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IPv6 Monitoring and Performance Measurement

ESnet
ENERGY SCIENCES NETWORK

National Science Foundation Award #1826994

IPv6 Monitoring

How eat an elephant… How do you monitor IPv6?

One service, one network at a time

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Progress Bar:

8:30a - 9:15a

Questions or Discussion topics?

IPv6 Monitoring: Suggested Plan (ScienceDMZ focus)

- Know your upstream providers and have open communications with them**
- Turn up IPv6 at your Border/Perimeter Router with R&E/I2
- Hold on commodity ISP until 100% comfortable
- Adjust BGP route space for IPv4 and IPv6 between 1-2 AS hop to full tables
- Add IPv6 BOGONS (slide 16 in this presentation)
- Complete MANRS
- Jumbo frames, enable them.
- Configure and collect Border Routers eyes and ears (e.g. NetFlow/IPFIX or sFlow)
- Document how to check IPv4 and IPv6 Router BGP Table sizes
- Create an IPv4 vs IPv6 chart with in your NetFlow/IPFIX or sFlow collector
- Setup BGP monitoring with a package such as Artemis

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IPv6 Monitoring: Suggested Plan (ScienceDMZ)

- Turn up a dual stack jumbo framed LAN on your Science DMZ and have your perfSONAR server(s) ready.
  - Monitor NetFlow/IPFIX or sFlow at your Science DMZ
  - Start IPv4 and IPv6 testing from your perfSONAR server(s) to and ESnet or regional pS server
- Build IPv4/IPv6 test network off of the core and add a small perfSONAR Server
  - Verify IPv6 as well as IPv4 routing through from test LAN through core, firewall out to Science DMZ perfSONAR server(s) and return connectivity and path.
  - Monitor TCAM tables and OSPF/ISIS/IGP routes
- Once testing is complete, monitoring is complete, and security is as good as it will get, turn up IPv6 BGP to commodity ISPs.
  - Turn BGP preference to R&E networks (especially if there are transit costs)
  - Complete pS testing again to R&E and commodity ISPs
- Rinse and repeat for other segments and networks as they arrive online (Instruments, project groups, etc…)

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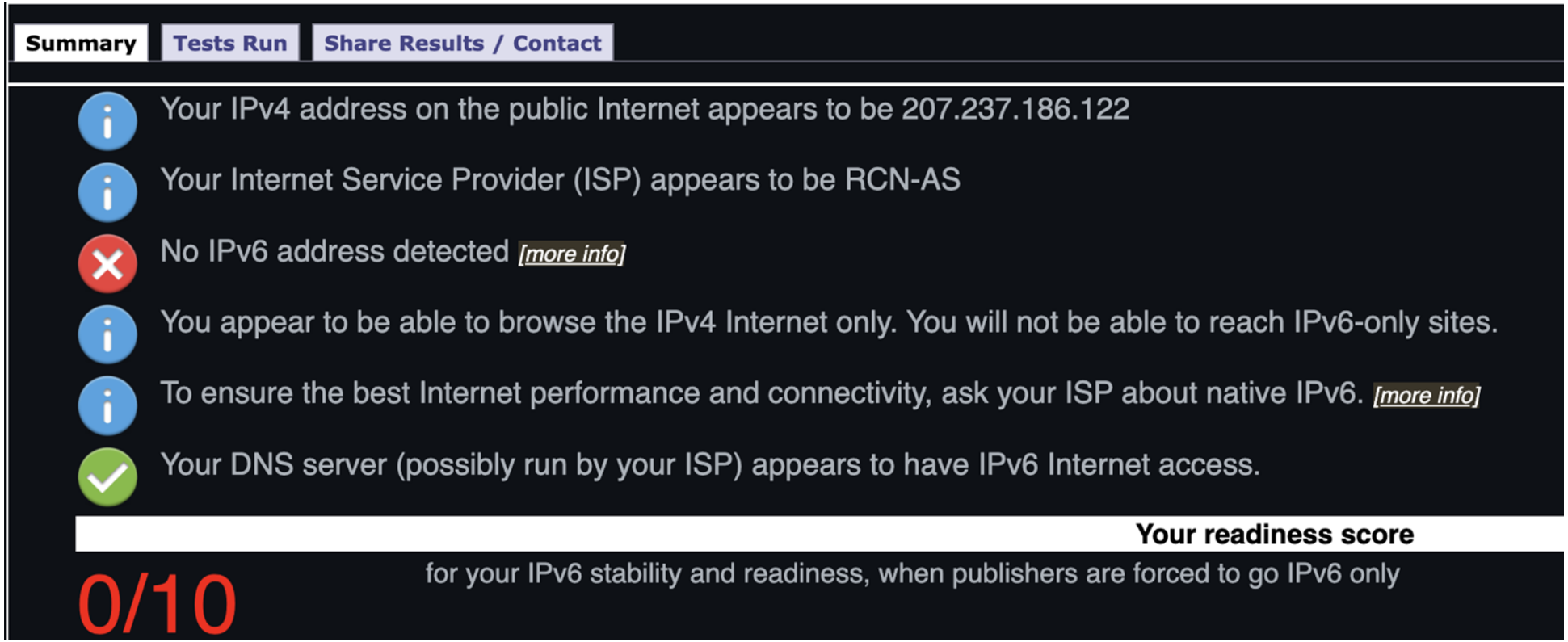
IPv6 test - https://test-ipv6.com/

https://test-ipv6.com/ from a IPv4 address



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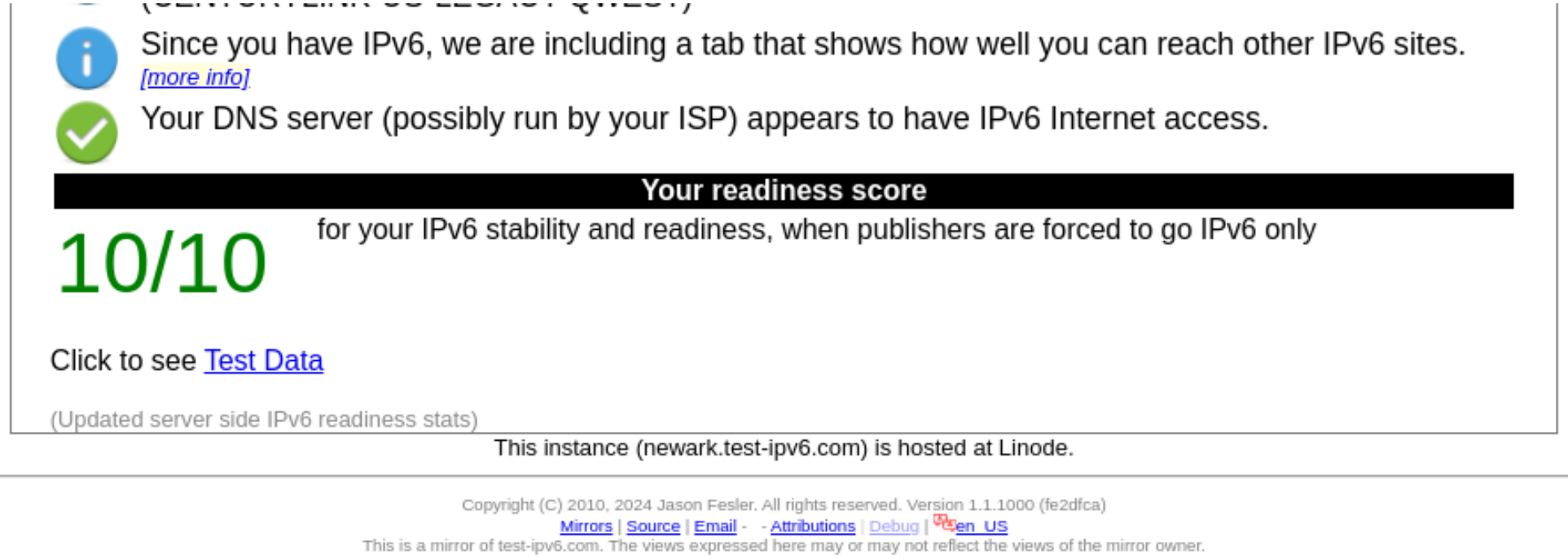
IPv6 test - https://test-ipv6.com/

