

# •Introduction to perfS-NAR

Network Startup Resource Center



**ESnet**

ENERGY SCIENCES NETWORK



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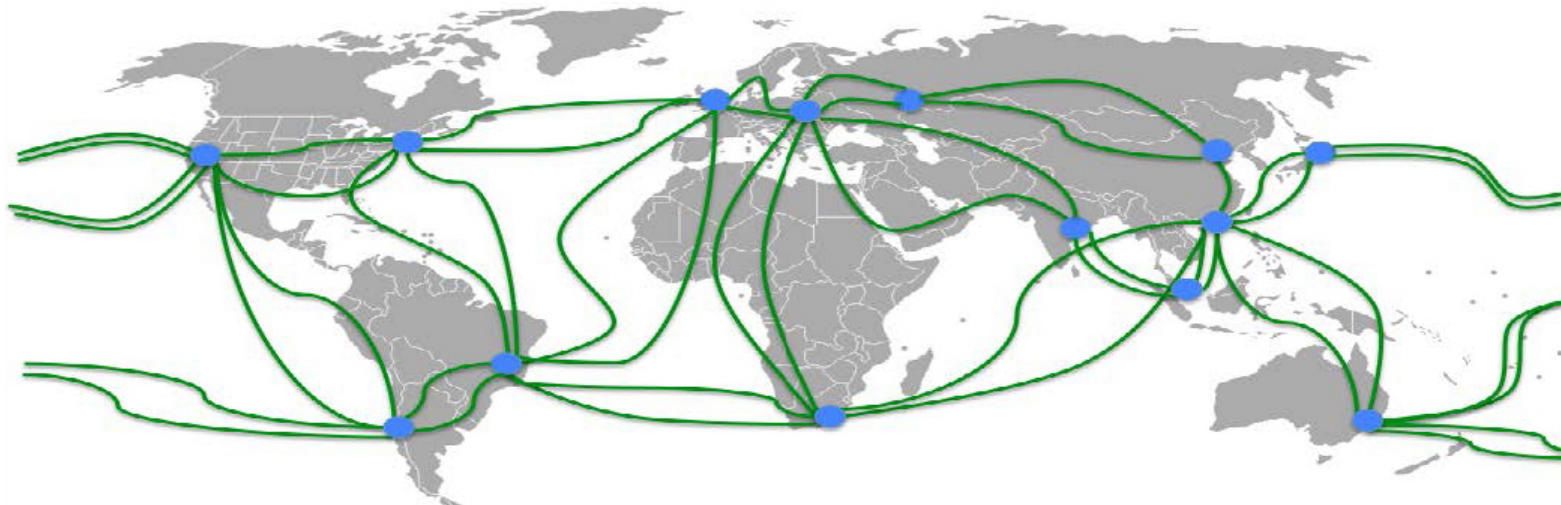
# What is it?

- **perfSONAR** is a network measurement toolkit that provides end-to-end statistics and helps to establish end-to-end usage expectations.
  - How fast is our circuit in reality?
  - Are there problems?
  - How do I fix problems?
- **perfSONAR** provides a uniform interface that allows for the scheduling of measurements, storage of data in uniform formats, and scalable methods to retrieve data and generate visualizations to help answer the three questions above.
- <http://www.perfsonar.net/about/what-is-perfsonar/>



# Problem Statement

- The global Research and Education network ecosystem is comprised of hundreds of international, national, regional and local-scale networks.

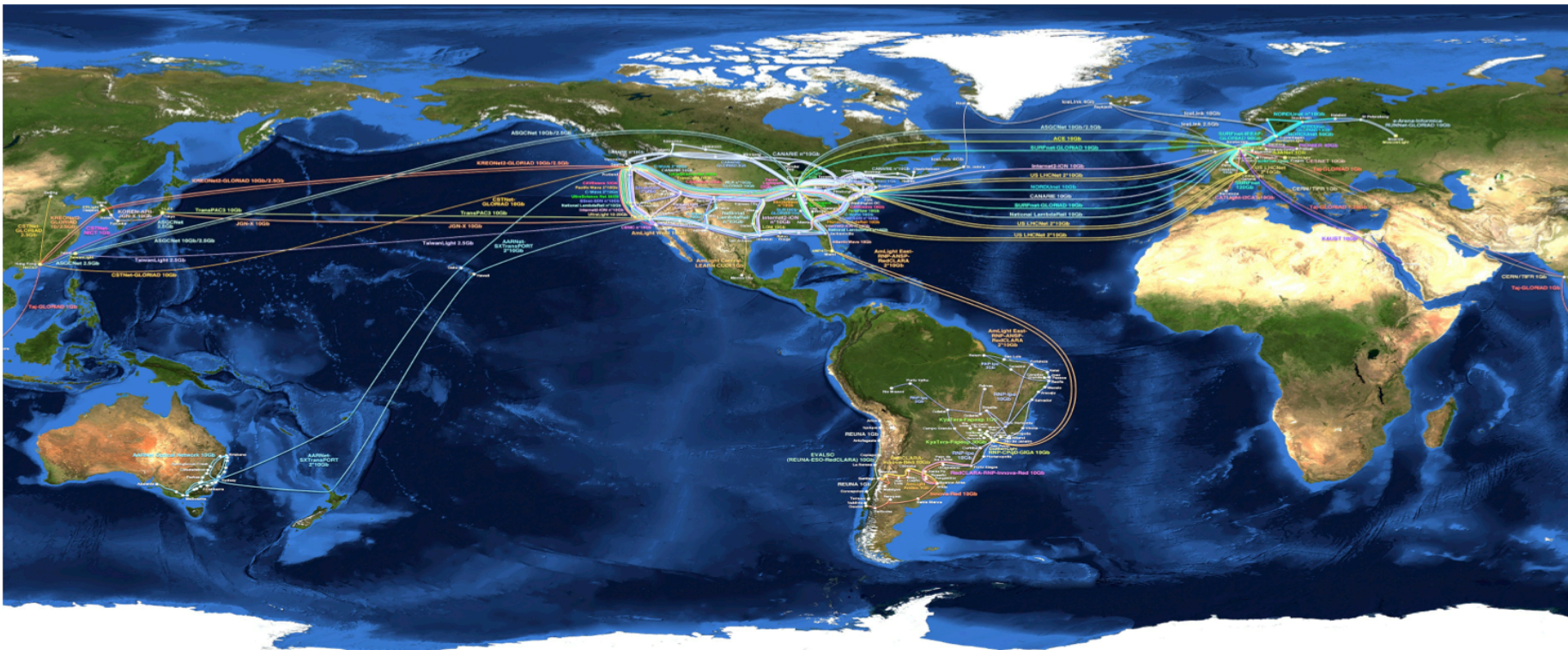


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# Problem Statement

- While these networks all interconnect, each network is owned and operated by separate organizations (called “domains”) with different policies, customers, funding models, hardware, bandwidth and configurations.



