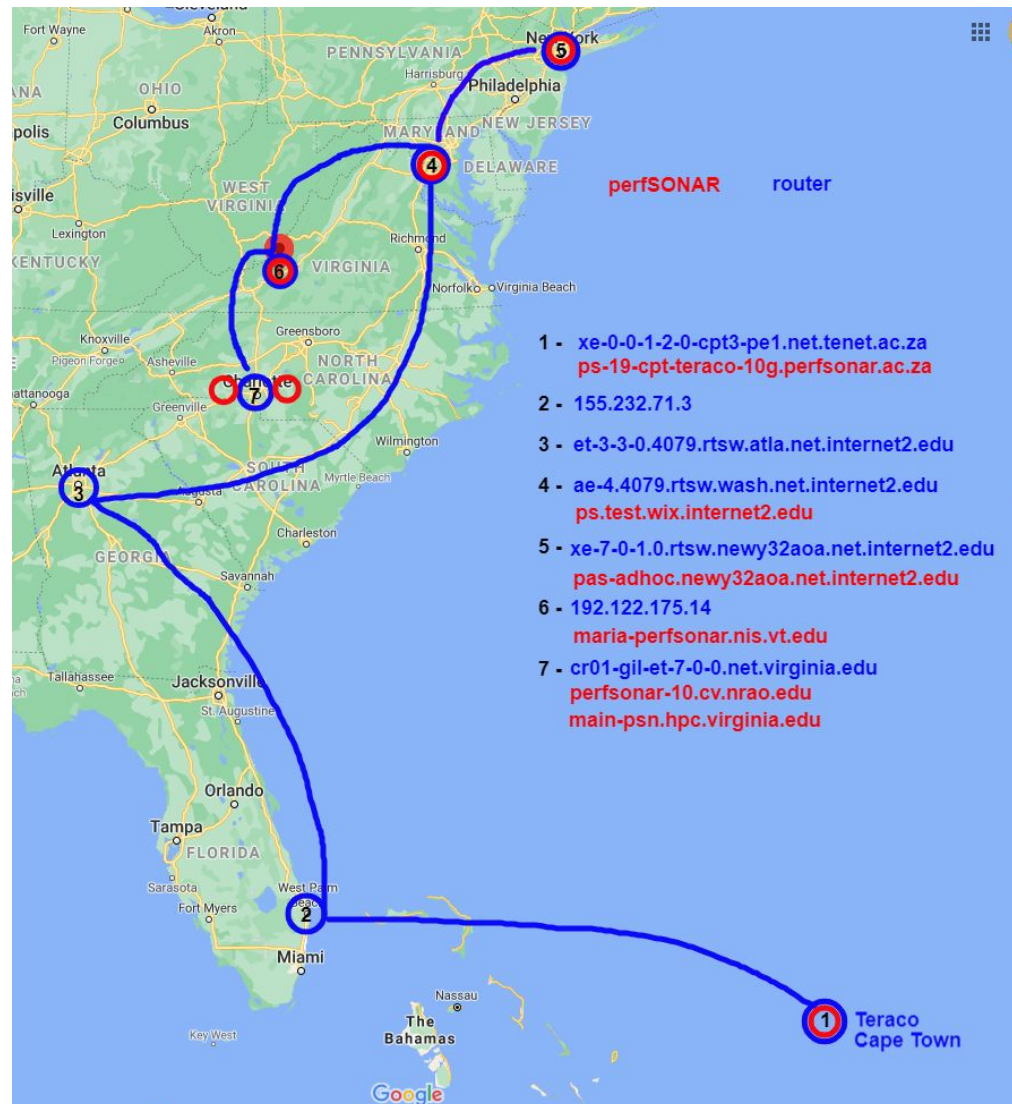


NRAO/UVA <> SARA O Performance Problem

- Data sharing from the National Radio Astronomy Observatory, located on the University of Virginia campus, to the South African Radio Astronomy Observatory
 - Low performance – 4.8Mbps
- Initial testing from the South African side revealed a few potential problems, such as asymmetric routing and paths with unnecessarily circuitous routes.
 - These were identified using normal traceroutes and quickly corrected
 - No appreciable change in performance



