perfSONAR

Embedded Network Systems

Juniper Research & Education Networks Symposium (J-RENS)

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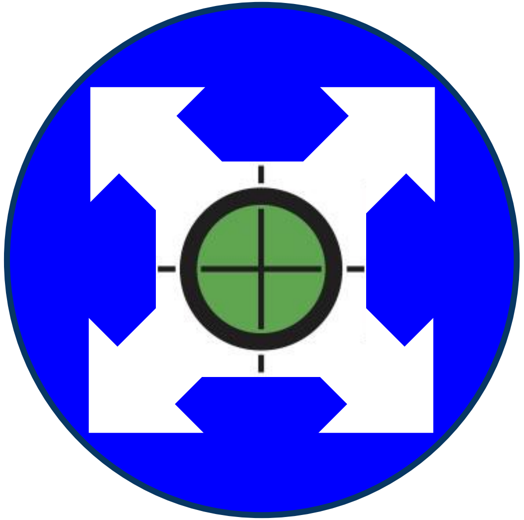
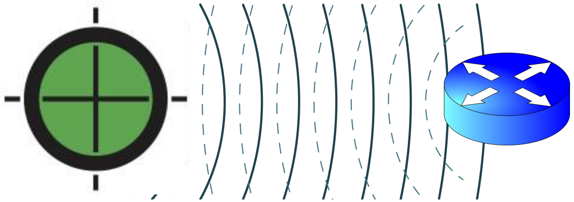
perfSONAR Embedded Systems

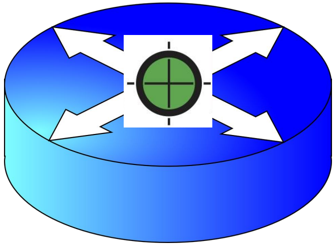
1. Background
2. Standards·Principles·Requirements
3. Vision and End Goal
4. Juniper Collaboration
5. Advice for Next Generation Appliances



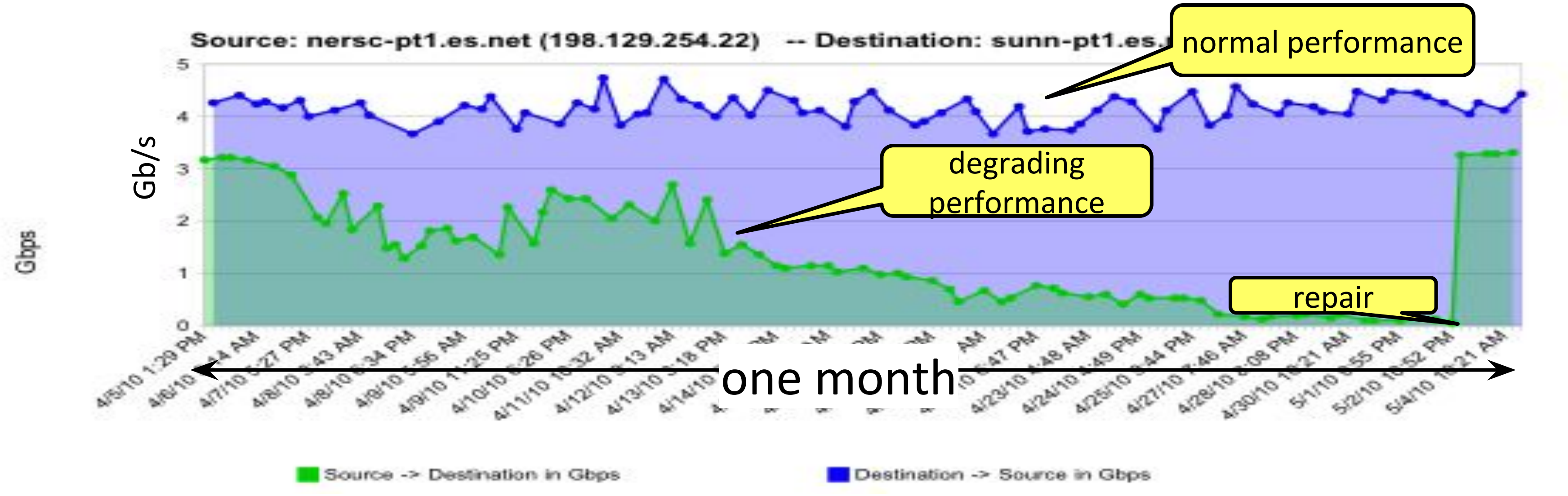
Background: Emerging Technology

- perfSONAR: over 2,000 deployments
- embedded systems: control many devices in common use today
- *NEW: next generation of the network gear - perfSONAR embedded in major network vendor hardware*