# Problem Statement

- In practice, performance issues are prevalent and distributed.
- When a network is underperforming or errors occur, it is difficult to identify the source, as problems can happen anywhere, in any domain.
- Local-area network testing is not sufficient, as errors can occur between networks.

# Problem Statement

## Hard vs Soft Failures

- “Hard failures” are the kind of problems every organization understands
  - Fiber cut
  - Power failure takes down routers
  - Hardware ceases to function
- Classic monitoring systems are good at alerting hard failures
  - i.e., NOC sees something turn red on their screen
  - Engineers paged by monitoring systems
- “Soft failures” are different and often go undetected
  - Basic connectivity (ping, traceroute, web pages, email) works
  - Performance is just poor
- How much should we care about soft failures?



# What does it take to transfer data...

Data set size				
10PB	1,333.33 Tbps	266.67 Tbps	66.67 Tbps	22.22 Tbps
1PB	133.33 Tbps	26.67 Tbps	6.67 Tbps	2.22 Tbps
100TB	13.33 Tbps	2.67 Tbps	666.67 Gbps	222.22 Gbps
10TB	1.33 Tbps	266.67 Gbps	66.67 Gbps	22.22 Gbps
1TB	133.33 Gbps	26.67 Gbps	6.67 Gbps	2.22 Gbps
100GB	13.33 Gbps	2.67 Gbps	666.67 Mbps	222.22 Mbps
10GB	1.33 Gbps	266.67 Mbps	66.67 Mbps	22.22 Mbps
1GB	133.33 Mbps	26.67 Mbps	6.67 Mbps	2.22 Mbps
100MB	13.33 Mbps	2.67 Mbps	0.67 Mbps	0.22 Mbps
	1 Minute	5 Minutes	20 Minutes	1 Hour
Time to transfer				

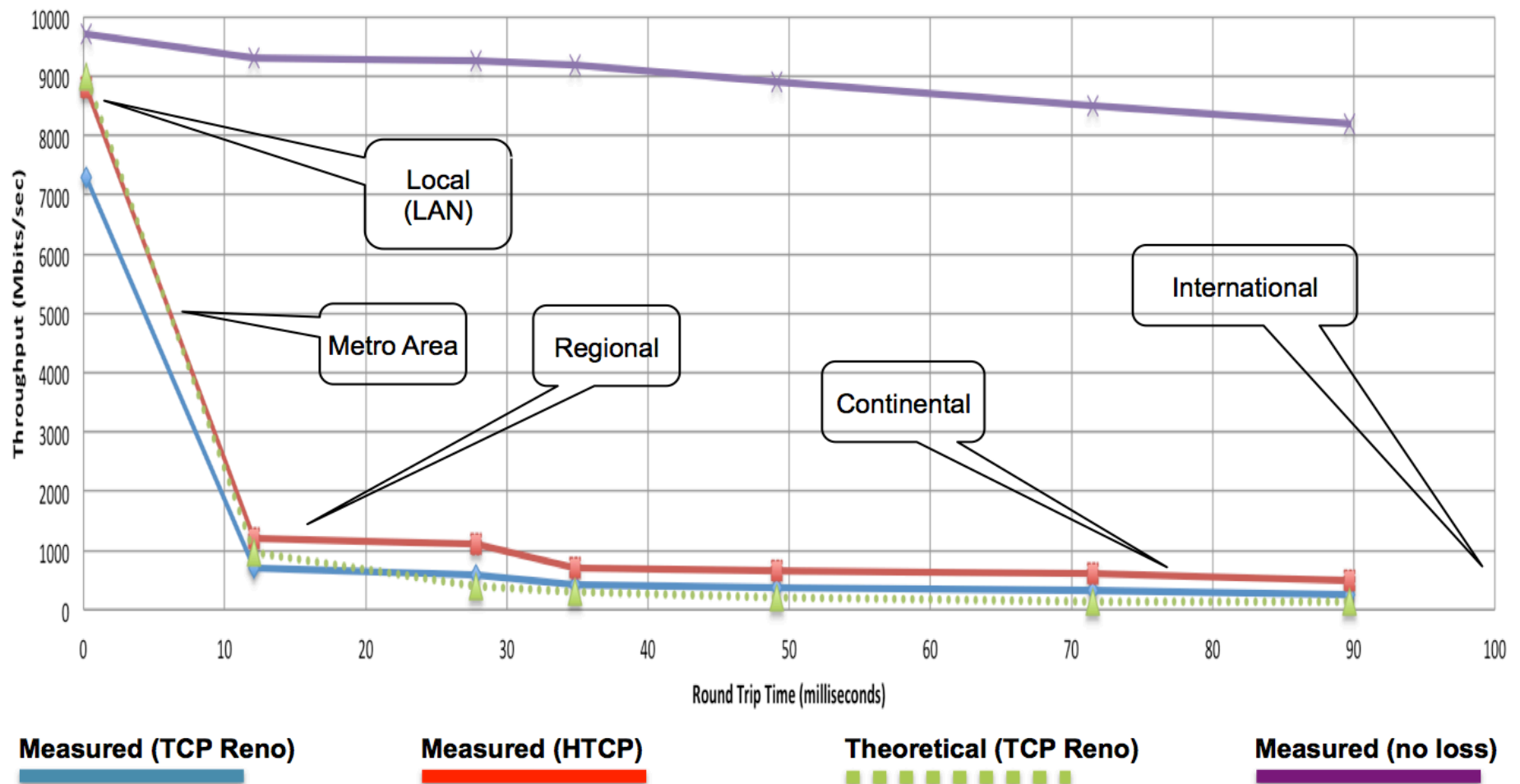


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# But, just a little packet loss...

Throughput vs. increasing latency on a 10Gb/s link with **0.0046%** packet loss





# A Solution

## perfSONAR and the perfSONAR Toolkit

- *A widely-deployed test and measurement infrastructure used by local, regional and national research networks and science facilities to actively track & troubleshoot network performance issues.*
- Open-source, community-developed software suite that:
  - Provides consistent set of proven tools to pinpoint and resolve network performance issues including soft failures across complex, multi-domain data paths.
  - Creates a standard way to visualize, publish, and archive network metrics and data for future analysis, and aids other networks in debugging issues.