Identification of possible pS toolkits



- 1 te0-1-0-1-cpt2-pe1.net.tenet.ac.za (155.232.40.9) AS2018 0.703 ms
- ...
- 5 155.232.71.3 AS2018 166.6 ms
TENET-1, ZA
- 6 et-3-3-0.4079.rts.w.atla.net.internet2.edu (162.252.70.42) AS11537 172.712 ms
INTERNET2-RESEARCH-EDU, US
- 7 ae-4.4079.rts.w.wash.net.internet2.edu (198.71.45.7) AS11537 185.775 ms
INTERNET2-RESEARCH-EDU, US
- 8 ae-0.4079.rts.w2.ashb.net.internet2.edu (162.252.70.137) AS11537 186.419 ms
INTERNET2-RESEARCH-EDU, US
- 9 ae-2.4079.rts.w.ashb.net.internet2.edu (162.252.70.74) AS11537 185.845 ms
INTERNET2-RESEARCH-EDU, US
- 10 192.122.175.14 AS40220 186.368 ms
MARIA, US
- 11 br01-udc-et-1-0-0-20.net.virginia.edu (192.35.48.33) AS225 188.065 ms
VIRGINIA-AS, US
- 12 cr01-udc-et-4-2-0.net.virginia.edu (128.143.236.6) AS225 188.448 ms
VIRGINIA-AS, US
- 13 cr01-gil-et-7-0-0.net.virginia.edu (128.143.236.89) AS225 203.281 ms
VIRGINIA-AS, US
- 14 perfsonar-10.cv.nrao.edu (198.51.208.55) AS225 188.179 ms
VIRGINIA-AS, US



perfSONAR Lookup Service Directory

Lookup Service Directory

<http://stats.es.net/ServicesDirectory/>

Search

Filter results by searching for specific terms:

Search **Show All**

Browser

- ▶ pScheduler Server 12
- ▶ BWCTL Server 6
- ▶ OWAMP Server 15
- ▶ NDT Server 5
- ▶ Ping Responder 1
- ▶ Traceroute Responder 1
- ▶ MA 11
- ▶ BWCTL MP 6
- ▶ OWAMP MP 4
- ▶ twamp 8

Service Information

Service Name	Addresses	Geographic Location	Communities	Version	Example Command-Line
Renater TH2 BWCTL Server	193.55.200.70	Renater TH2, Paris, France (48.8560, 2.3834)			bwctl -T iperf3 -t 30 -O 4 -c "193.55.200.70:4823" bwtraceroute -T tracepath -c "193.55.200.70:4823" bwping -c "193.55.200.70:4823" bwctl -T iperf -t 30 -i 1 -f m -c

Host Information

Host Name	Hardware	System Info	Toolkit Version	Communities
paris2-snd-021.perfsonar.renater.fr 193.55.200.70	Processor #1: 3.50GHz (8 cores) Processor #2: 3.50GHz (8 cores) Memory: 64.18GB	Operating System: CentOS 6.10 (Final) Kernel: Linux 2.6.32-754.35.1.el6.x86_64	4.0.2.5-1.el6	

Service Map

Showing: 69 of 7919 services on 14 hosts.

Communities

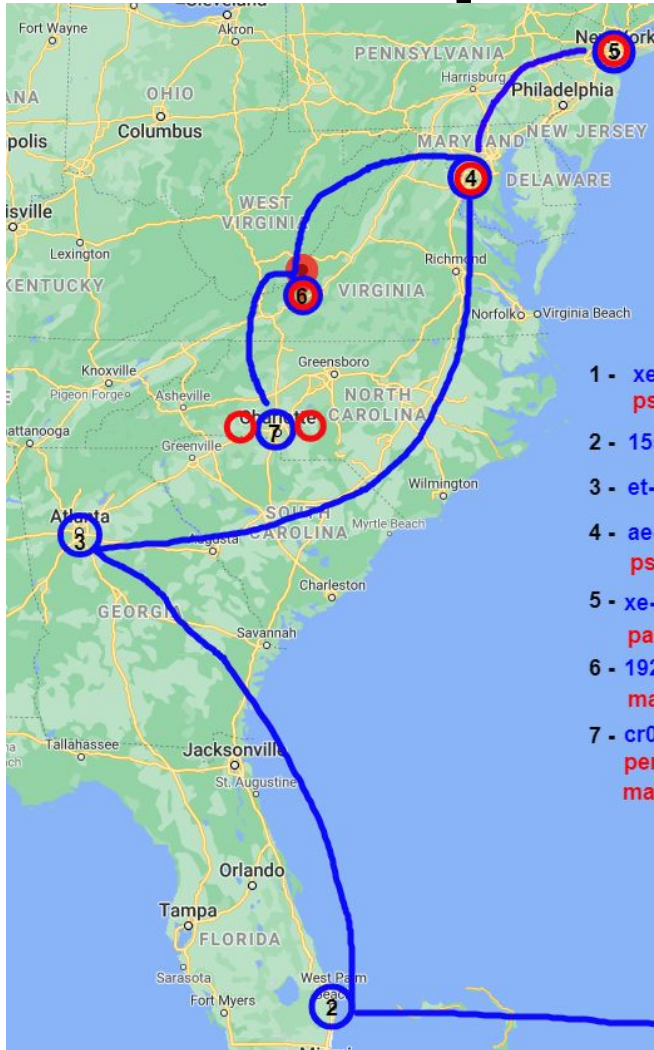
Developer

Lookup listed testpoints and toolkits by almost any criteria:

- Hostname
- IP address
- Institution
- City
- Country
- REN

pS instance must have commodity internet access to be listed.

