Introduction to

perfSONAR

Network Startup Resource Center

ESnet
ENERGY SCIENCES NETWORK

U.S. DEPARTMENT OF ENERGY
Office of Science

BERKELEY LAB

UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

What is it?

perfSONAR is a network measurement toolkit that provides end-to-end statistics and helps to establish end-to-end usage expectations.

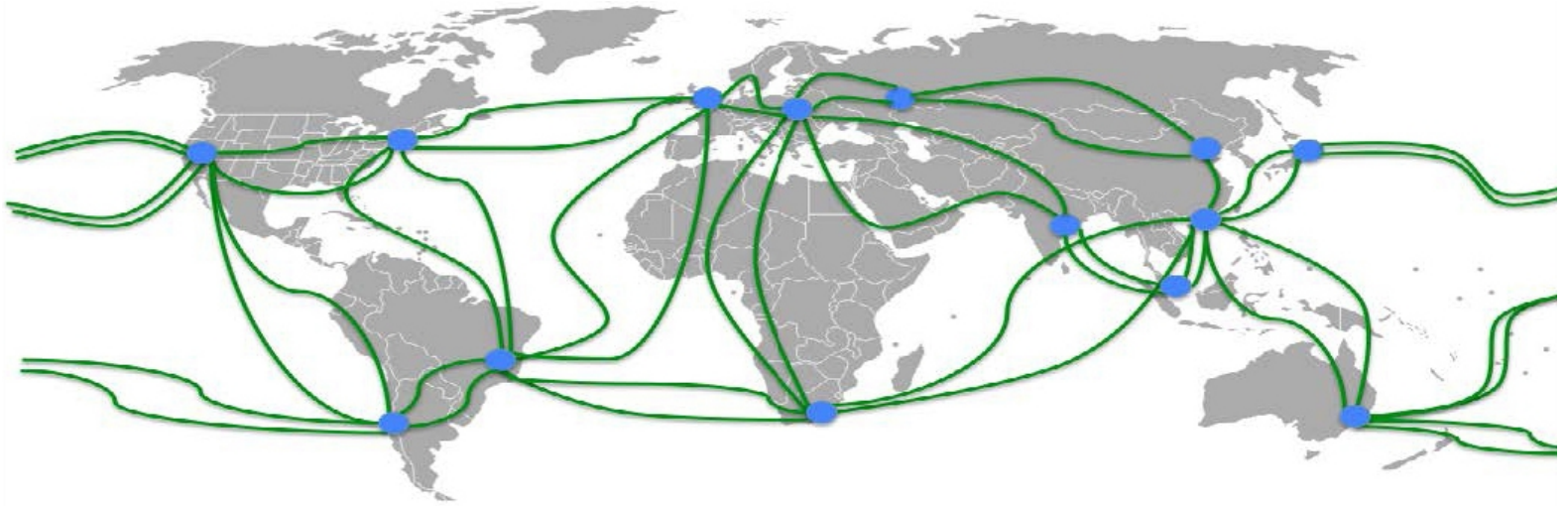
1) How fast is our circuit in reality?
2) Are there problems?
3) How do I fix problems?