Sample Soft Failure: failing optics



Credit: Jason Zurawski, ESNet

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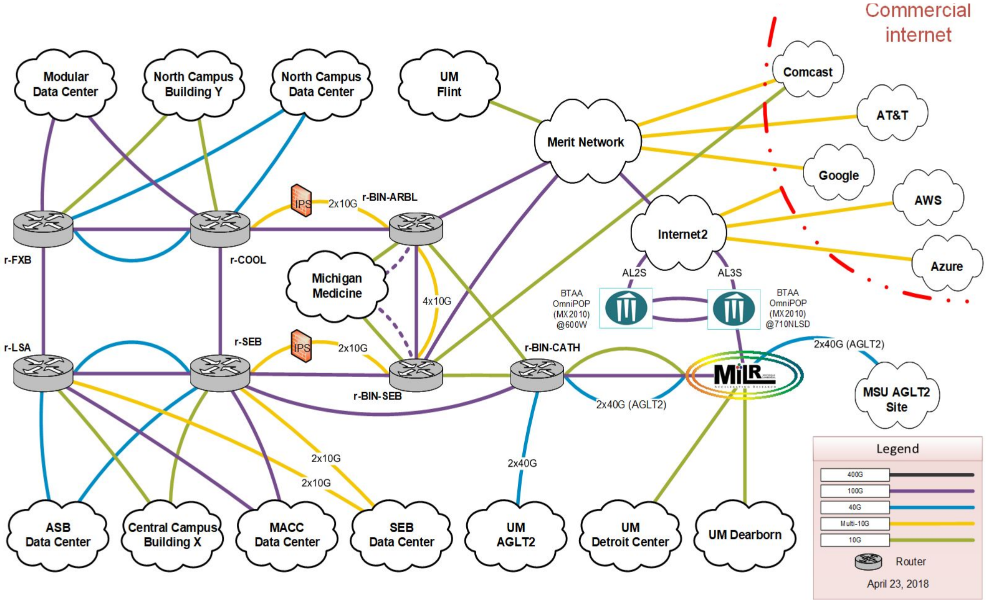
Background: Problem of Scale

The ability to benchmark and troubleshoot the “last mile” of large distributed networks.

U-M current scope:

- Number of AL switches: 101 models, 3,825 devices
- Number of DL switches: 22 models, 239 devices



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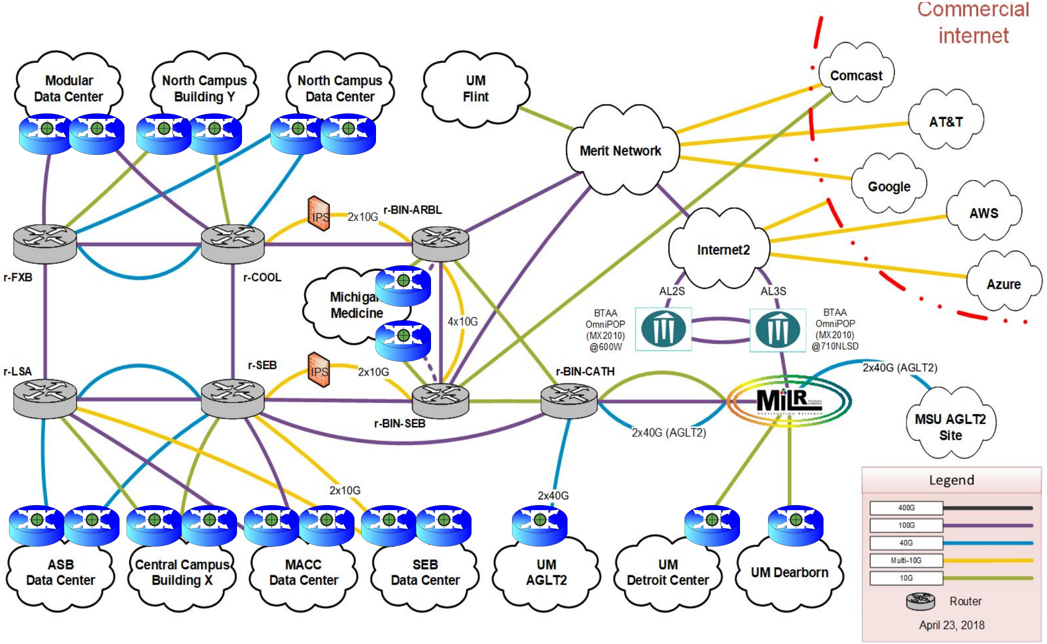
Emerging Technology Vision

Provision perfSONAR on the network gear itself.

- Scalable
  - Deploy
  - Support
  - Grow
- Fewer costs/ fewer machines
- Fewer dependencies
- Becomes a part of the in-building network replacement lifecycle