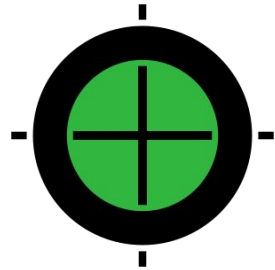
Initial problem isolation



- Tests from various domestic and international perfSONAR nodes to UVAs campus were telling:
 - CHPC South Africa -> Internet2 Washington - 6.67 Gbps
 - Internet2 Albany -> Internet2 Washington - 9.893 Gbps
 - Internet2 Washington -> NRAO - 3.31 Gbps (lots of retries)
 - Internet2 Washington -> HPC University Virginia - 2.21 Gbps (lots of retries)
 - NRAO -> HPC University Virginia - 6.64 Gbps (lots of retries)

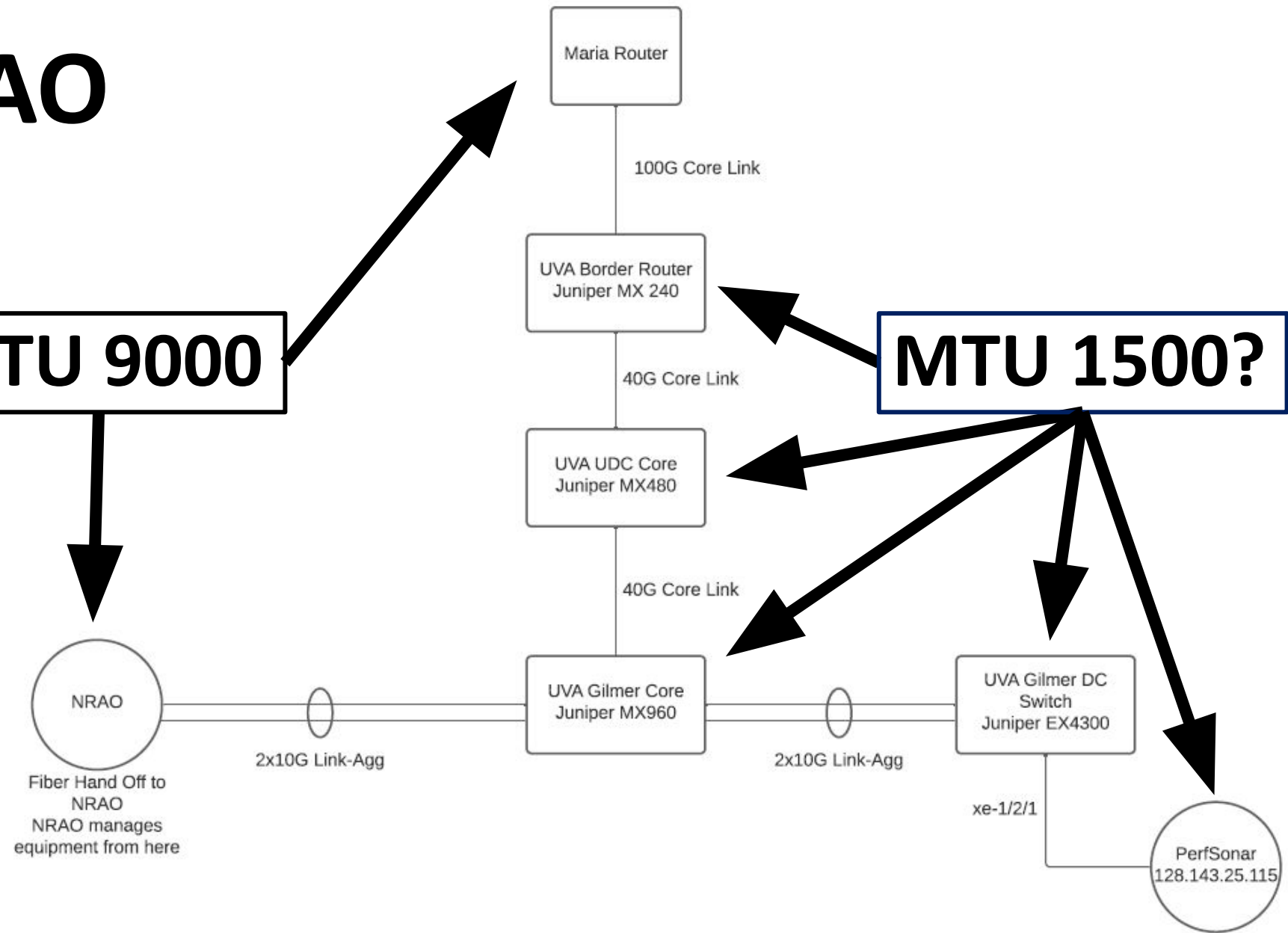


UVA/NRAO Network



MTU 9000

MTU 1500?