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/

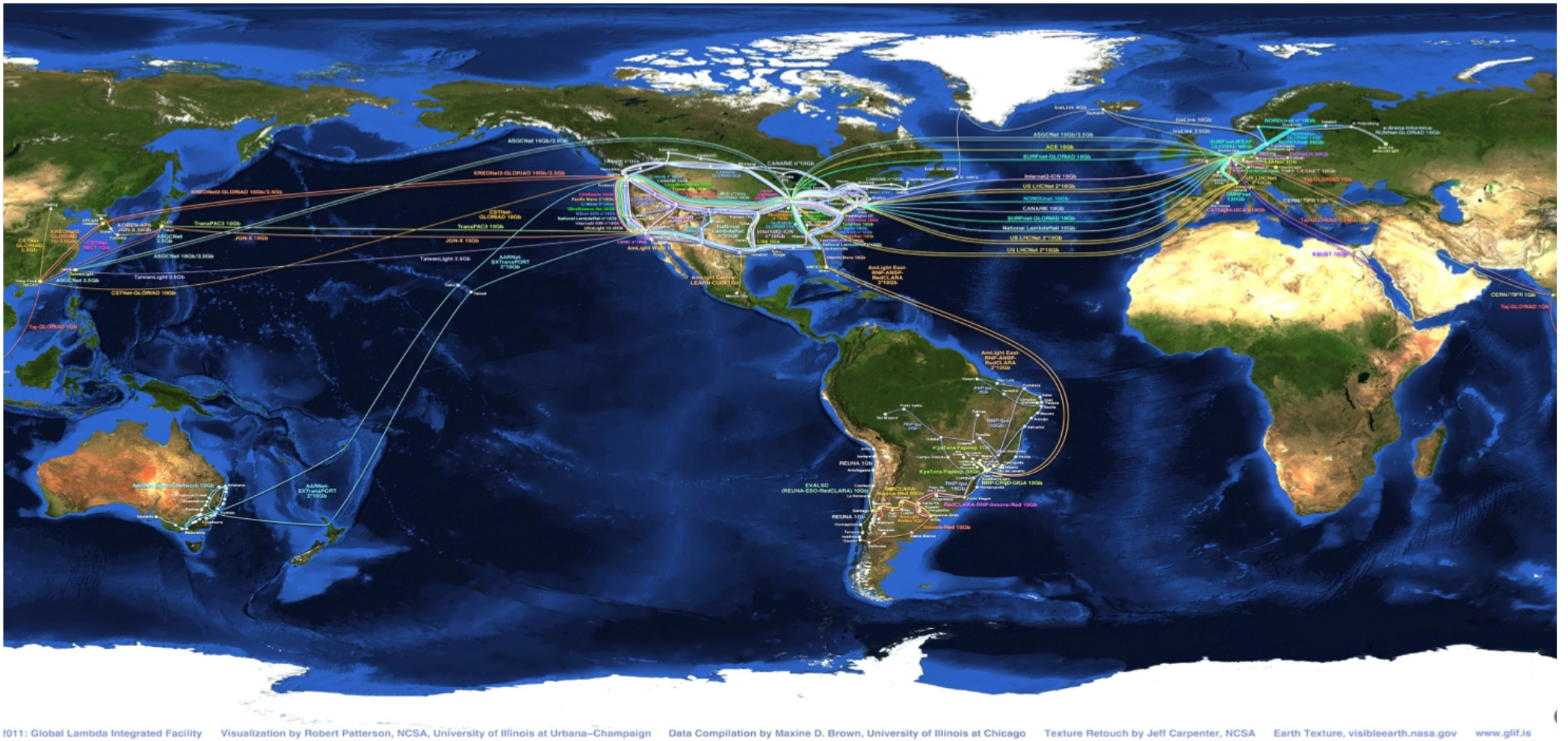
Problem Statement

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



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

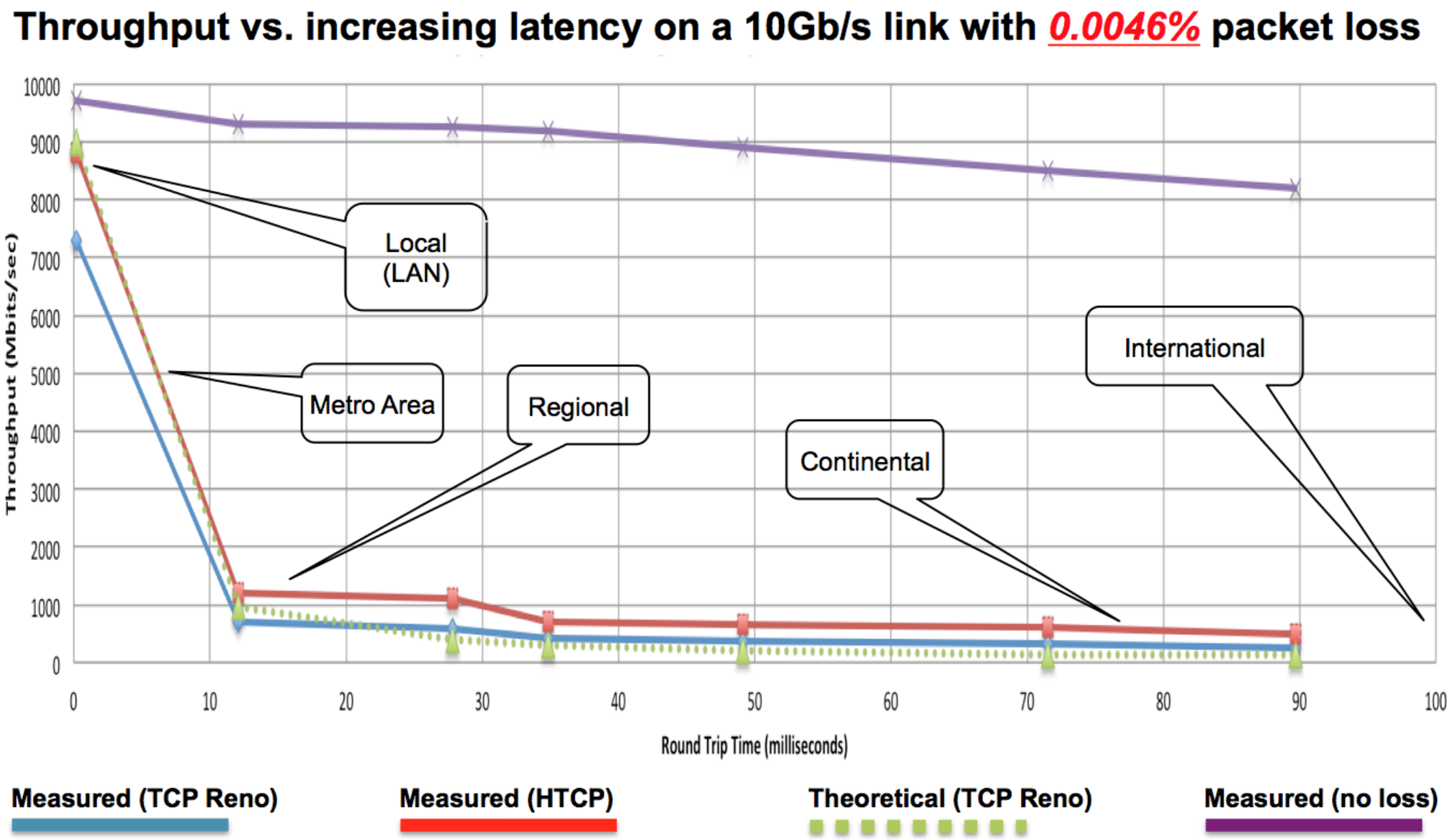
- Basic connectivity (ping, traceroute, web pages, email) works
- Performance is just poor

How much should we care about soft failures?

What's it take to transfer data...

Data set size	1 Minute	5 Minutes	20 Minutes	1 Hour
	Time to transfer			
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

But, just a little 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.

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 utiliization, 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...