https://test-ipv6.com/ from a IPv6 address



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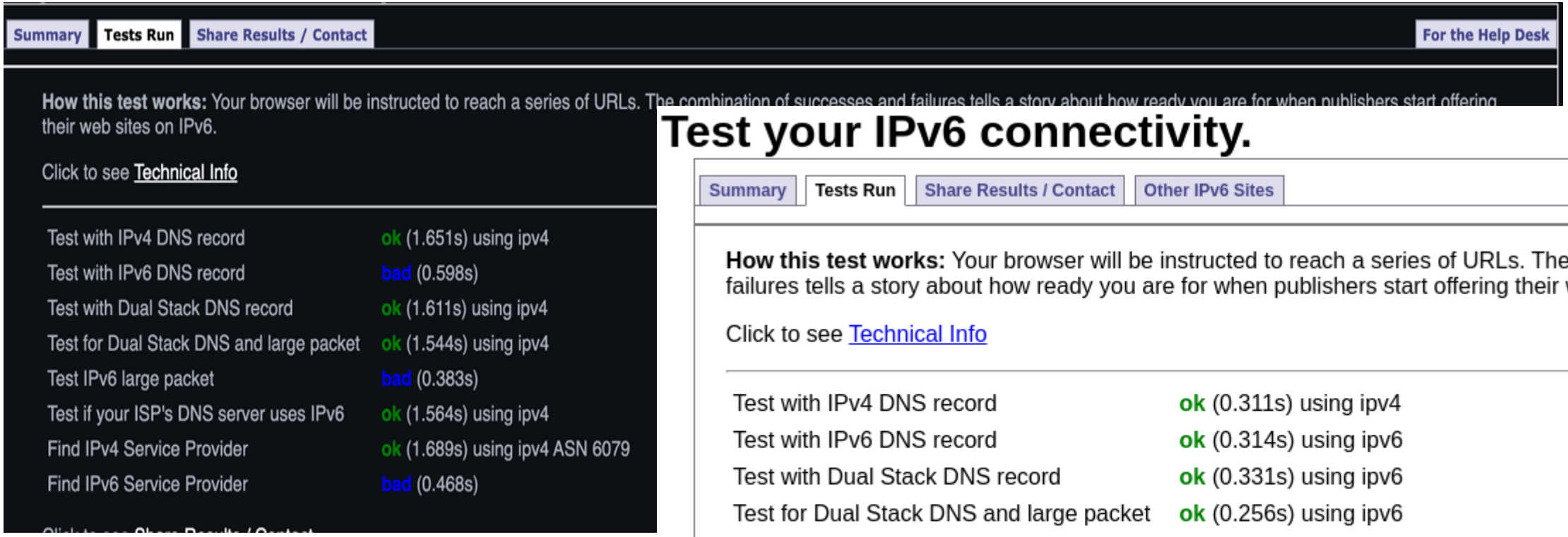
IPv6 test - https://test-ipv6.com/



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IPv6 Service Monitoring - Don’t let your customers be the monitor…

https://www.mrp.net/ipv6_survey/

- Verify IPv6 enabled services
- Check performance too…
  - HTTPS
  - eMail
  - DNS/DNS SEC
  - DHCP
  - Time / NTP / PTP
  - Monitoring suites
  - Management software
    - Policy at procurement?
  - XMPP
  - SIP/VoIP
  - SecNet/NVRs
  - LDAP/Access/shibboleth
  - APIs
  - Wireless
  - perfSONAR
  - Science DMZ
  - DTNs

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IPv6 DNS Resolution Monitoring

- Monitor DNS!
  - host AAAA record lookup failures and successful IPv4 A record lookups for the same query

```
es.net has address 142.93.181.71

es.net has IPv6 address 2604:a880:800:c1::105:b001
```

- Review NetFlow/IPFIX or sFlow data for top talkers
- Review firewall logs for DNS queries
- Look at perfSONAR DNS latency monitoring - https://docs.perfsonar.net/pscheduler_ref_tests_tools.html#dns-tests
- If you want an Example of the perfSONAR DNS latency config
- Other tools support this as well like smokeping, etc.

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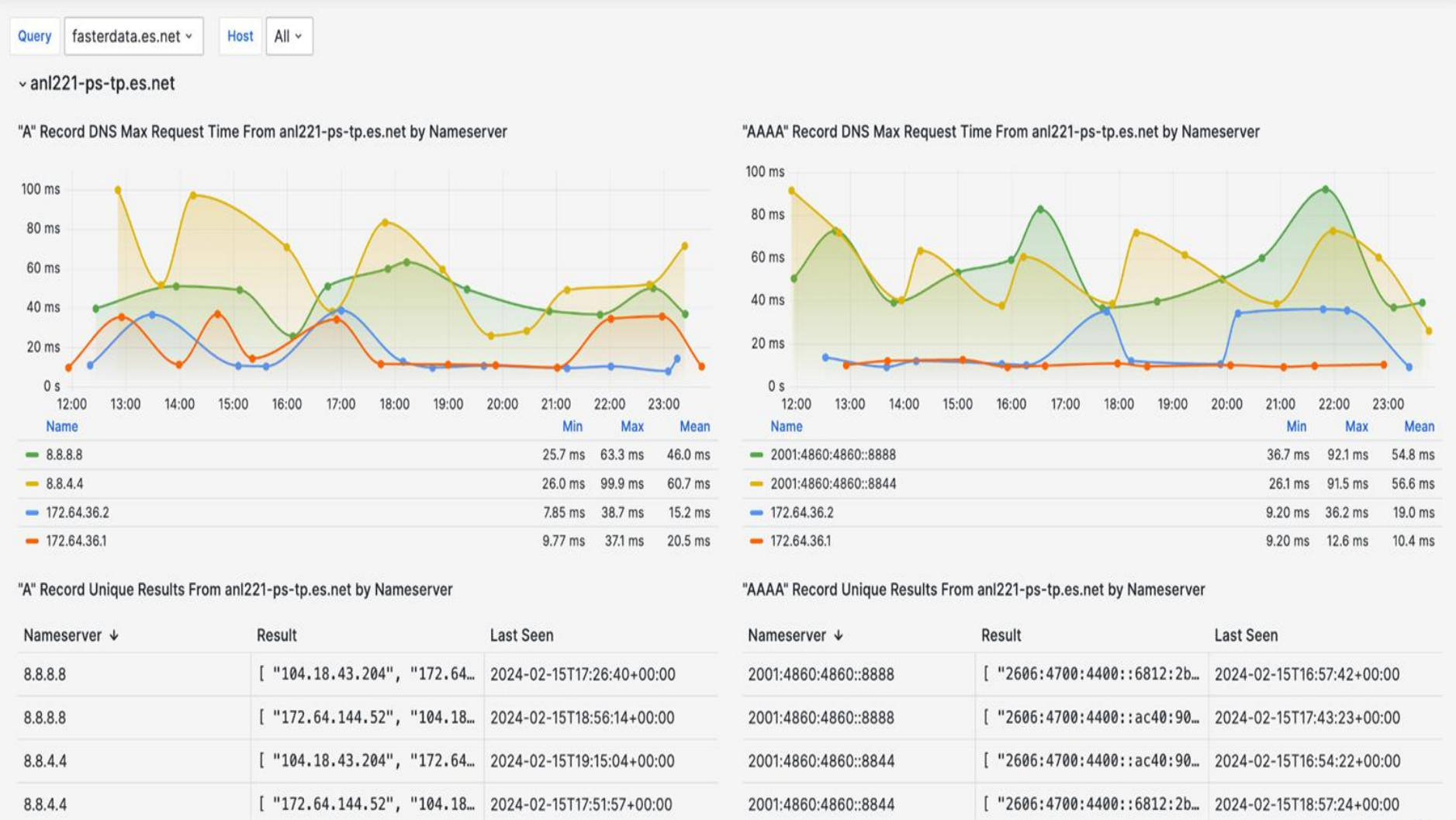
IPv6 DNS Resolution Monitoring