Path MTU Discovery (PMTUD)

- Is a layer 3 construct
- Requires UDP and ICMP to function
 - UDP packets larger than the MTU setting of the receiving router interface will trigger an ICMP “unreachable” message back to the sending router, which in turn causes a renegotiation to a lower MTU
- All is not lost if PMTUD doesn't work
 - Smart transfer tools can figure out a common MTU, at the cost of time
 - Packets sent at 9K can be fragmented to adhere to a smaller MTU, at the cost of performance...unless the no-fragment flag is set
 - Neither of these scenarios is good for high performance. PMTUD should be made to work and common MTUs enforced wherever possible



Further isolation

Working inward from a known good ESnet perfSONAR node to UVA:

Interval	Throughput	Retransmits	Current Window
0.0 - 1.0	9.13 Gbps	22	33.17 MBytes
1.0 - 2.0	9.35 Gbps	0	33.58 MBytes
2.0 - 3.0	9.38 Gbps	0	33.58 MBytes
3.0 - 4.0	9.38 Gbps	0	33.58 MBytes
4.0 - 5.0	9.38 Gbps	0	33.58 MBytes
5.0 - 6.0	9.35 Gbps	0	33.58 MBytes
6.0 - 7.0	9.36 Gbps	0	33.58 MBytes
7.0 - 8.0	9.38 Gbps	0	33.58 MBytes
8.0 - 9.0	9.37 Gbps	0	33.58 MBytes
9.0 - 10.0	9.37 Gbps	0	33.58 MBytes

**This test looks good,
because the hosts were
forced to 1500 MTU**

Summary			
Interval	Throughput	Retransmits	Receiver Throughput
0.0 - 10.0	9.35 Gbps	22	9.25 Gbps



Negotiations break down

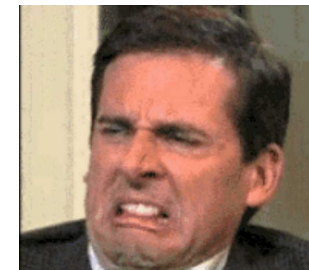
Working inward from a known good ESnet perfSONAR node to NRAO:
(Keep in mind, we know MTU 9000 on both ends, but with a step down to 1500 in the middle of the UVA campus)

Interval	Throughput	Retransmits	Current Window
0.0 - 1.0	2.54 Mbps	2	8.95 KBytes
1.0 - 2.0	0.00bps	1	8.95 KBytes
2.0 - 3.0	0.00bps	0	8.95 KBytes
3.0 - 4.0	0.00bps	31	3.07 KBytes
4.0 - 5.0	0.00bps	67	5.12 KBytes
5.0 - 6.0	4.45 Mbps	2	17.41 KBytes
6.0 - 7.0	8.26 Mbps	0	33.79 KBytes
7.0 - 8.0	23.28 Mbps	0	94.21 KBytes
8.0 - 9.0	51.75 Mbps	0	218.11 KBytes
9.0 - 10.0	83.88 Mbps	0	392.19 KBytes

9000B packets failing

**1500B packets after
re-negotiation**

Summary Interval	Throughput	Retransmits	Receiver Throughput
0.0 - 10.0	17.42 Mbps	103	10.29 Mbps



Traceroute: ESnet to NRAO

traceroute to perfsonar-10.cv.nrao.edu (198.51.208.55), 30 hops max, 60 byte packets

```

1 esneteastrt1-eastdcpt1.es.net (198.124.238.37) 0.549 ms 0.544 ms 0.547 ms
2 newycr5-ip-a-esneteastrt1.es.net (198.124.218.17) 1.969 ms 1.963 ms 1.953 ms
3 aofacr5-ip-a-newycr5.es.net (134.55.37.77) 2.330 ms 2.304 ms 2.313 ms
4 et-2-1-5.197.rts.w.newy32aoa.net.internet2.edu (64.57.28.14) 2.323 ms 2.324 ms 2.327
ms
5 ae-3.4079.rts.w.wash.net.internet2.edu (162.252.70.138) 7.571 ms 7.672 ms 7.528 ms
6 ae-0.4079.rts.w2.ashb.net.internet2.edu (162.252.70.137) 8.095 ms 8.077 ms 8.061 ms
7 ae-2.4079.rts.w.ashb.net.internet2.edu (162.252.70.74) 28.089 ms 18.414 ms 18.454 ms
8 192.122.175.14 (192.122.175.14) 8.221 ms 8.179 ms 8.205 ms
9 br01-udc-et-1-0-0-20.net.virginia.edu (192.35.48.33) 10.310 ms 10.310 ms 10.383 ms
10 cr01-udc-et-4-2-0.net.virginia.edu (128.143.236.6) 12.609 ms 12.603 ms 12.638 ms
11 cr01-gil-et-7-0-0.net.virginia.edu (128.143.236.89) 12.407 ms 12.403 ms 12.393 ms
12 perfsonar-10.cv.nrao.edu (198.51.208.55) 10.058 ms 10.032 ms 10.022 ms