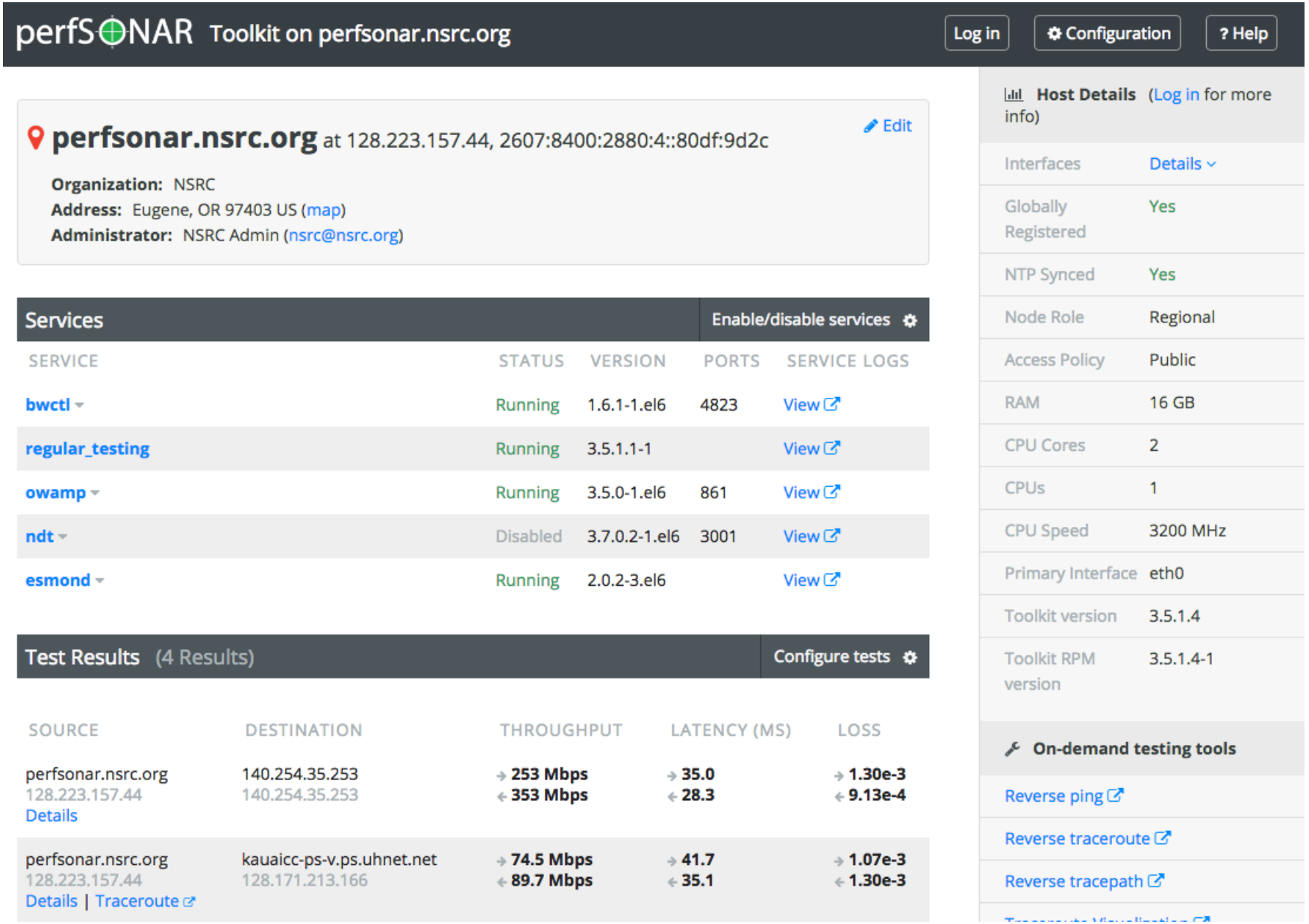
```
[root@perfsonar100 ~]# bwctl -fM -t 30 -s 202.28.229.115
bwctl: Using tool: iperf
bwctl: 37 seconds until test results available

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
```

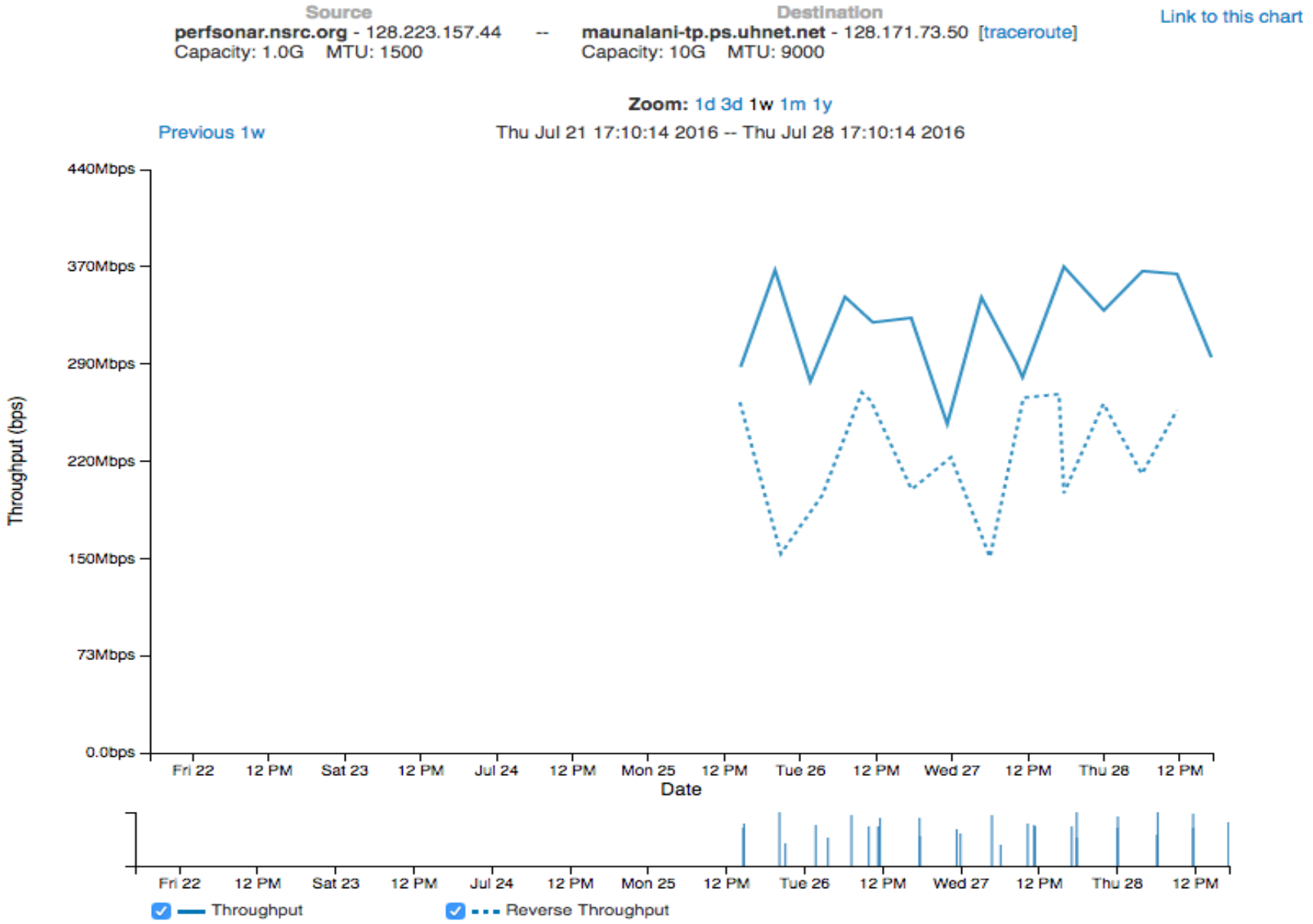
Then automate this within web GUI and build historical trends...