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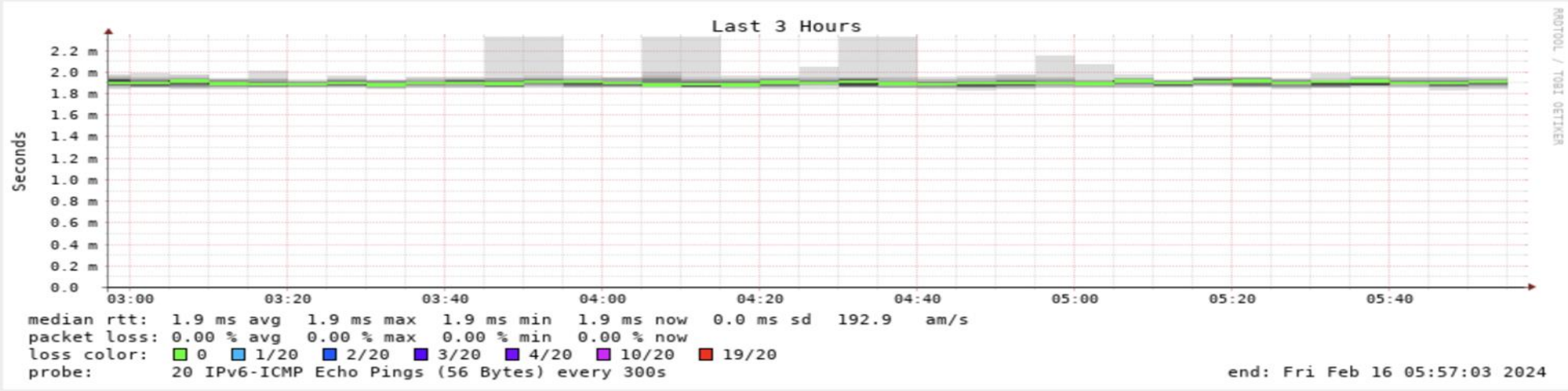
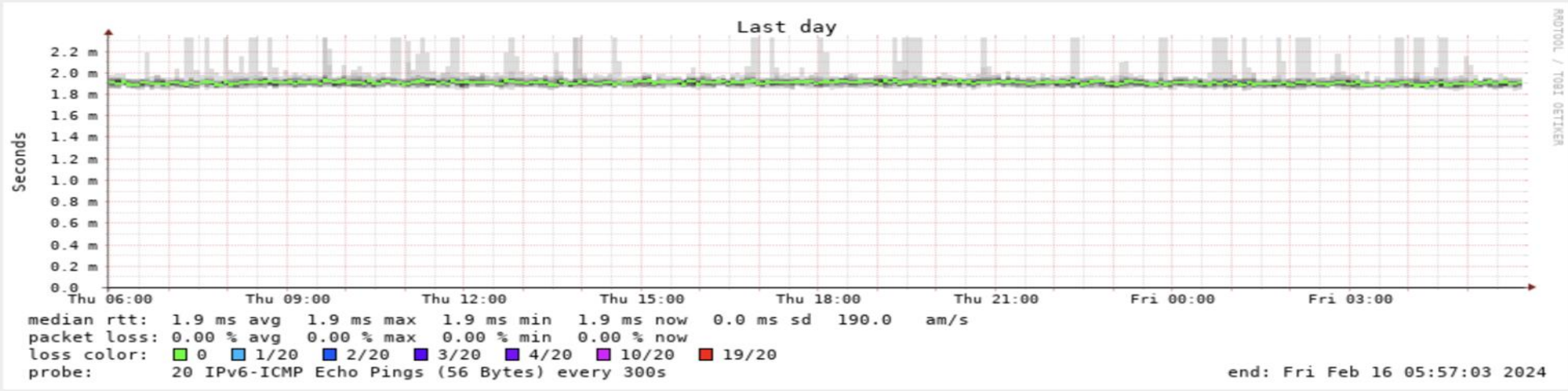
Google DNS IPv6