```

Well, that looks good. Let's try tracepath and see where the MTU changes



Tracepath: ESnet to NRAO

1?: [LOCALHOST]	pmtu 9000
1: esneteastrt1-eastdcpt1.es.net	0.788ms
1: bnlnr2-bnlpt1.es.net	0.728ms
2: no reply	
3: aofacr5-ip-b-newycr5.es.net	2.411ms asymm 2
4: et-2-1-5.197.rtsw.newy32aoa.net.internet2.edu	2.468ms asymm 3
5: ae-3.4079.rtsw.wash.net.internet2.edu	8.176ms asymm 4
6: ae-0.4079.rtsw2.ashb.net.internet2.edu	8.889ms asymm 5
7: ae-2.4079.rtsw.ashb.net.internet2.edu	8.242ms asymm 6
8: 192.122.175.14	8.522ms asymm 7
9: no reply	
10: no reply	
11: no reply	
12: no reply	

Traceroute works, but tracepath doesn't??



Different Tools, Different Packets

- Traceroute uses small 60B UDP packets
- Tracepath uses larger 64KB UDP packets

So, somewhere we have a roadblock. Small packets can make it through, but larger ones are dropped (not fragmented).

How do we figure out the max size? Trial and error. Start at 9K and cut the size in half until you get a response, then sneak back up until the packets disappear again.



Tracepath: ESnet to NRAO, 1509 bytes

1: esneteastrt1-eastdcpt1.es.net	0.340ms
2: no reply	
3: aofacr5-ip-a-newycr5.es.net	2.279ms asymm 2
4: et-2-1-5.197.rtsw.newy32aoa.net.internet2.edu	2.310ms asymm 3
5: ae-3.4079.rtsw.wash.net.internet2.edu	7.574ms asymm 4
6: ae-0.4079.rtsw2.ashb.net.internet2.edu	9.422ms asymm 5
7: ae-2.4079.rtsw.ashb.net.internet2.edu	7.986ms asymm 6
8: 192.122.175.14	8.123ms asymm 7
9: no reply	

← MARIA
← UVA



Tracepath: ESnet to NRAO, 1508 bytes

1: bnlmr2-bnlpt1.es.net	0.327ms	
2: no reply		
3: aofacr5-ip-b-newycr5.es.net	2.332ms asymm	2
4: et-2-1-5.197.rtsw.newy32aoa.net.internet2.edu	2.338ms asymm	3
5: ae-3.4079.rtsw.wash.net.internet2.edu	7.668ms asymm	4
6: ae-0.4079.rtsw2.ashb.net.internet2.edu	9.833ms asymm	5
7: ae-2.4079.rtsw.ashb.net.internet2.edu	7.872ms asymm	6
8: 192.122.175.14	8.166ms asymm	7
9: br01-udc-et-1-0-0-20.net.virginia.edu	9.998ms asymm	7
9?: br01-udc-et-1-0-0-20.net.virginia.edu	asymm	7
10: cr01-udc-et-4-2-0.net.virginia.edu	10.470ms asymm	8
11: cr01-gil-et-7-0-0.net.virginia.edu	10.208ms asymm	9
12: cr01-gil-et-7-0-0.net.virginia.edu	10.253ms pmtu	1500
12: perfsonar-10.cv.nrao.edu	10.154ms	!H
Resume: pmtu 1500		

← MARIA
← UVA



Problem located

- The issue was between the MARIA router and the UVA router
 - The MARIA interface was configured for MTU 9192
 - The UVA interface was configured for MTU 1518
- With PMTUD broken there was no hope for external MTU 9000 equipment to negotiate an appropriate MTU with the NRAO node
- UVA changed the MTU on their router interface to match that of MARIA, while keeping their downstream equipment at their campus standard MTU 1500