Sample perfSONAR site



Throughput Historical Trends

bwctl (throughput) testing over time with saved graphs



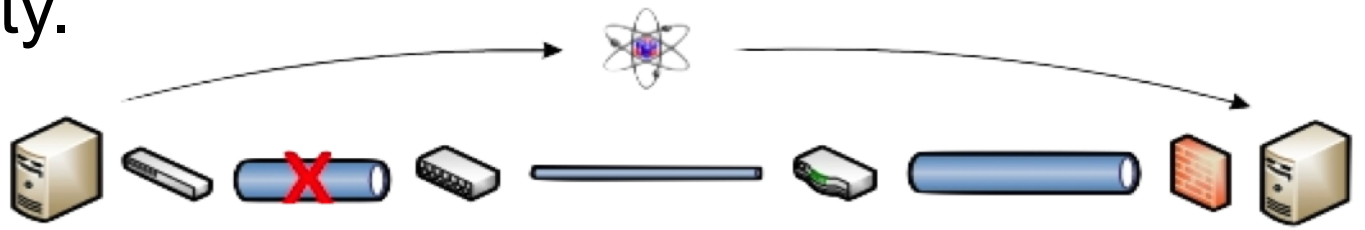
Benefits: Finding hidden problems

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

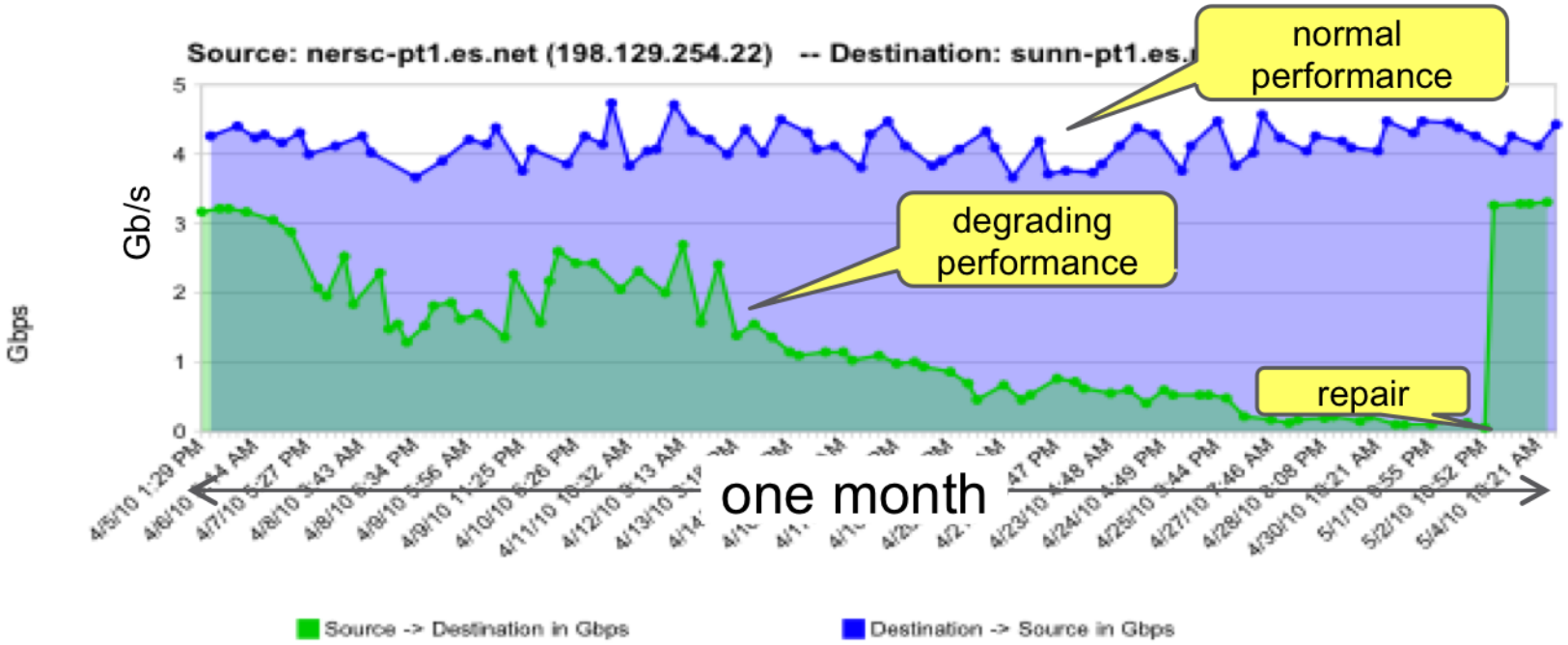
- perfSONAR tests the network in ways that classical monitoring systems do not
- More perfSONAR distributions equal better network visibility.



Benefits: Finding hidden problems

perfSONAR is designed to pinpoint and identify soft failures to accelerate resolution.