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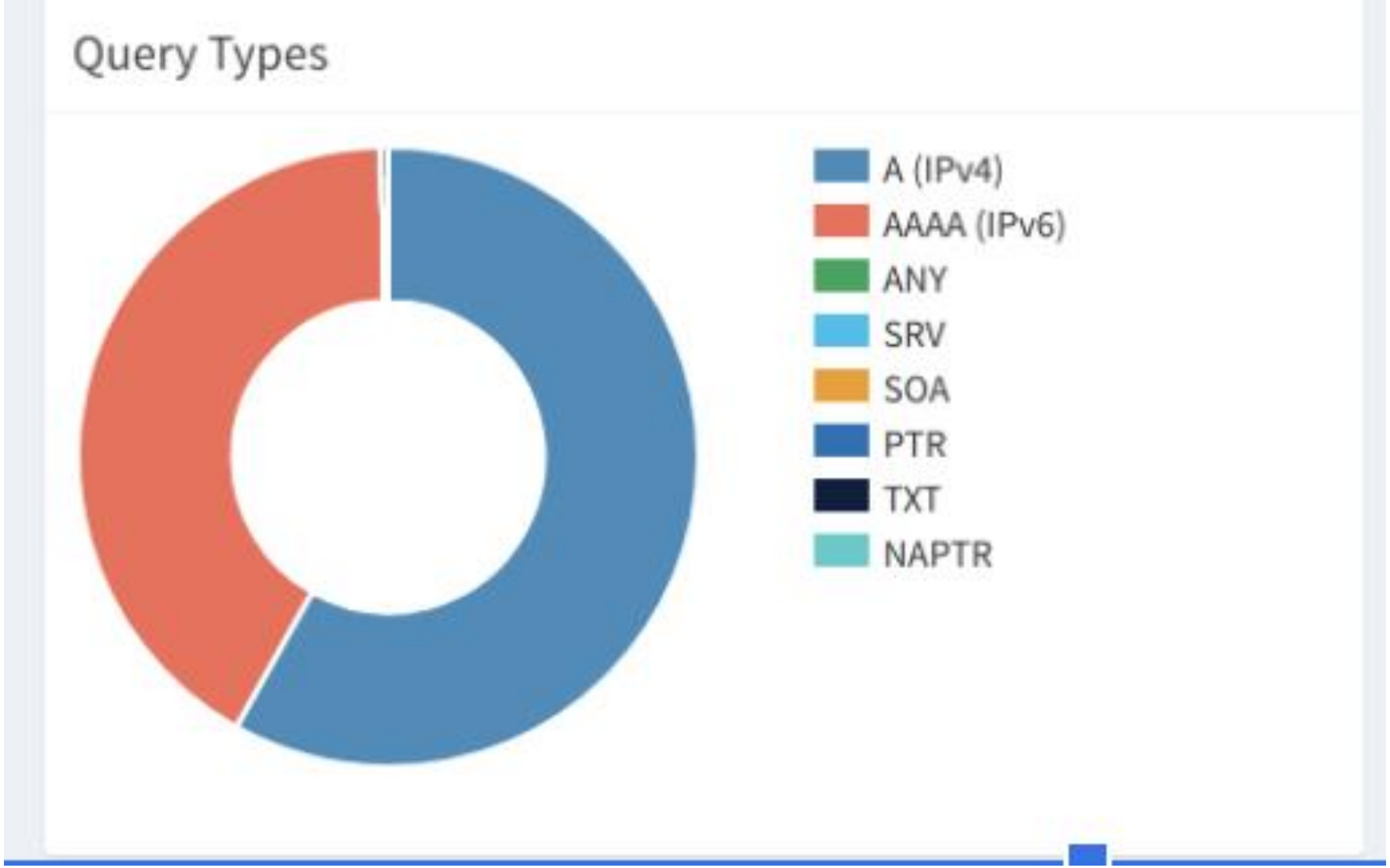
Home DNS monitoring and filtering with PiHole



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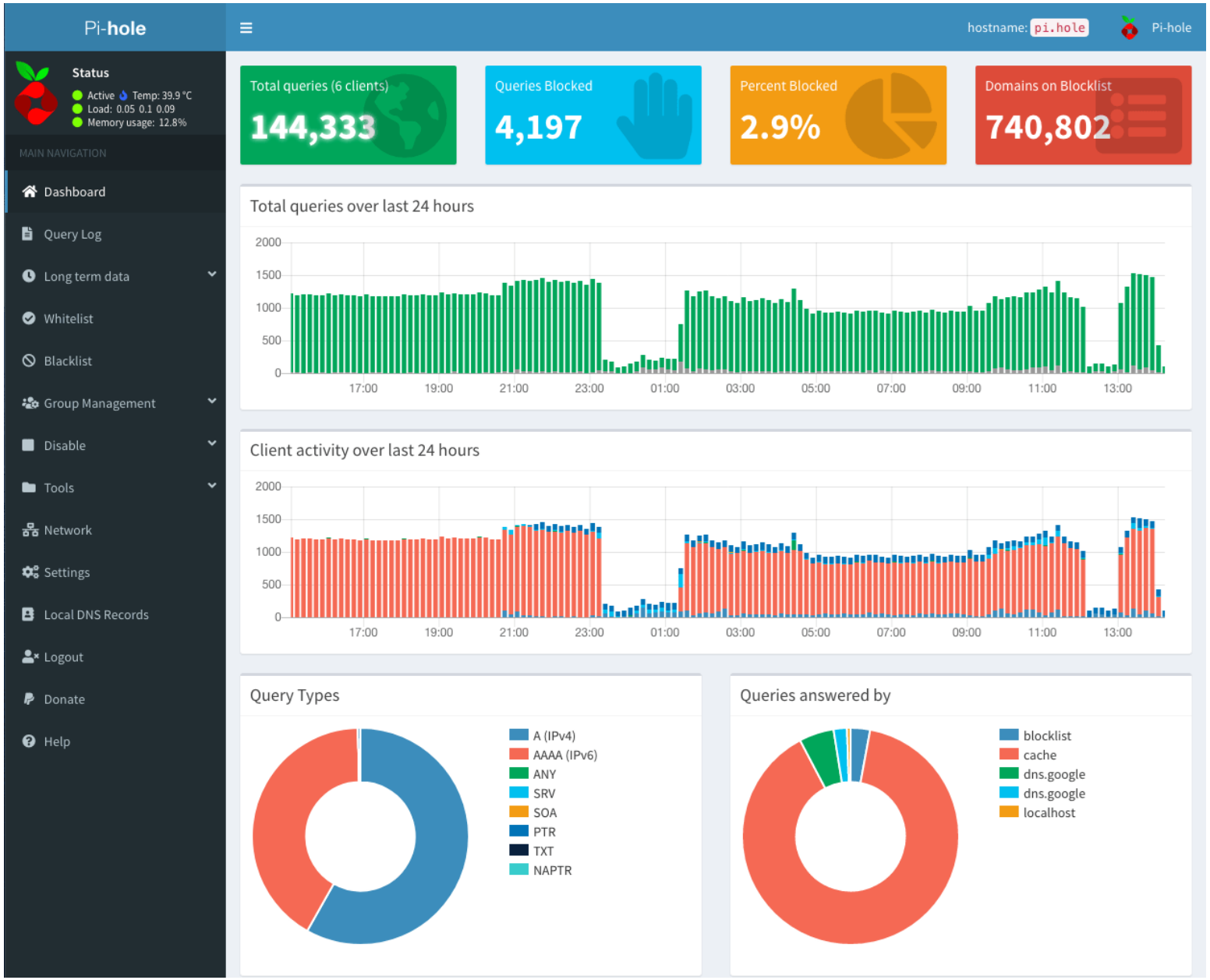