Ping verification

```
ping -s 8972 -M do -c 4 perfsonar-10.cv.nrao.edu (don't fragment)
```

```
PING perfsonar-10.cv.nrao.edu (198.51.208.55) 8972(9000) bytes of data.  
From cr01-gil-et-7-0-0.net.virginia.edu (128.143.236.89) icmp_seq=1 Frag needed and DF set (mtu = 1500)  
ping: local error: Message too long, mtu=1500  
ping: local error: Message too long, mtu=1500  
ping: local error: Message too long, mtu=1500
```

```
ping -s 8972 -M dont -c 4 perfsonar-10.cv.nrao.edu (do fragment)
```

```
PING perfsonar-10.cv.nrao.edu (198.51.208.55) 8972(9000) bytes of data.  
8980 bytes from perfsonar-10.cv.nrao.edu (198.51.208.55): icmp_seq=1 ttl=55 time=10.3 ms  
8980 bytes from perfsonar-10.cv.nrao.edu (198.51.208.55): icmp_seq=2 ttl=55 time=10.2 ms  
8980 bytes from perfsonar-10.cv.nrao.edu (198.51.208.55): icmp_seq=3 ttl=55 time=10.2 ms  
8980 bytes from perfsonar-10.cv.nrao.edu (198.51.208.55): icmp_seq=4 ttl=55 time=10.2 ms
```



Yeah, yeah, but what about performance??

Before:

```
pscheduler task throughput --source cpt-chpc-10g.perfsonar.ac.za --dest
perfsonar-10.cv.nrao.edu
```

Summary

Interval	Throughput	Retransmits	Receiver Throughput
0.0 - 10.0	380.37 Kbps	58	108.18 Kbps

After:

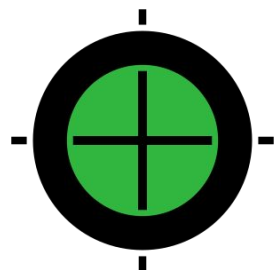
```
pscheduler task throughput -t 30 --source cpt-chpc-10g.perfsonar.ac.za --dest
perfsonar-10.cv.nrao.edu
```

Summary

Interval	Throughput	Retransmits	Receiver Throughput
0.0 - 30.0	2.67 Gbps	0	2.62 Gbps



**You think we need one more?
You think we need one more.**

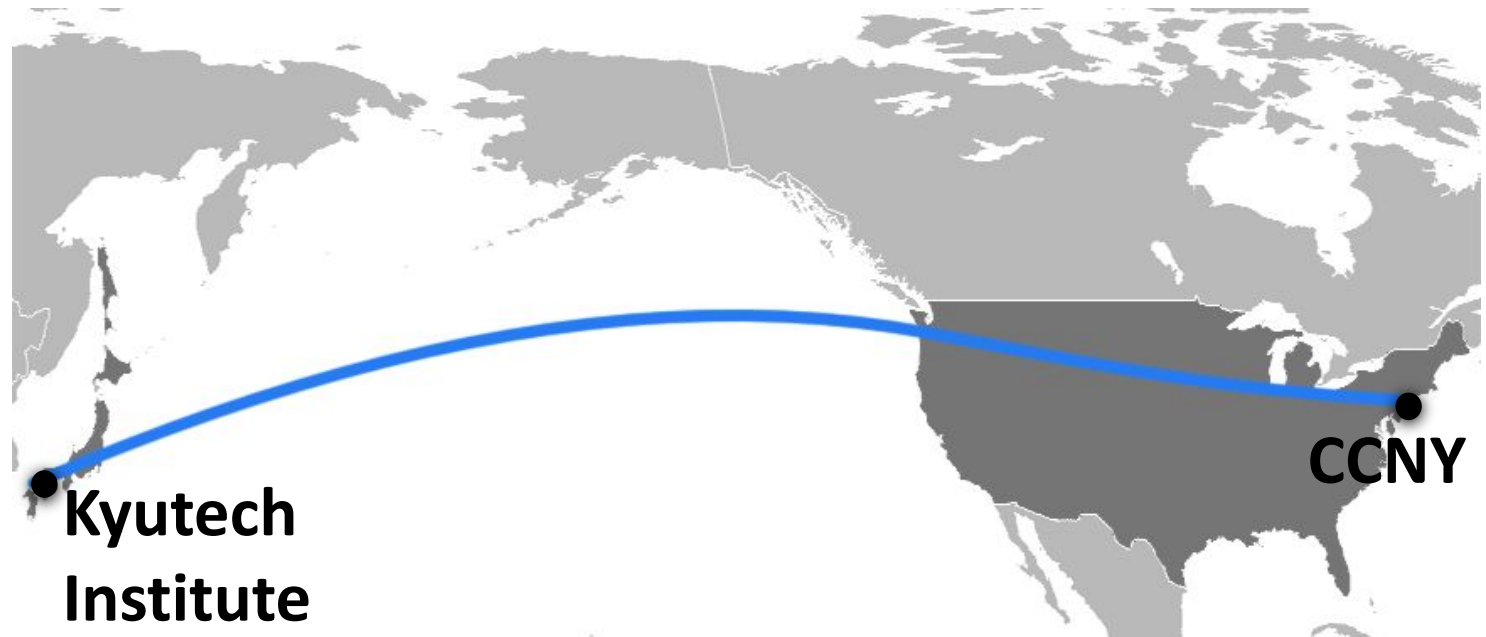


Alright. We'll do one more.