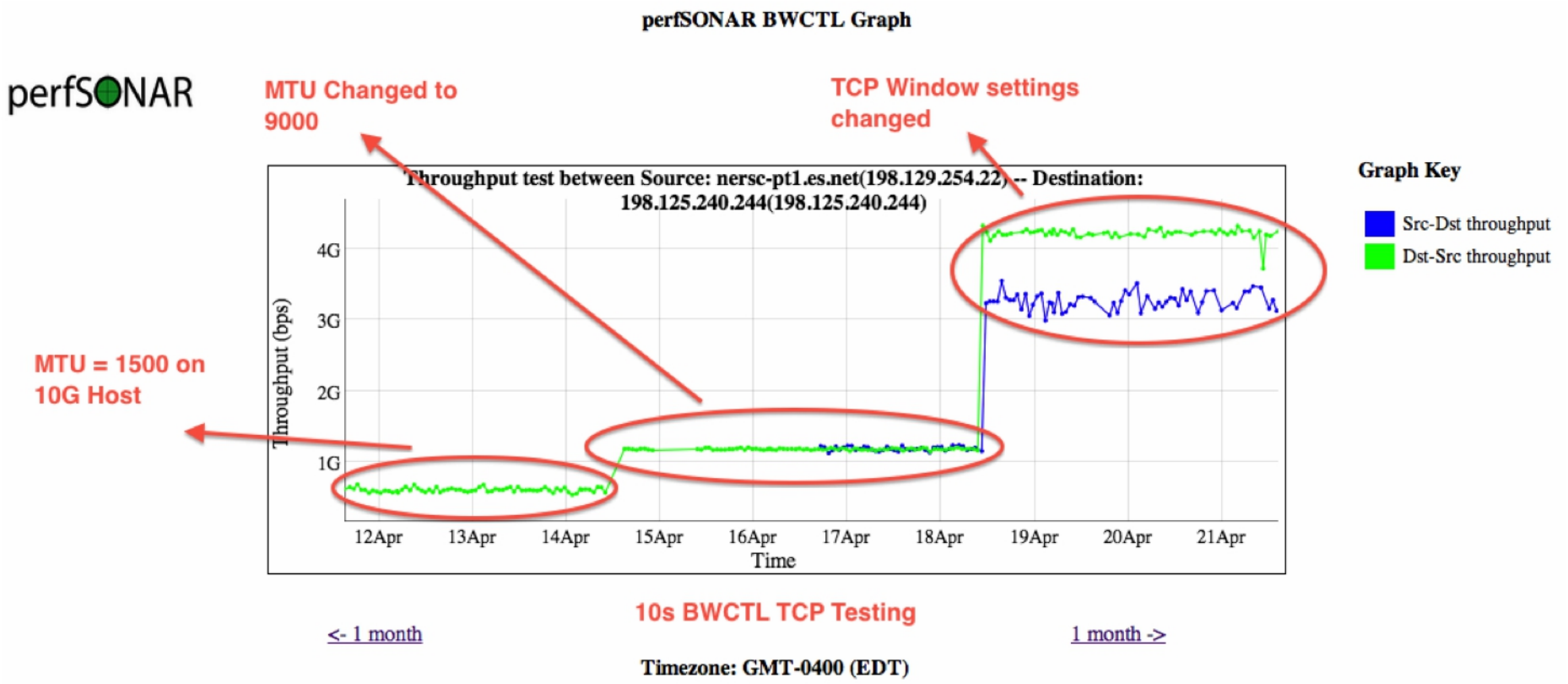
Example: Find and replace failing optics:



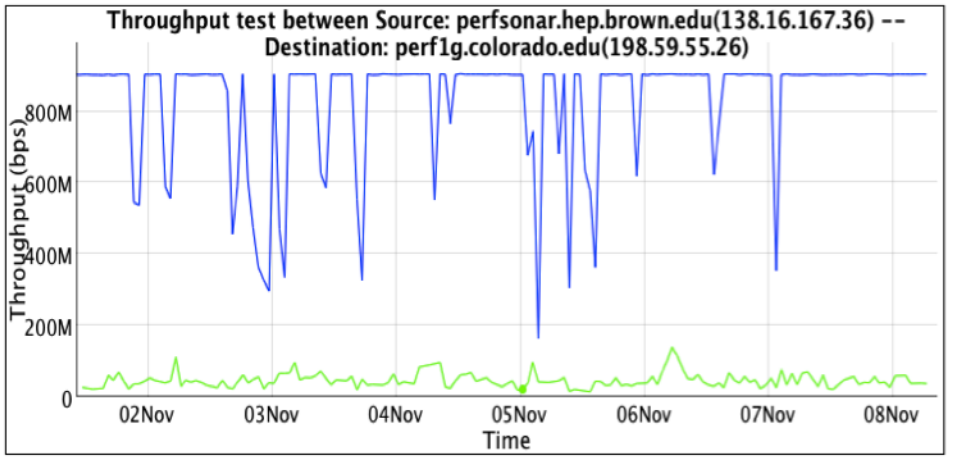
Benefits: Finding hidden problems

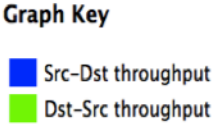
perfSONAR is designed to pinpoint and identify soft failures to accelerate resolution.