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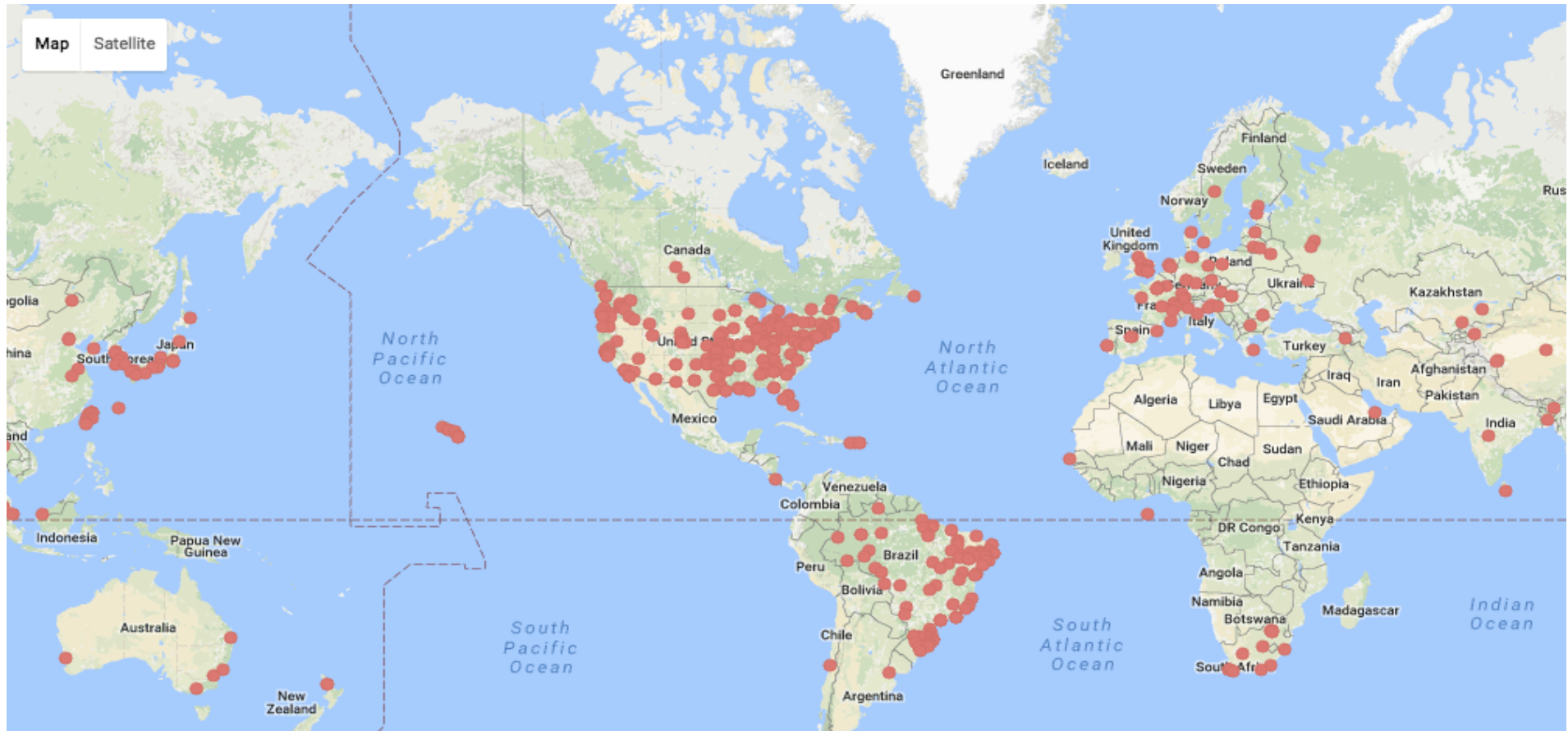


# perfSONAR Toolkit

- What do we care about measuring?
- **Latency**: Ping, OWAMP, NDT, NPAD (don't trust Traceroute)
- **Jitter**: OWAMP, UDP Iperf, UDP NuQcp, NDT, NPAD
- **Packet loss, duplication, unordered data**: OWAMP, UDP Iperf, UDP NuQcp, NDT, NPAD
- **Interface utilization, discards, errors**: - SNMP
- **Achievable bandwidth**: Iperf, NuQcp, NDT, NPAD
- **Traveled route**: Traceroute, Tracepath
- **MTU feedback**: Tracepath, Ping, NDT, NPAD

# Benefit: Multi-domain Insight

- Over 1700 public perfSONAR nodes are deployed globally
  - This allows you to test performance between your perfSONAR node and any other publicly available perfSONAR node. Very cool. Reverse traceroute!



# perfSONAR Community Benefits

- i.e., Testing from client A between points B and C...


```
[root@perfsonar100 ~]# bwctl -fM -t 30 -s 202.28.229.115
bwctl: Using tool: iperf
bwctl: 37 seconds until test results available

RECEIVER START
-----
Server listening on TCP port 5204
Binding to local address 203.159.61.100
TCP window size: 0.08 MByte (default)
-----
[ 15] local 203.159.61.100 port 5204 connected with 202.28.229.115 port 38953
[ ID] Interval          Transfer      Bandwidth
[ 15]  0.0-30.1 sec    210 MBytes  6.96 MBytes/sec
[ 15] MSS size 1448 bytes (MTU 1500 bytes, ethernet)


RECEIVER END
```

- *Then automate this within web GUI and build historical trends...*

# Sample perfSONAR site


 Toolkit on [perfsonar.nsrc.org](https://perfsonar.nsrc.org)






[Log in](#) [Configuration](#) [? Help](#)

 **perfsonar.nsrc.org** at 128.223.157.44, 2607:8400:2880:4::80df:9d2c [Edit](#)


**Organization:** NSRC  
**Address:** Eugene, OR 97403 US ([map](#))  
**Administrator:** NSRC Admin ([nsrc@nsrc.org](mailto:nsrc@nsrc.org))