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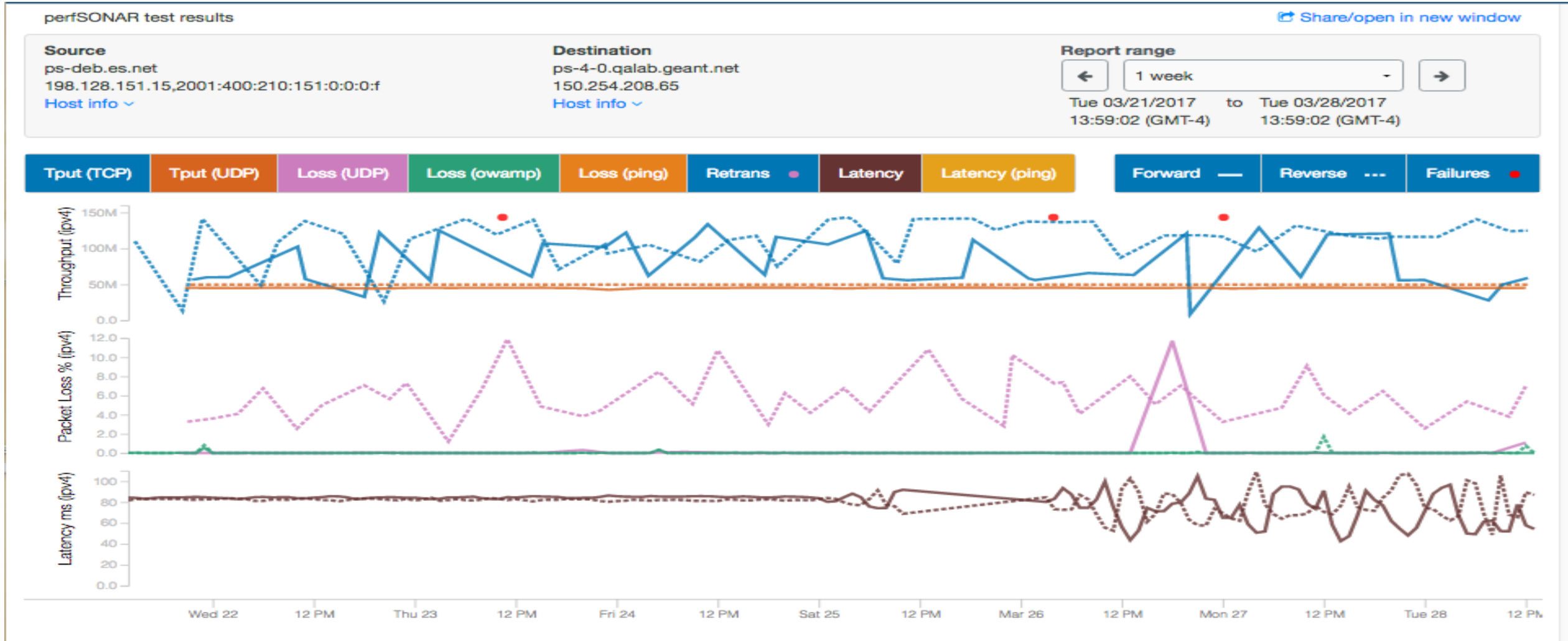
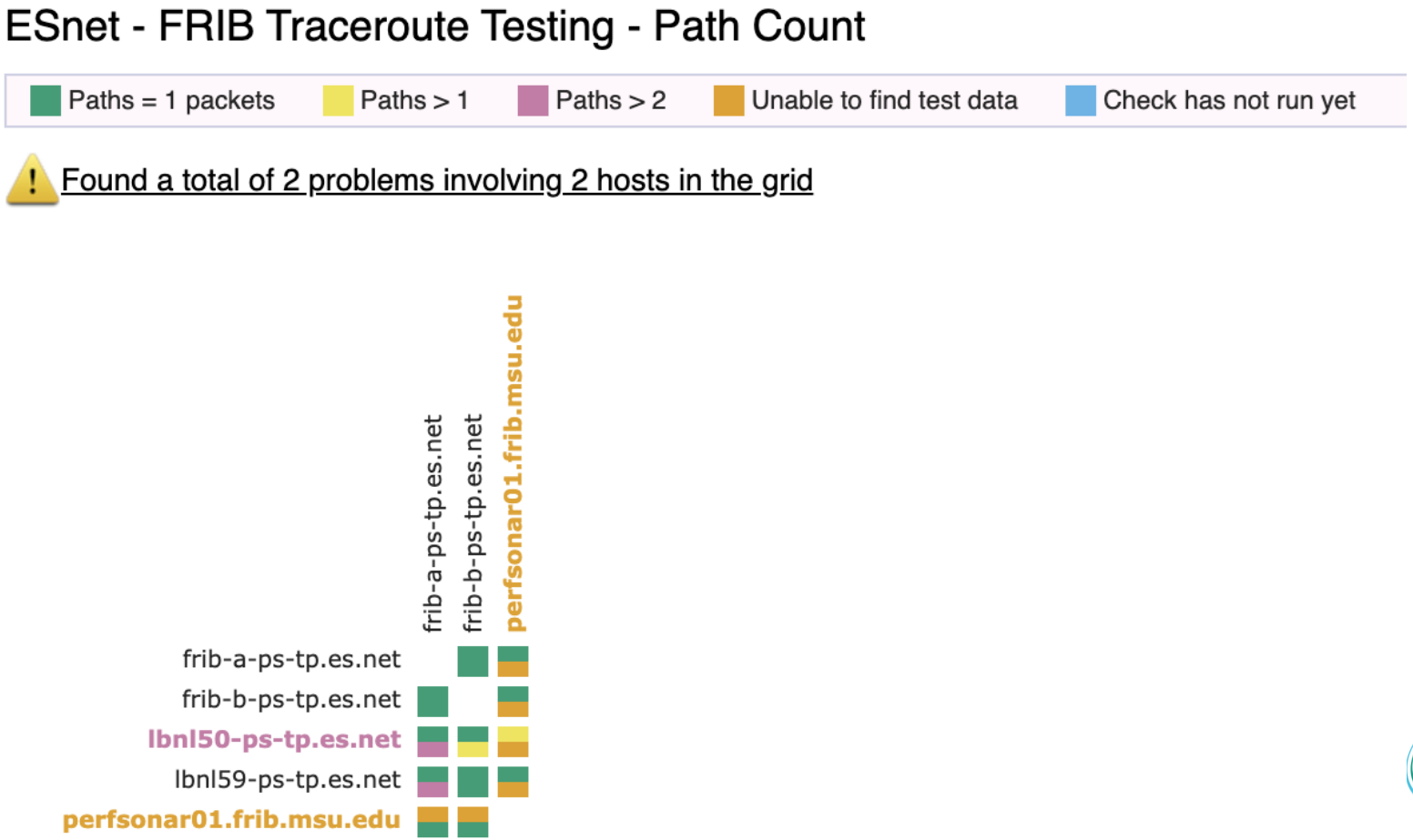
IPv6 Traffic Destinations - perfSONAR

- perfSONAR can test this, with **rtt tests**
- https://docs.perfsonar.net/pscheduler_ref_tests_tools.html#rtt-tests



IPv6 Traffic Paths - perfSONAR

- perfSONAR can test this with **traceroute tests**
- https://docs.perfsonar.net/pscheduler_ref_tests_tools.html#trace-tests



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IPv6 BGP BOGONS

```
define BOGON_PREFIXES = [ ::/8+,                    # RFC 4291 IPv4-compatible, loopback, et al
                          0100::/64+,               # RFC 6666 Discard-Only
                          2001:2::/48+,             # RFC 5180 BMWG
                          2001:10::/28+,            # RFC 4843 ORCHID
                          2001:db8::/32+,           # RFC 3849 documentation
                          2002::/16+,               # RFC 7526 6to4 anycast relay
                          3ffe::/16+,               # RFC 3701 old 6bone
                          fc00::/7+,                # RFC 4193 unique local unicast
                          fe80::/10+,               # RFC 4291 link local unicast
                          fec0::/10+,               # RFC 3879 old site local unicast
                          ff00::/8+                 # RFC 4291 multicast
 ];
```

https://bgpfilterguide.nlnog.net/guides/bogon_prefixes/#configuration-examples-ipv6
https://www.team-cymru.com/ty/cisco-router-traditional-bogons
https://manrs.org/netops/guide/