Example: Host Tuning:



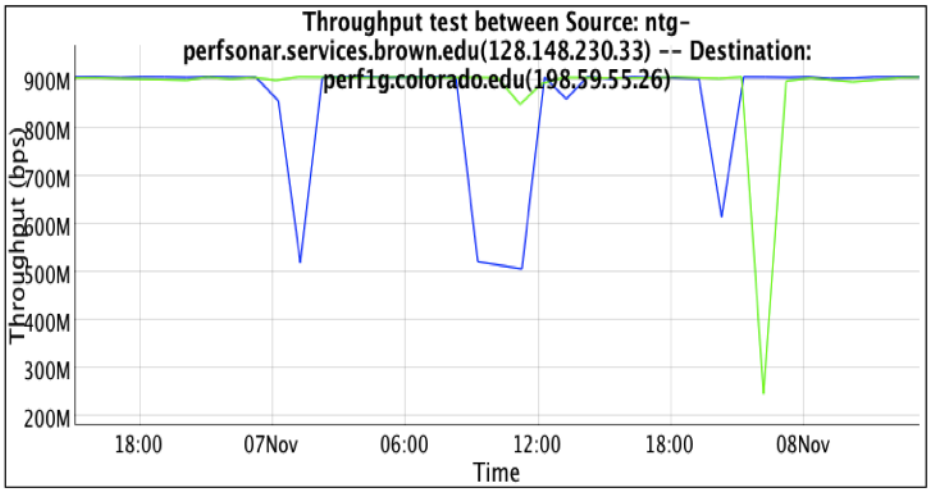
Benefits: Finding hidden problems

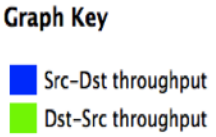




Inside the firewall

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

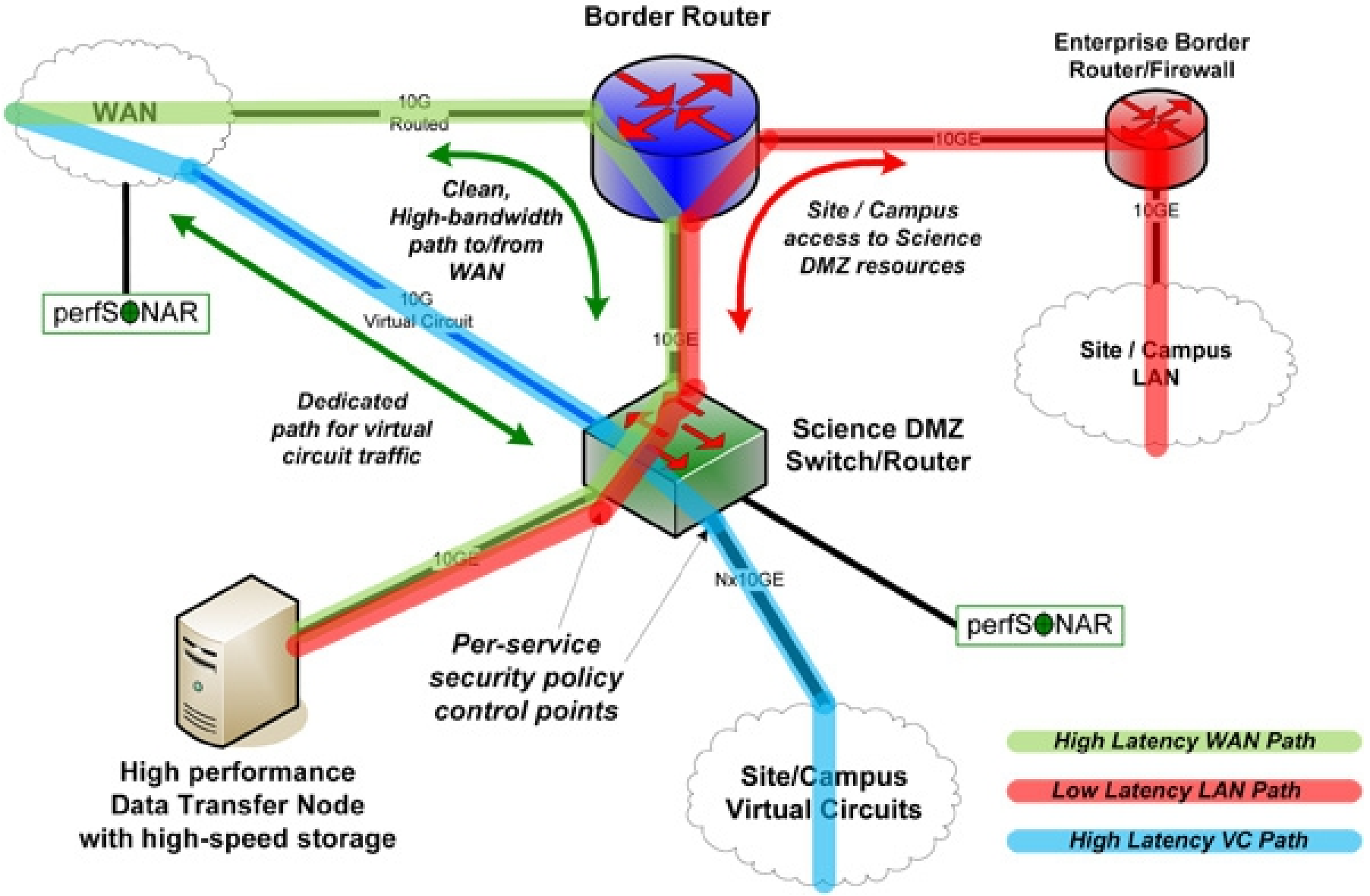




Outside the firewall

- Good performance in both directions

Firewalls and throughput



Some local results
powstream long-term-loss

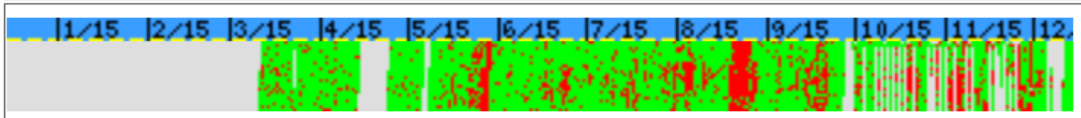
src: 172.25.91.228 dst: 192.168.71.246

Router: networksl3-itc	
Ingress	**Egress**
172.25.91.227 TenGigabitEthernet1/6	192.168.221.77 Vlan667
physint:	physint: TenGigabitEthernet1/2
speed dup	speed 10G dup full

Router: temp-manoa6504	
Ingress	**Egress**
192.168.221.89 Vlan667	192.168.76.250 Vlan3253
physint: TenGigabitEthernet2/8	physint: GigabitEthernet4/2
speed 10G dup full	speed 1G dup full