Services


Enable/disable services 

SERVICE	STATUS	VERSION	PORTS	SERVICE LOGS
<a href="#">bwctl</a> ▾	Running	1.6.1-1.el6	4823	<a href="#">View</a> 
<a href="#">regular_testing</a>	Running	3.5.1.1-1		<a href="#">View</a> 
<a href="#">owamp</a> ▾	Running	3.5.0-1.el6	861	<a href="#">View</a> 
<a href="#">ndt</a> ▾	Disabled	3.7.0.2-1.el6	3001	<a href="#">View</a> 
<a href="#">esmond</a> ▾	Running	2.0.2-3.el6		<a href="#">View</a> 

Test Results (4 Results)

Configure tests 

SOURCE	DESTINATION	THROUGHPUT	LATENCY (MS)	LOSS
perfsonar.nsrc.org 128.223.157.44 <a href="#">Details</a>	140.254.35.253 140.254.35.253	→ <b>253 Mbps</b> ← <b>353 Mbps</b>	→ <b>35.0</b> ← <b>28.3</b>	→ <b>1.30e-3</b> ← <b>9.13e-4</b>
perfsonar.nsrc.org 128.223.157.44 <a href="#">Details</a>   <a href="#">Traceroute</a> 	kauaicc-ps-v.ps.uhnet.net 128.171.213.166	→ <b>74.5 Mbps</b> ← <b>89.7 Mbps</b>	→ <b>41.7</b> ← <b>35.1</b>	→ <b>1.07e-3</b> ← <b>1.30e-3</b>

 **Host Details** ([Log in](#) for more info)

Interfaces

[Details](#) ▾

Globally Registered

Yes

NTP Synced

Yes

Node Role

Regional

Access Policy

Public

RAM

16 GB

CPU Cores

2

CPUs

1

CPU Speed

3200 MHz

Primary Interface


eth0


Toolkit version


3.5.1.4


Toolkit RPM version


3.5.1.4-1

 On-demand testing tools

[Reverse ping](#) 

[Reverse traceroute](#) 

[Reverse tracepath](#) 

[Traceroute Visualization](#) 

# Throughput Historical Trends

Source: **perfsonar.nsrc.org** - 128.223.157.44  
Capacity: 1.0G MTU: 1500

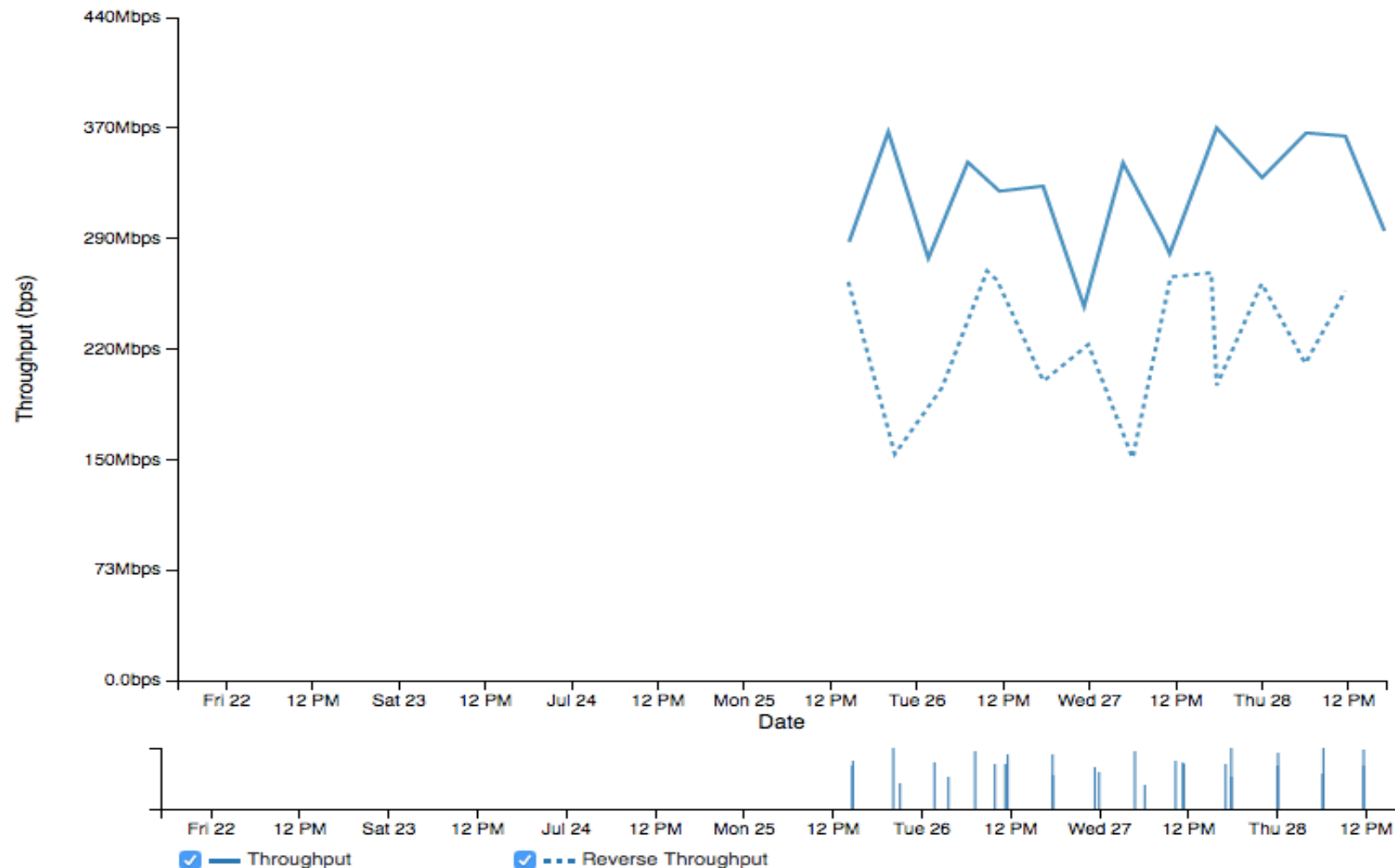
Destination: **maunalani-tp.ps.uhnet.net** - 128.171.73.50 [\[traceroute\]](#)  
Capacity: 10G MTU: 9000

[Link to this chart](#)

Zoom: [1d](#) [3d](#) [1w](#) [1m](#) [1y](#)

[Previous 1w](#)