City College of New York (CCNY) to Kyutech Institute (JGN)

Reported asymmetric,
poor performance
across GRE tunnel

- JGN \square CCNY (TCP)
 - No packet loss
 - 79Mbps throughput
- CCNY \square JGN (TCP)
 - **0.082%** packet loss
 - **8Mbps** throughput



Tested UDP performance, however, was symmetric at 90Mbps either direction

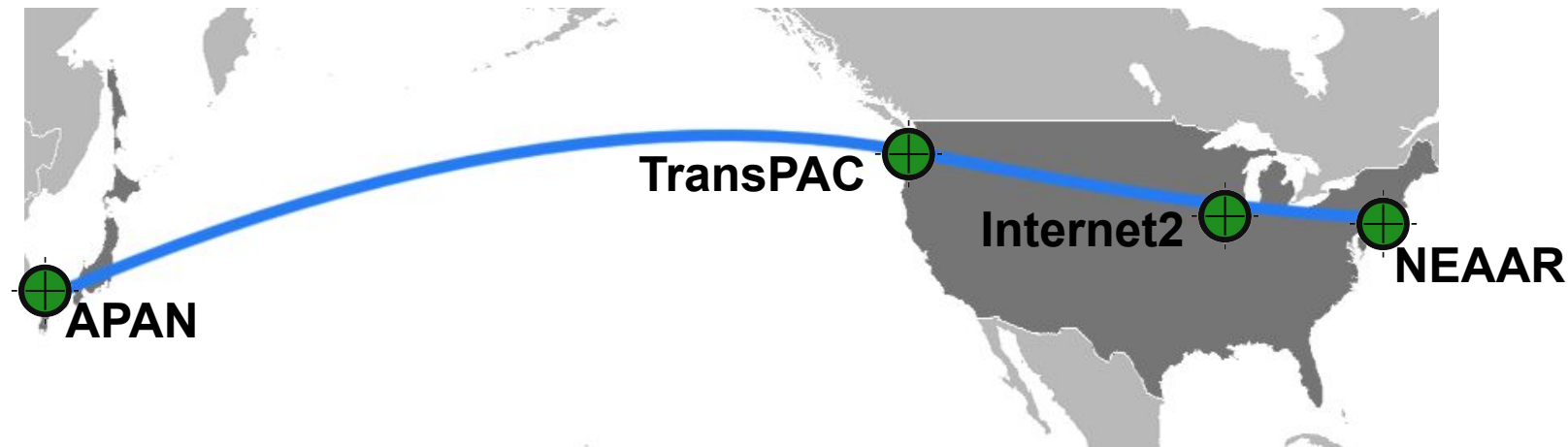


Initial troubleshooting

Used perfSONAR nodes along the path to test to closest open node available-at ManLan.

Nodes located at

- APAN/Tokyo
- TransPAC/Seattle
- Internet2/Chicago
- NEAAR/ManLan



Testing to NYC showed good performance and no packet loss- indicating problem was likely within CCNY



Internal troubleshooting



- CCNY and EPOC engineers installed perfSONAR node in researcher's lab
- Tests from prior locations to lab showed same packet loss as original problem
- Verified issue within campus

Regional troubleshooting

- NYSERNet
 - Regional network for NY
 - Provides R&E connectivity for CCNY
 - Engineers installed a new CCNY pS node at campus edge
- Testing edge to lab
 - Packet fragmentation and MTU issues on the ingress path to CCNY
 - Packet loss isolated to specific segment of the CCNY campus network