Router: agscil3hub	
Ingress	**Egress**
192.168.76.251 vlan.3253	192.168.44.234 vlan.3117
physint: ge-0/0/1.0	physint: xe-0/0/27.0
speed 1G dup full	speed 10G dup full

Router: Mitchelll3bldg	
Ingress	**Egress**
192.168.44.235 Vlan3117	
physint: TenGigabitEthernet0/2	physint:
speed 10G dup full	speed dup



[GRAPH]

172.25.91.228 ps-node genpop01
TO >>>
dst: 192.168.71.246 armv7l-6c-ec-eb-ac-86-bc swarm-inactive
rtr: 192.168.71.192/26, MitchellL3Bldg Mitchell BET 4D Vlan442
swx: ,

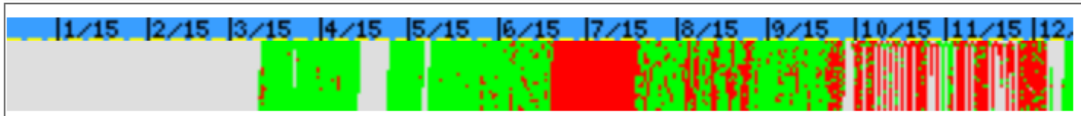
src: 192.168.71.246 dst: 172.25.91.228

Router: Mitchelll3bldg	
Ingress	**Egress**
192.168.71.193 Vlan442	192.168.44.235 Vlan3117
physint:	physint: TenGigabitEthernet0/2
speed dup	speed 10G dup full

Router: agscil3hub	
Ingress	**Egress**
192.168.44.234 vlan.3117	192.168.76.253 vlan.3254
physint: xe-0/0/27.0	physint: xe-0/0/0.0
speed 10G dup full	speed 10G dup full

Router: manoa6506-1	
Ingress	**Egress**
192.168.76.252 Vlan3254	192.168.221.80 Vlan667
physint: TenGigabitEthernet5/8	physint: TenGigabitEthernet5/5
speed 10G dup full	speed 10G dup full

Router: networksl3-itc	
Ingress	**Egress**
192.168.221.77 Vlan667	
physint: TenGigabitEthernet1/2	physint:
speed 10G dup full	speed dup



[GRAPH]

src: 192.168.71.246 armv7l-6c-ec-eb-ac-86-bc swarm-inactive
rtr: 192.168.71.192/26, MitchellL3Bldg Mitchell BET 4D Vlan442
swx: ,
TO >>>
172.25.91.228 ps-node genpop01

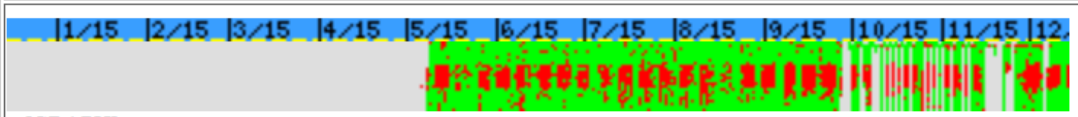
resolves router/interface information for bwtraceroute results by querying netdot

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

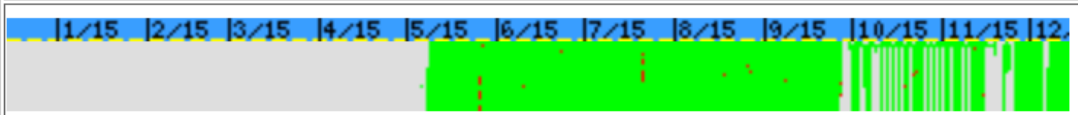


[GRAPH]