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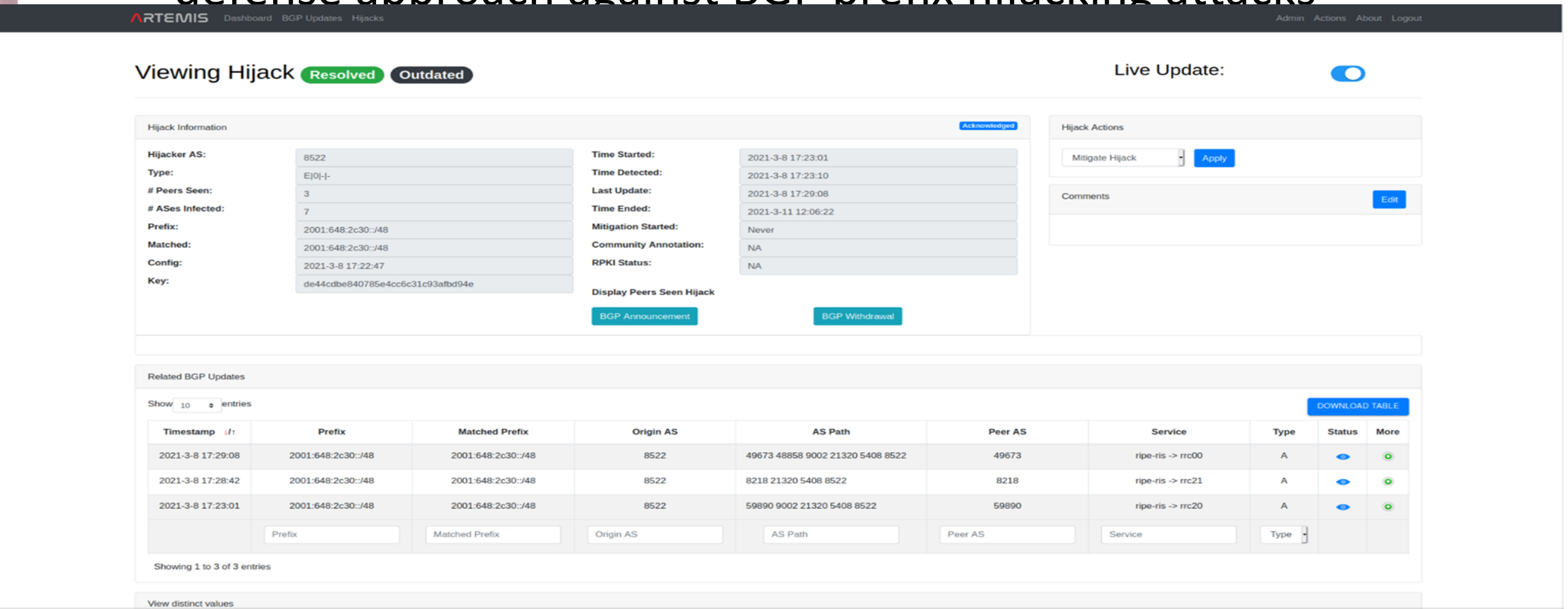
IPv6 BGP Monitoring with Artemis

- ARTEMIS is an open-source tool, that implements a defense approach against BGP prefix hijacking attacks



IPv6 Security monitoring with Zeek, firewall with pfSense/OPNSense

- https://zeek.org/
  - https://docs.securityonion.net/en/2.3/zeek.html
  - https://securityonionsolutions.com/
- https://corelight.com/
- https://www.pfsense.org/
- https://opnsense.org/

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IPv6 MTU Monitoring

- **Mismatched MTU's - EPOC's largest number of support tickets**
  - Define a MTU strategy
  - Personally, I jumbo frame enabled IPv4 (9198) and IPv6(9216) to the MAX MTU the device can handle for the border/perimeter, Science DMZ, core, and data center networks
  - Then enable whatever access/edge networks you need to
- Don't forget to set BOTH IPv4 and IPv6 on network, storage, and compute
- Verify Path MTU Discovery - later

Network MTU (bytes)
---
16 Mbps Token Ring
4 Mbps Token Ring
FDDI
Ethernet
IEEE 802.3/802.2
PPPoE (WAN Miniport)
X.25
ATM
IEEE 802.11 Wi-Fi (WLAN)
T-Mobile Starlink
Ethernet Jumbo

Network MTU (bytes)
---
16 Mbps Token Ring 17914
4 Mbps Token Ring 4464
FDDI 4352
Ethernet 1500
IEEE 802.3/802.2 1492
PPPoE (WAN Miniport) 1480
X.25 576
ATM 4470
IEEE 802.11 Wi-Fi (WLAN) 2304[19]
T-Mobile ~1420 STARLINK ~1472
Ethernet Jumbo 9000

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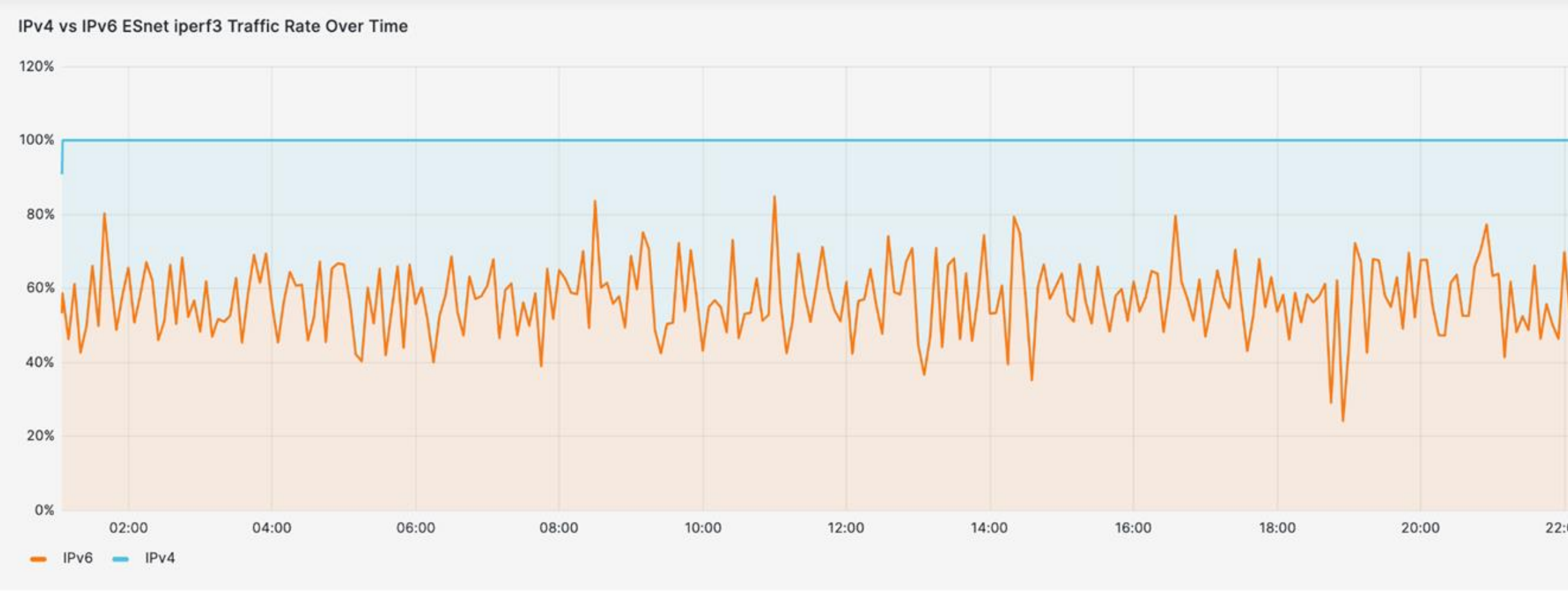
IPv4 vs IPv6 iperf3