Problem located



With this data

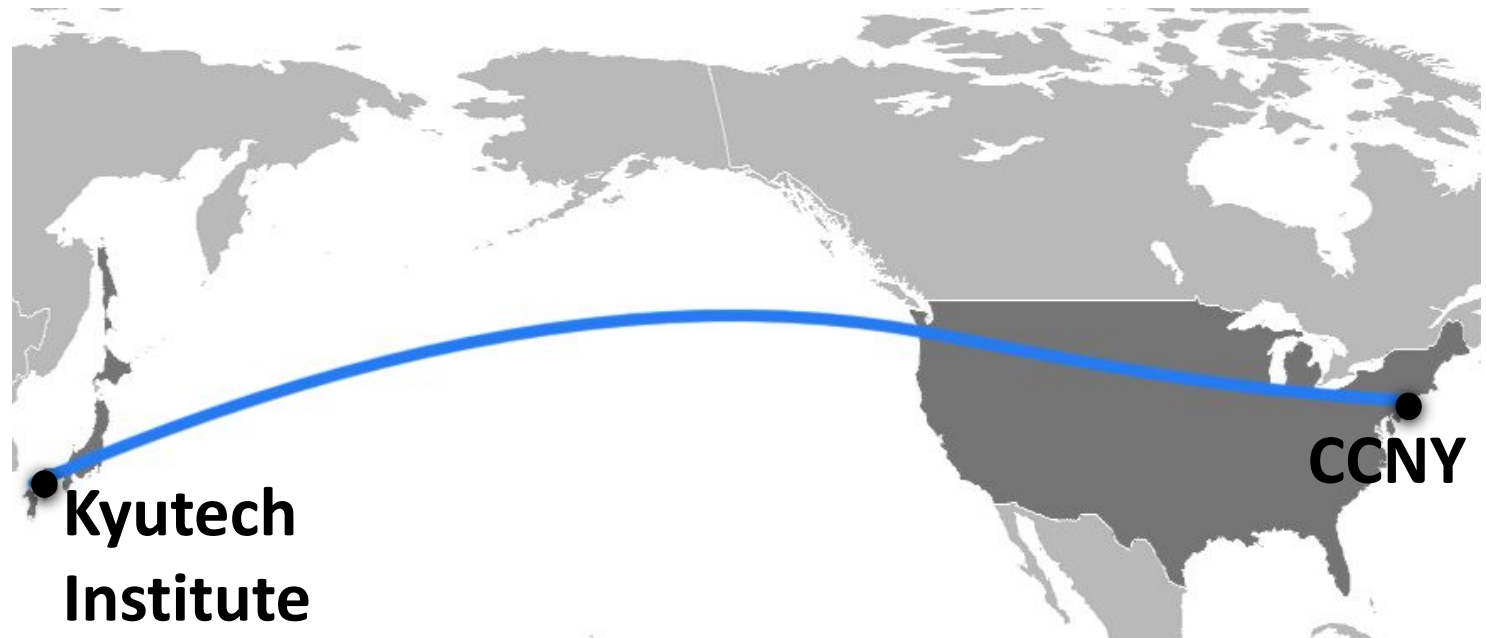
- CCNY engineers did additional local troubleshooting
- Cause identified as outdated network security device
- Replacement had been scheduled, expedited due to results

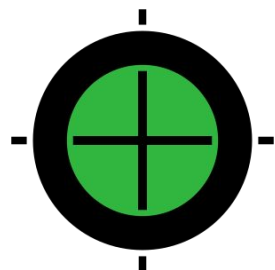
After replacement

- pS tests verified performance was greatly improved

Final Results

- CCNY/JGN GRE tunnel shows consistent, symmetric performance
- JGN ☐ CCNY (TCP)
 - No packet loss
 - 80Mbps throughput
- CCNY ☐ JGN (TCP)
 - No packet loss
 - 85Mbps throughput
 - **10-fold improvement**

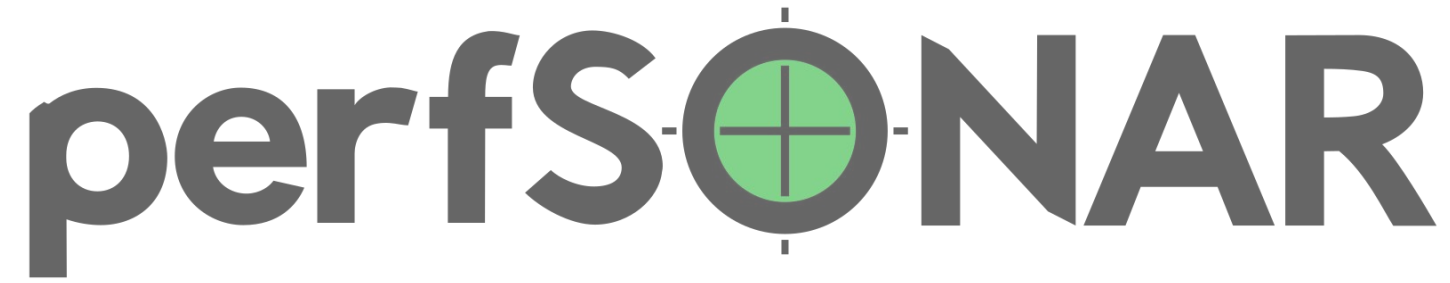




Questions and Answers

Question and answer icon by iconosphere from The Noun Project





CLI Testing and Troubleshooting

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perfSONAR is developed by a partnership of



ESnet



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