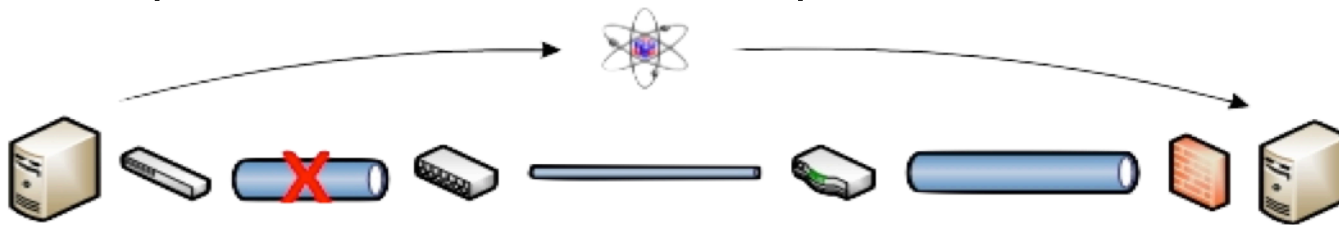
Thu Jul 21 17:10:14 2016 -- Thu Jul 28 17:10:14 2016





# Benefits: Finding hidden problems

- Above all, perfSONAR allows you to maintain a healthy, high-performing network because it helps identify the “soft failures” in the network path.
- Classical monitoring systems have limitations
  - Performance problems are often only visible at the ends
  - Individual network components (e.g. routers) have no knowledge of end host state
  - perfSONAR tests the network in ways that classical monitoring systems do not
  - More perfSONAR distributions equal better network visibility.