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

src: 192.168.88.57 dst: 172.25.91.228

No trace results available

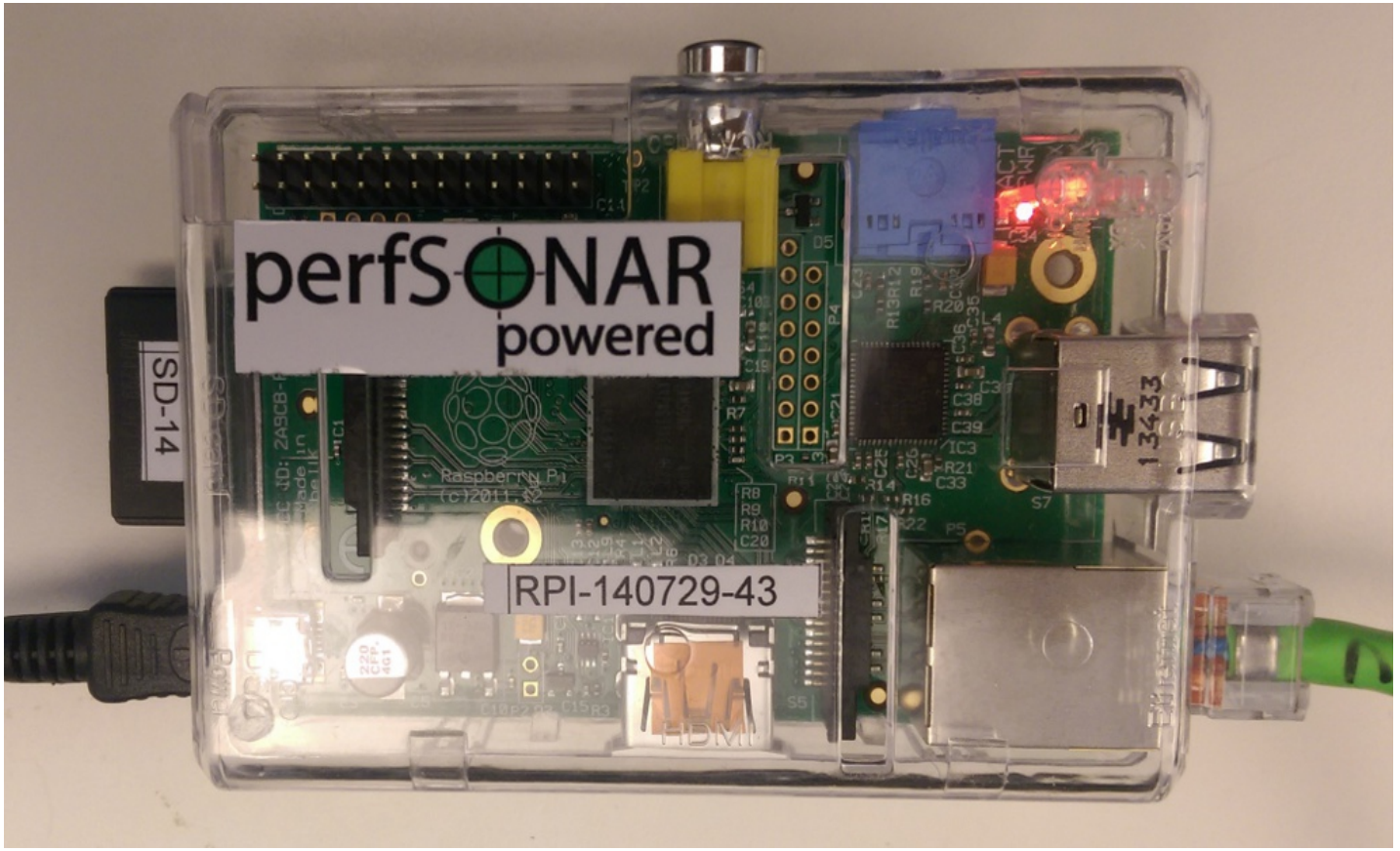


[GRAPH]

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

diurnal patterns in loss suggest mid-day congestion relationship

Raspberry Pi Sensor Node
U. Hawaii CCNIE “Swarm”



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

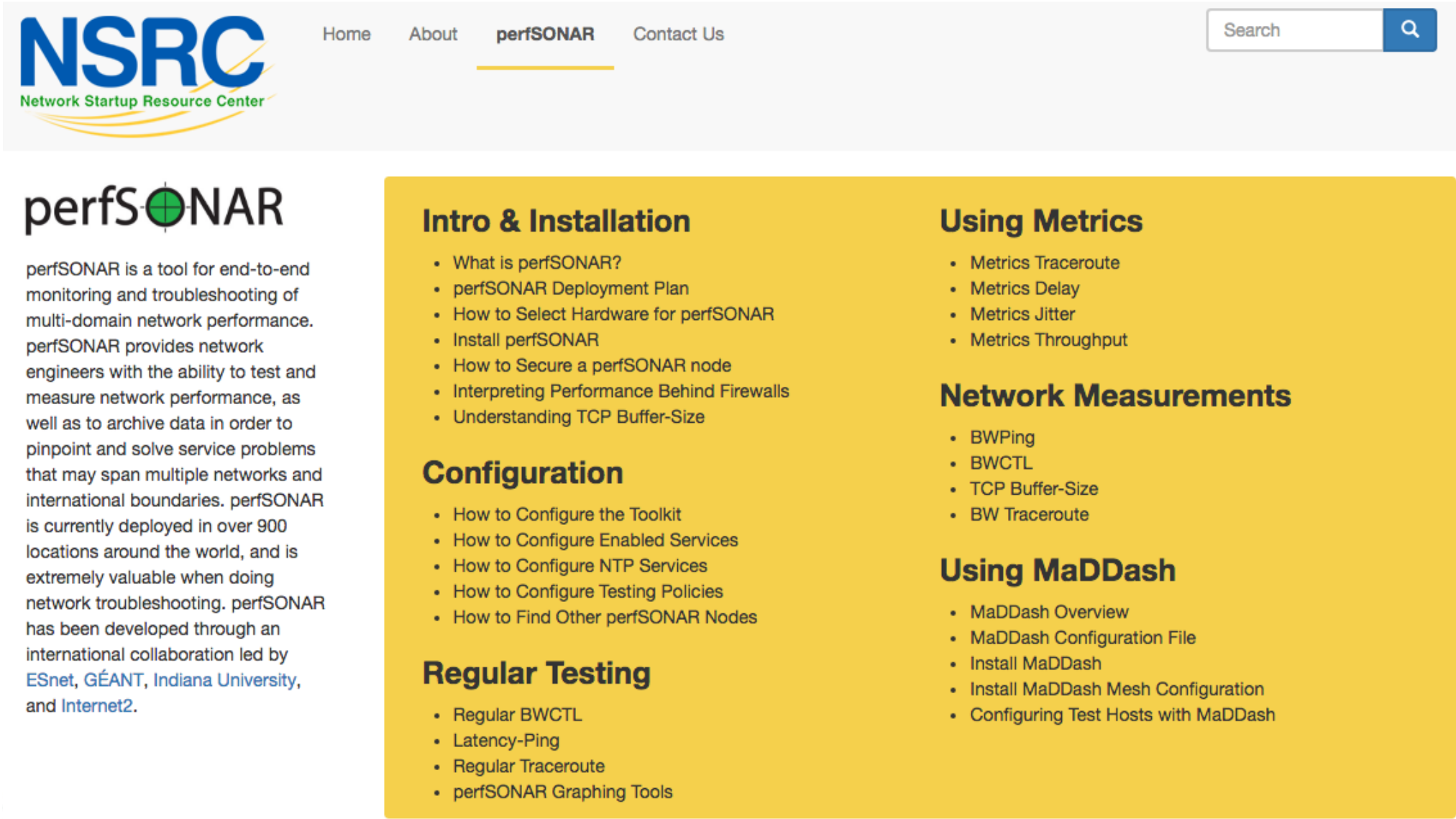
- Put resources in places with demonstrated need
- Example: if your firewall is limiting performance, buying more bandwidth won't solve the problem

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



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/
FasterDate Knowledgebase
http://fasterdata.es.net/
perfSONAR Checklist
https://code.google.com/p/perfsonar-ps/wiki/PerformanceToolkitTestingChecklist

Primary perfSONAR Development

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

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