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IPv6 Flow Labels - SCItags

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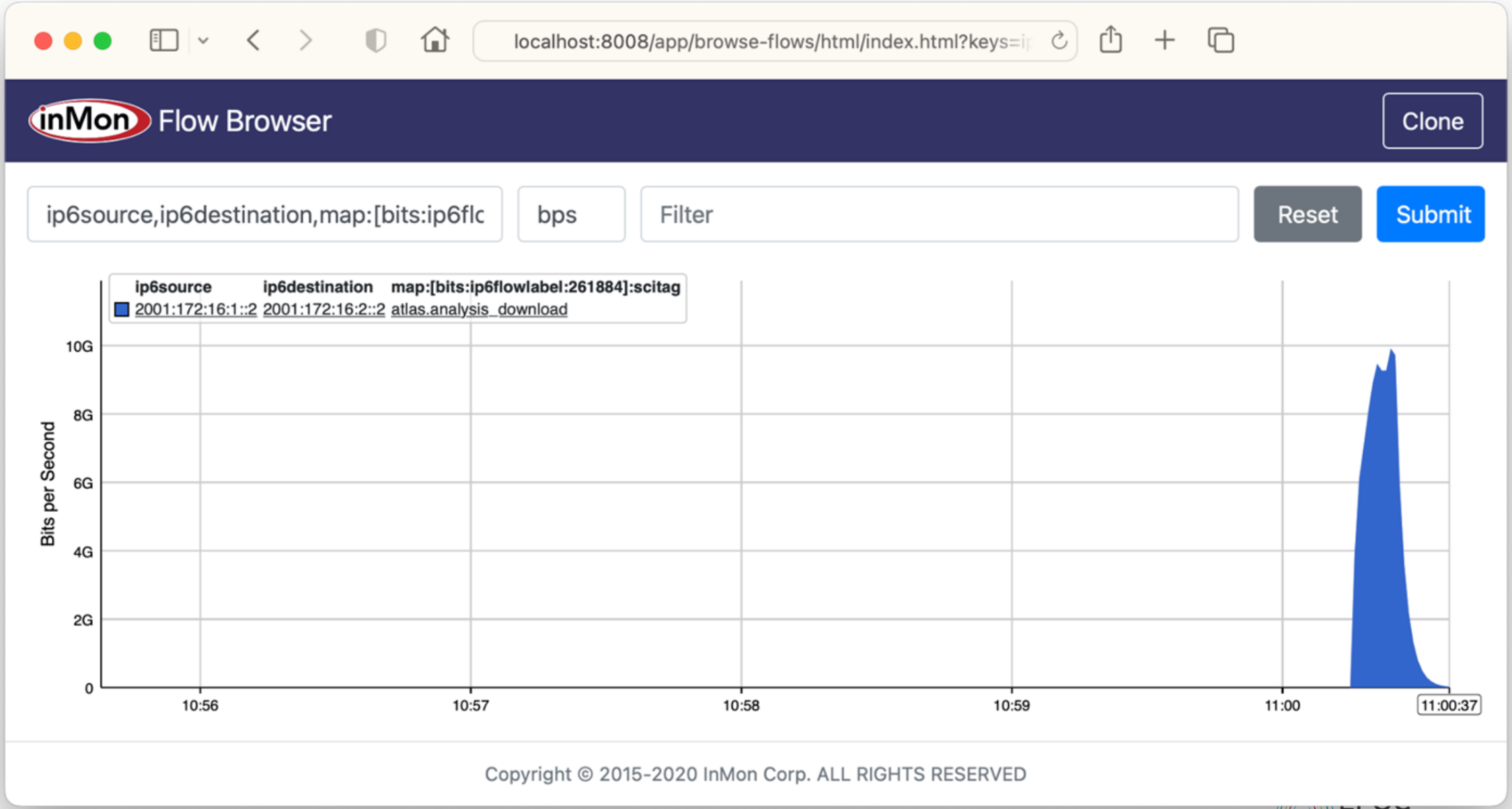

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From IPv6 Monitoring to

IPv6 Performance Measurement

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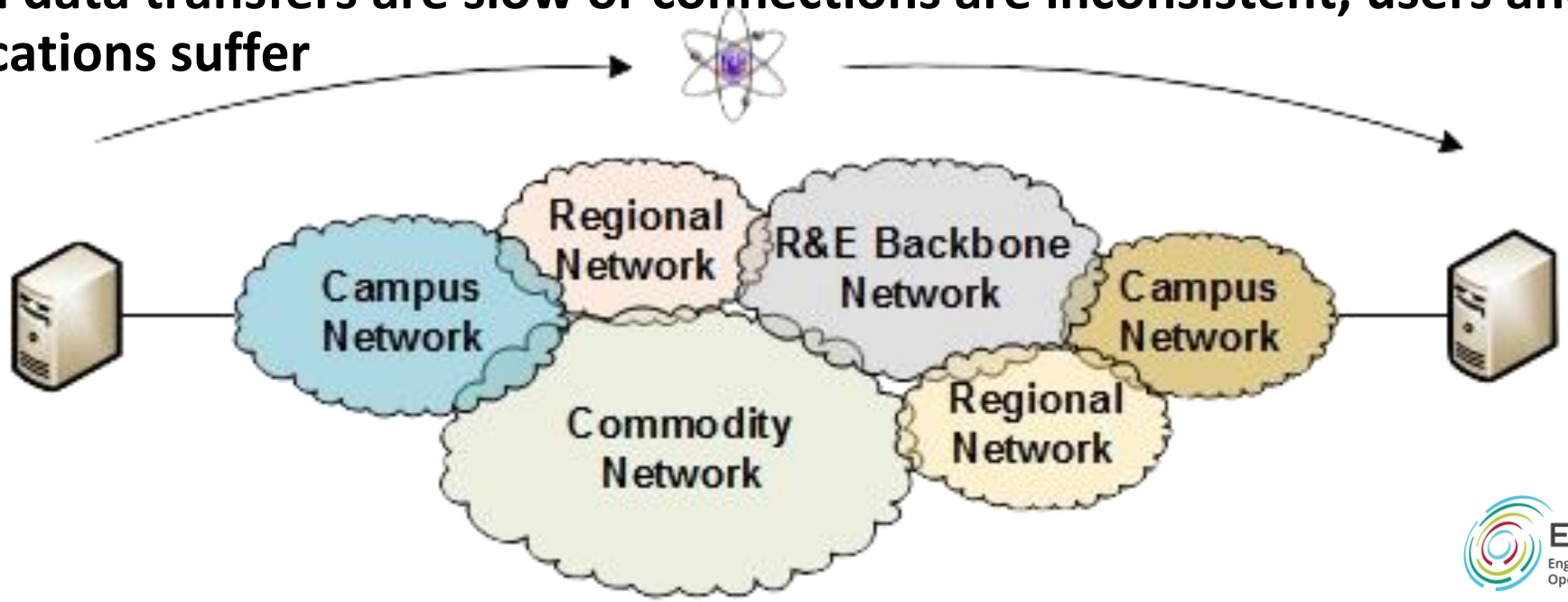
Why performance measurement