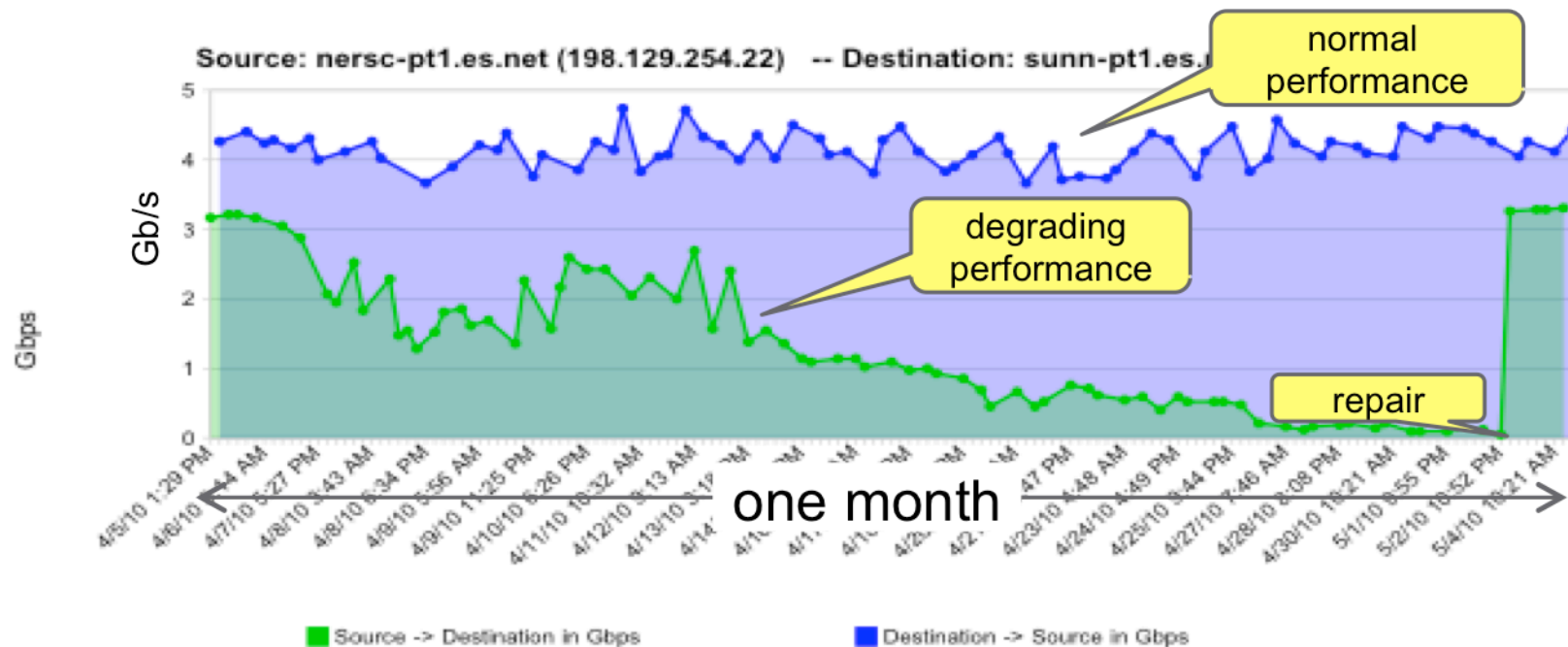


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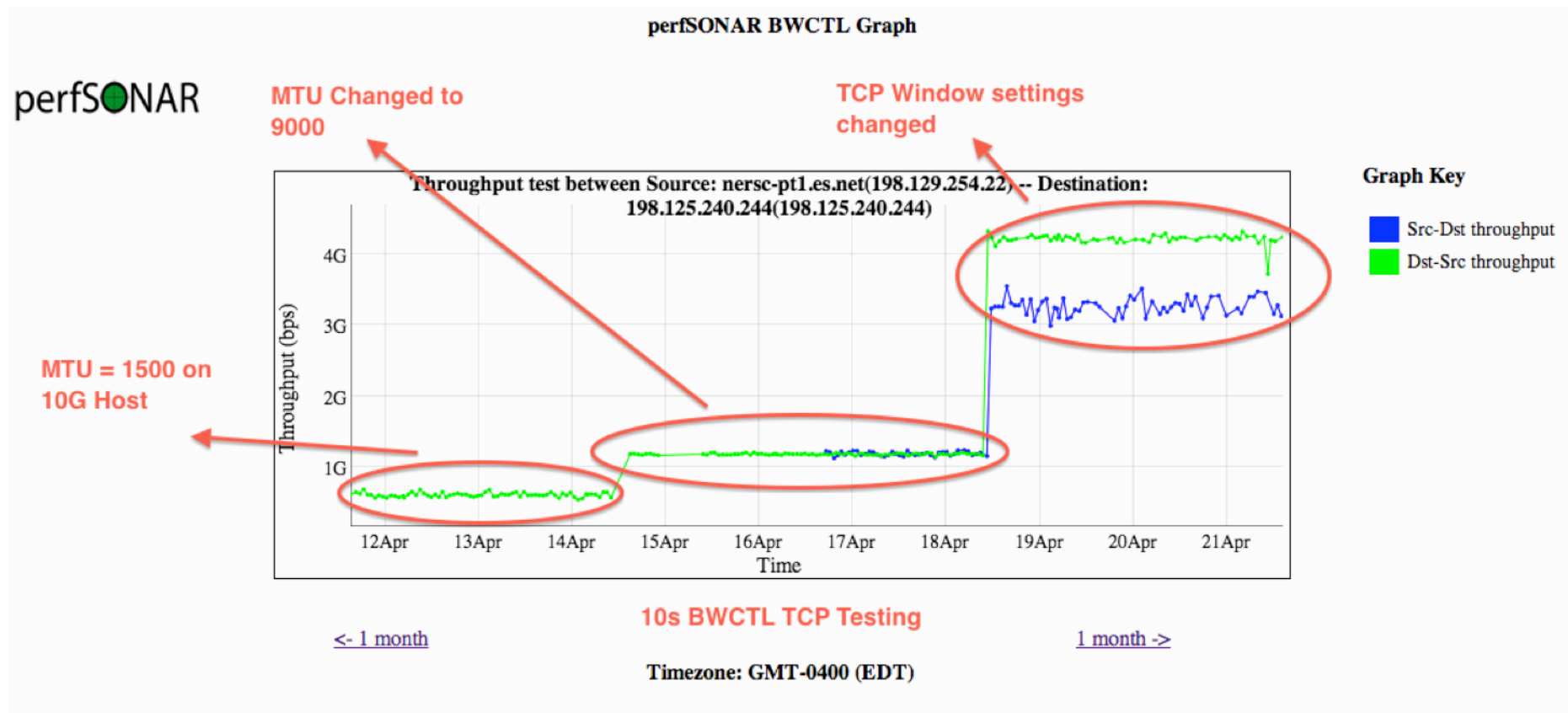
# Benefits: Finding hidden problems

- perfSONAR is designed to pinpoint and identify soft failures to accelerate resolution.
- Example: Find and replace failing optics:

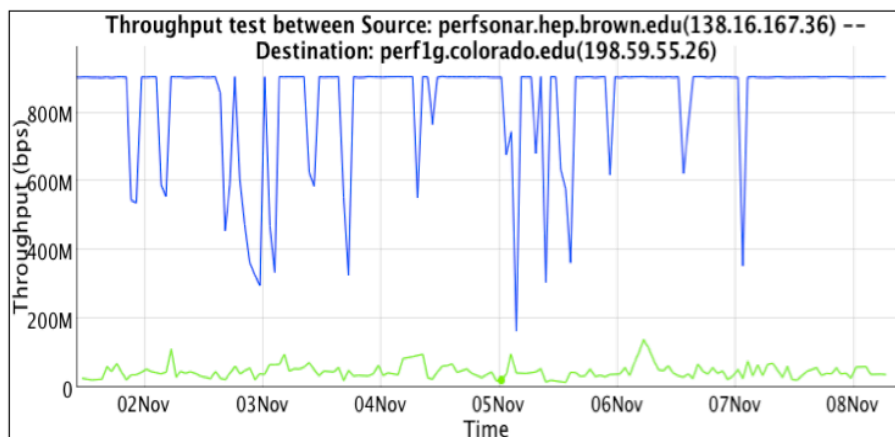


# Benefits: Finding hidden problems

- perfSONAR is designed to pinpoint and identify soft failures to accelerate resolution.
- Example: Host Tuning:



# Benefits: Finding hidden problems

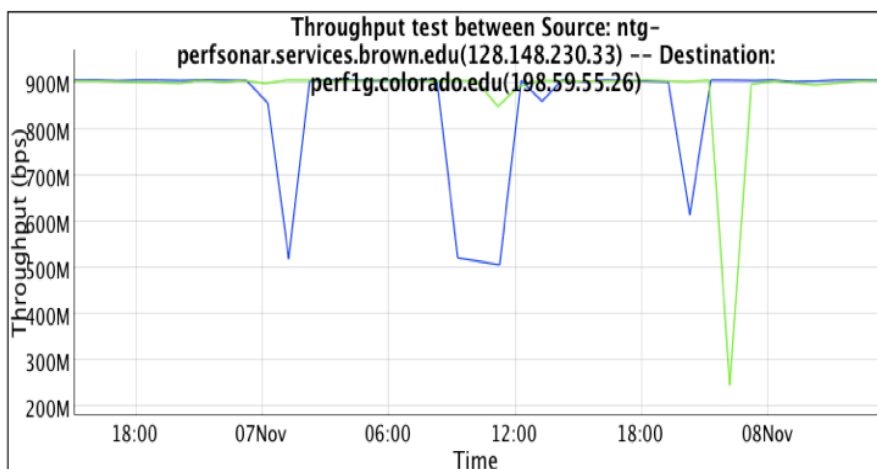


Graph Key

■ Src-Dst throughput  
■ Dst-Src throughput

## Inside the firewall

- One direction severely impacted by firewall
- Not useful for science data



Graph Key

■ Src-Dst throughput  
■ Dst-Src throughput

## Outside the firewall

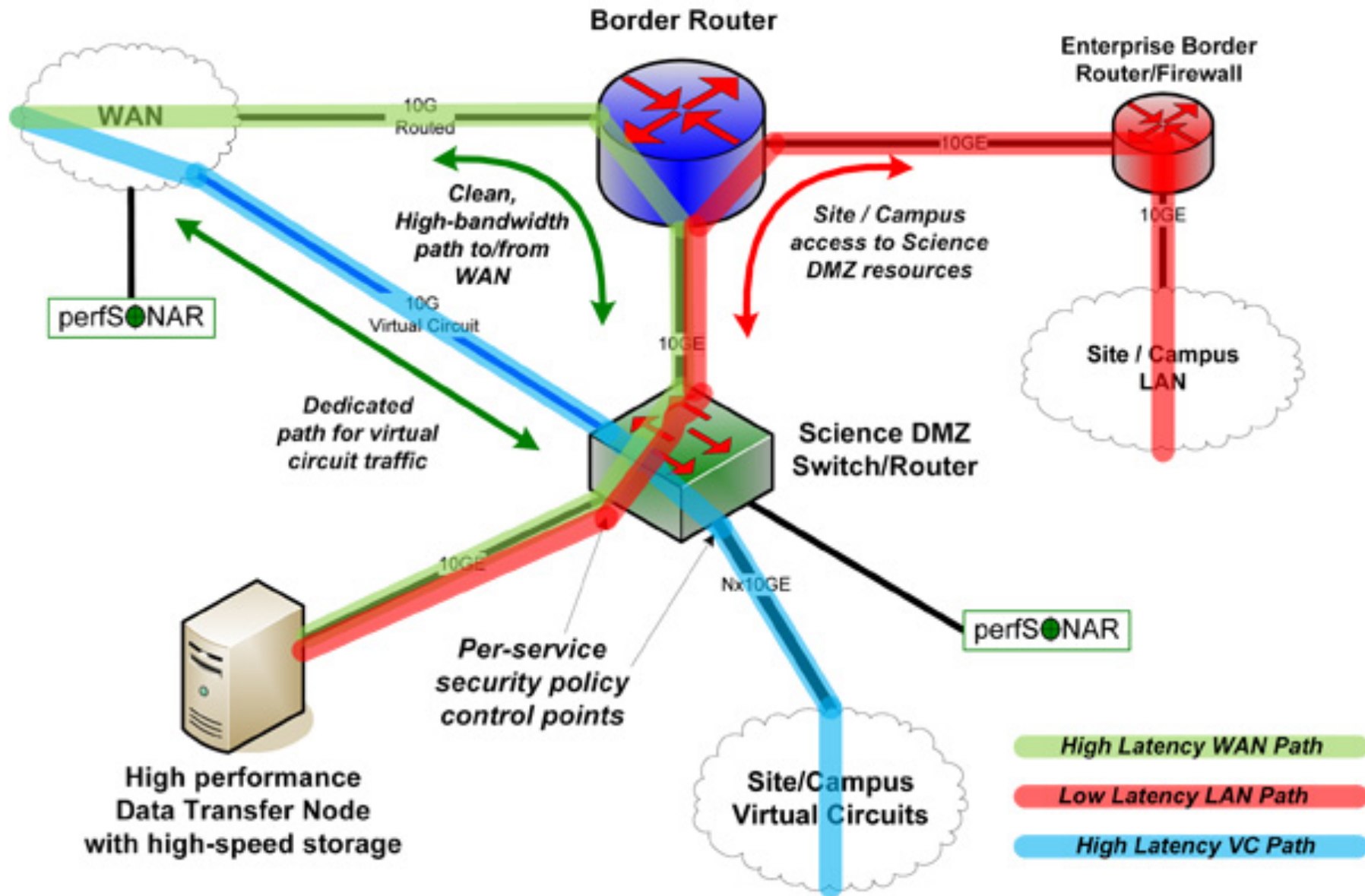
- Good performance in both directions



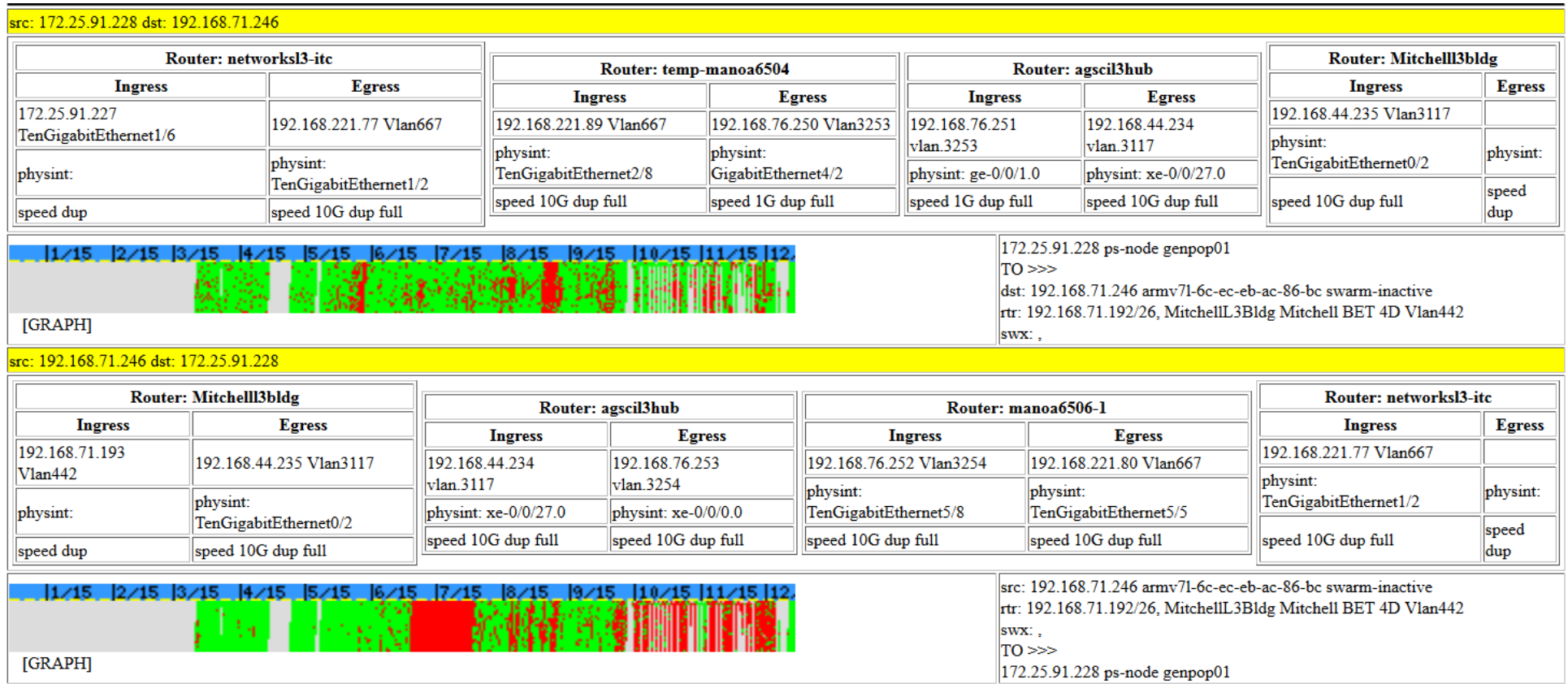
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# Firewalls and throughput



# Some local results powstream long-term-loss



resolves router/interface information for bwtraceroute results by querying netdot