- Data Transfers to/from your campus typically transfer over five different R&E networks
  - Only one of which you control
  - The others would require contacting each network operator to work with you and sharing their monitoring and configurations
- When data transfers are slow or connections are inconsistent, users and applications suffer



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perfSONAR

- https://www.perfsonar.net/
- perfSONAR is the performance Service-Oriented Network monitoring ARchitecture, a network measurement toolkit designed to provide federated coverage of paths and help to establish end-to-end usage expectations.
- In addition to the RTT and Traceroute tools mentioned earlier:
  - latency tests are available through owamp, powstream, twamp
  - throughput tests are available through iperf3, nuttcp, and iperf2

NEW: iperf3 multi threaded Jan 2024:

https://www.es.net/news-and-publications/esnet-news/2024/esnet-releases-new-version-of-iperf-network-performance-measurement-tool/

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perfSONAR IPv6

- **Q: How can I force testing over IPv4 or IPv6 in a pSConfig template?¶**
  - A: The exact option may very depending on the test plug-in, but in a test object's spec most of the default plug-ins support an ip-version field that can get set to 4 or 6.
- **Q: How do I change the MTU for a device?¶**
  - A: Changing the MTU on your perfSONAR host should only be done if the underlying network supports the chosen size. Please work with your local network staff before making this change on any host. You can view the MTU of your network devices by executing the /sbin/ifconfig command. To temporarily change the MTU for a device, you use the ifconfig command and specify the device and the new MTU. For example: ifconfig eth0 mtu 9000 up
  - To make these changes permanent you need to modify the specific devices configuration file. These files are in /etc/sysconfig/network-scripts/ and have names like ifcfg-eth0 for the device eth0 and ifcfg-eth1 for eth1.
  - For example you could add the line MTU="9000" for IPv4 or IPV6_MTU="9000" for IPv6 to /etc/sysconfig/network-scripts/ifcfg-eth0. After making the changes you need to restart the network services by running the command 'service network restart' as root.

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perfSONAR IPv6 performance monitoring

https://github.com/esnet/esnet-perfsonar-mesh/blob/master/psconfig/esnet-psconfig.json

```
"ESnet6_LAT_1_v6" : {
   "spec" : {
      "dest" : "{% address[1] %}",
      "dest-node" : "{% pscheduler_address[1] %}",
      "flip" : "{% flip %}",
      "packet-count" : 600,
      "packet-interval" : 0.1,
      "packet-padding" : 0,
      "source" : "{% address[0] %}",
      "source-node" : "{% pscheduler_address[0] %}",
      "ip-version": 6
   },
   "type" : "latencybg"
},
```

```
"ESnet6_TP_1_v6" : {
   "spec" : {
      "dest" : "{% address[1] %}",
      "dest-node" : "{% pscheduler_address[1] %}",
      "duration" : "PT10S",
      "omit" : "PT5S",
      "source" : "{% address[0] %}",
      "source-node" : "{% pscheduler_address[0] %}",
      "ip-version": 6,
      "flow-label": 131080,
      "bandwidth": 26000000000
   },
   "type" : "throughput"
},
```

ESnet's perfSONAR central pSconfig

https://github.com/esnet/esnet-perfsonar-mesh/blob/master/psconfig/esnet-psconfig.json

https://fasterdata.es.net/performance-testing/perfsonar/esnet-perfsonar-services/esnet-limits-file/

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perfSONAR psconfig IPv6 ping test text

```
"ESnet6_v6_rtt_icmp" : {
  "spec" : {
    "dest" : "{% address[1] %}",
    "count" : 10,
    "source" : "{% address[0] %}",
    "interval": "PT2S",
    "length": 1000,
    "ip-version": 6,
    "flow-label": 131080
  },
  "type" : "rtt"
},
```

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perfSONAR psconfig IPv6 traceroute test text

```
"ESnet6_v6_trace" : {
  "spec" : {
    "dest" : "{% address[1] %}",
    "probe-type" : "icmp",
    "sendwait" : "PT5S",
    "source" : "{% address[0] %}",
    "source-node" : "{% pscheduler_address[0] %}",
    "wait" : "PT30S",
    "ip-version": 6,
    "flow-label": 131080
  },
  "type" : "trace"
},
```

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perfSONAR psconfig Ipv6 Latency test text

```
"ESnet6_LAT_1_v6" : {
  "spec" : {
    "dest" : "{% address[1] %}",
    "dest-node" : "{% pscheduler_address[1] %}",
    "flip" : "{% flip %}",
    "packet-count" : 600,
    "packet-interval" : 0.1,
    "packet-padding" : 0,
    "source" : "{% address[0] %}",
    "source-node" : "{% pscheduler_address[0] %}",
    "ip-version": 6
  },
  "type" : "latencybg"
},
```

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perfSONAR psconfig IPv6 throughput test text

```
"ESnet6_TP_1_v6" : {
  "spec" : {
    "dest" : "{% address[1] %}",
    "dest-node" : "{% pscheduler_address[1] %}",
    "duration" : "PT10S",
    "omit" : "PT5S",
    "source" : "{% address[0] %}",
    "source-node" : "{% pscheduler_address[0] %}",
    "ip-version": 6,
    "flow-label": 131080,
    "bandwidth": 26000000000
  },
  "type" : "throughput"
},
```

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perfSONAR psconfig IPv6 DNS test text

```
"ESnet6_v6_DNS" : {
   "spec" : {
      "host": "{% address[0] %}",
      "nameserver" : "{% address[1] %}",
      "query": "fasterdata.es.net",
      "record" : "aaaa"
      },
      "type" : "dns"
    },
```

```
"ESnet6_v4_DNS" : {
   "spec" : {
      "host": "{% address[0] %}",
      "nameserver" : "{% address[1] %}",
      "query": "fasterdata.es.net",
      "record" : "a"
   },
   "type" : "dns"
},
```

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perfSONAR CLI Commands

- Ping RTT ICMP
  - pscheduler task rtt --ip-version=6 --source ps-test-east.es.net --dest ps-test-west.es.net --flow-label=131080
- Traceroute
  - pscheduler task trace --ip-version=6 --source ps-test-east.es.net --dest ps-test-west.es.net --flow-label=131080
- Traceroute - tracepath - Shows MTU per hop
  - pscheduler task --tool=tracepath trace --ip-version=6 --source ps-test-east.es.net --dest ps-test-west.es.net --flow-label=131080
- Latency - owamp
  - pscheduler task latency --ip-version=6 --source ps-test-east.es.net --dest ps-test-west.es.net
- Throughput - iperf3
  - pscheduler task throughput --ip-version=6 --source ps-test-east.es.net --dest ps-test-west.es.net --flow-label=131080

Globus IPv6 support

v5.4.70 (Nov 9, 2023)

Improvements

Support accessing GCS services on IPv6-only endpoints

Add support for the Dropbox connector

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