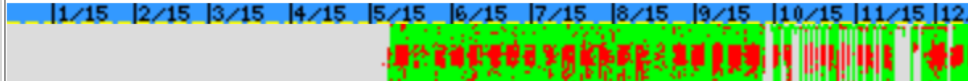
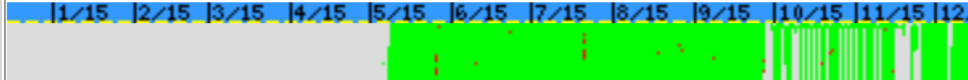


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# powstream long-term loss

Image				test			
src: 172.25.91.228 dst: 192.168.88.57							
Router: networksl3-itc		Router: temp-manoa6504		Router:		Router: wilsonl3bldg	
Ingress	Egress	Ingress	Egress	Ingress	Egress	Ingress	Egress
172.25.91.227 TenGigabitEthernet1/6	192.168.221.77 Vlan667	192.168.221.89 Vlan667		192.168.76.247		192.168.44.77 Vlan3038	
physint:	physint: TenGigabitEthernet1/2	physint: TenGigabitEthernet2/8	physint:	physint:	physint:	physint:	physint:
speed dup	speed 10G dup full	speed 10G dup full	speed dup	speed dup	speed dup	speed dup	speed dup
				172.25.91.228 ps-node genpop01 TO >>> dst: 192.168.88.57 rpi-140729-4 swarm-ACTIVE rtr: 192.168.88.0/23, WilsonL3Bldg Wilson BET 5167 Vlan194 swx: WilsonBETsw1, FastEthernet0/9			
[GRAPH]							
src: 192.168.88.57 dst: 172.25.91.228							
No trace results available							
				src: 192.168.88.57 rpi-140729-4 swarm-ACTIVE rtr: 192.168.88.0/23, WilsonL3Bldg Wilson BET 5167 Vlan194 swx: WilsonBETsw1, FastEthernet0/9 TO >>> 172.25.91.228 ps-node genpop01			
[GRAPH]							

diurnal patterns in loss suggest mid-day congestion relationship



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# Raspberry Pi Sensor Node U. Hawaii CCNIE “Swarm”



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# Small ARM based devices

- **Raspberry Pi** – famous, \$50, med-perf, file system on SD card, 100 Mb Ethernet, USB 2.0
- **BeagleBone Black** – \$50, more perf, FS on internal flash, and/or SD card, 100 Mb, USB 2.0
- **CuBox i4** – \$147, more perf, FS on SD, GigE, WiFi, USB 2.0
- **MiraBox** – \$149 – most perf, FS on SD, dual GigE, WiFi, USB 3.0



# Small x86\_64 devices

- **Liva X – gigabit Ethernet \*\*\***
  - 2 GB/32 GB \$110
  - 4 GB/64 GB \$290
  - (<http://perfclub.org/?p=112> )
- **Gigabyte BRIX (GB-BXBT-2807)**
  - Gigabit Ethernet
  - 4 GB/120 GB - \$225



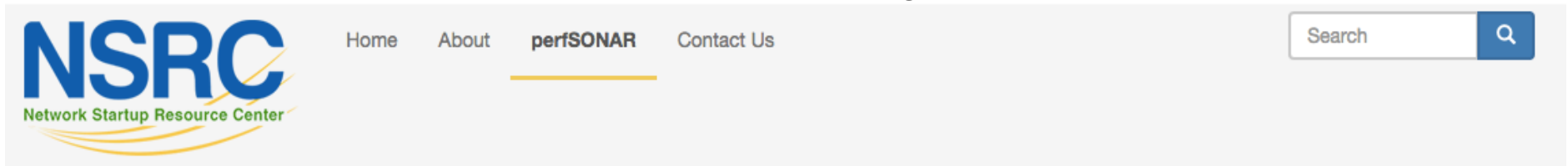
# In summary

- perfSONAR helps you to test data and metrics verifies performance of current investments
  - Can you get full use out of the carrier circuit you're paying for?
  - If performance suddenly changes, what caused it?
- Data informs future investments
  - Put resources in places with demonstrated need
  - Example: if your firewall is limiting performance, buying more bandwidth won't solve the problem
- Make the case for architectural improvements
  - How might a Science DMZ or alternate architecture change performance?
  - How to evaluate potential purchases?
    - Put perfSONAR hosts on them and run tests
    - Prototype new model



# Resources

## Online perfSONAR training videos



## perfSONAR

perfSONAR is a tool for end-to-end monitoring and troubleshooting of multi-domain network performance. perfSONAR provides network engineers with the ability to test and measure network performance, as well as to archive data in order to pinpoint and solve service problems that may span multiple networks and international boundaries. perfSONAR is currently deployed in over 900 locations around the world, and is extremely valuable when doing network troubleshooting. perfSONAR has been developed through an international collaboration led by [ESnet](#), [GÉANT](#), [Indiana University](#), and [Internet2](#).

### Intro & Installation

- What is perfSONAR?
- perfSONAR Deployment Plan
- How to Select Hardware for perfSONAR
- Install perfSONAR
- How to Secure a perfSONAR node
- Interpreting Performance Behind Firewalls
- Understanding TCP Buffer-Size

### Configuration

- How to Configure the Toolkit
- How to Configure Enabled Services
- How to Configure NTP Services
- How to Configure Testing Policies
- How to Find Other perfSONAR Nodes

### Regular Testing

- Regular BWCTL
- Latency-Ping
- Regular Traceroute
- perfSONAR Graphing Tools

### Using Metrics

- Metrics Traceroute
- Metrics Delay
- Metrics Jitter
- Metrics Throughput

### Network Measurements

- BWPing
- BWCTL
- TCP Buffer-Size
- BW Traceroute

### Using MaDDash

- MaDDash Overview
- MaDDash Configuration File
- Install MaDDash
- Install MaDDash Mesh Configuration
- Configuring Test Hosts with MaDDash



# Resources

- perfSONAR Website
  - <http://www.perfsonar.net/>
- perfSONAR mailing lists
  - <http://www.personar.net/about/getting-help/>
- perfSONAR Directory of Users
  - <http://stats.es.net/Services>
- perfSONAR Online Training Videos
  - <https://learn.nsrc.org/perfsonar/>
- FasterData Knowledgebase
  - <http://fasterdata.es.net/>
- perfSONAR Checklist
  - <https://code.google.com/p/perfsonar-ps/wiki/PerformanceToolkitTestingChecklist>



# Primary perfSONAR Development



**ESnet**  
ENERGY SCIENCES NETWORK



*For a full list of development collaborators and history of perfSONAR, please visit:*

<http://www.perfsonar.net/about/who-is-involved/>



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# Questions?