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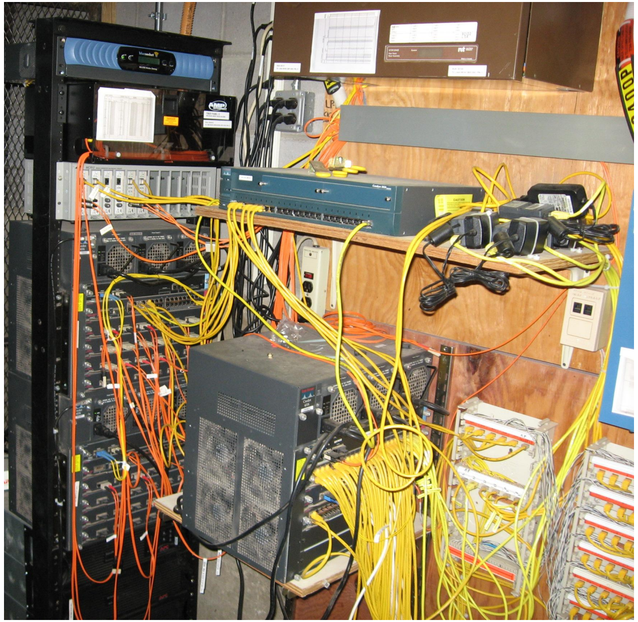
Background: Challenge

Legacy location issues:

- Space
- Power
- Climate control

On-site support challenges:

- Too many locations (>1,000)
- Impossible to provide 24x7 operations
- Servers with management planes more expensive



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Standards, Principles, Requirements

Embedded Solution vs. a stand-alone perfSONAR node:

- **Don't gouge:** cost of the Embedded solution must not be greater than a discreet solution
- **Don't suck:** Network hardware must perform switching and routing duties unimpeded.
- **Don't lie**: performance measurements must be as accurate as discreet servers.

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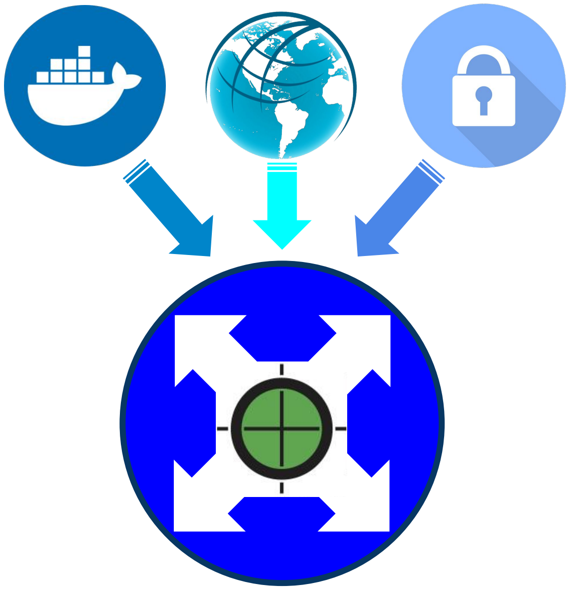
Obstacles: Net Admin Perspective

- Multiple proficiencies required to configure
- Complicated container creation
- Network Architecture
  - Container requires public IP address + small subnet per building
  - Often rebooting is not an option
  - “Switch First” philosophy
- Security Architecture
  - Non-network admins require administrative access to the switch
  - How well is the container separated from control plane
  - What other security issues does this present...



Embedded Platform Options

- "Bare Metal" port (Yocto / Wind River)
  - High effort - Embedded Linux not a dev environment
  - Unsupportable
- KVM
  - Poor performance
  - Larger containers
- Docker, LXC
  - Better performance
  - Standards for creation
  - Some existing support (perfSONAR on Docker)
- Proprietary container process
  - Start with base image/container (Docker, LXC, etc.)
  - More complex provisioning process
  - Security concerns may require perfSONAR redesign / development

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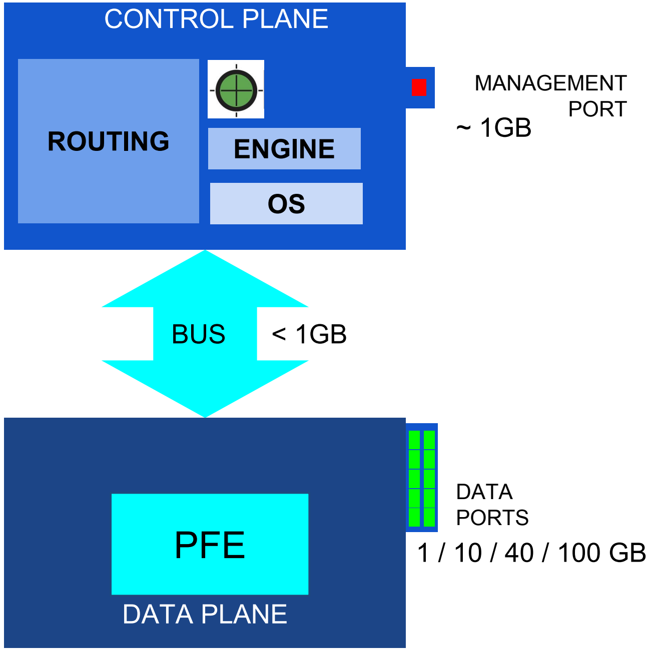
Emerging Technology Architecture

Current throughput constraints:

- Desired performance
  - Max data port rate (10GB / 40GB / 100GB / etc.)
- Management port constraints
  - ~ 1 GB (Sometimes limited to copper interfaces)
- Bus performance
  - Currently < 1 GB



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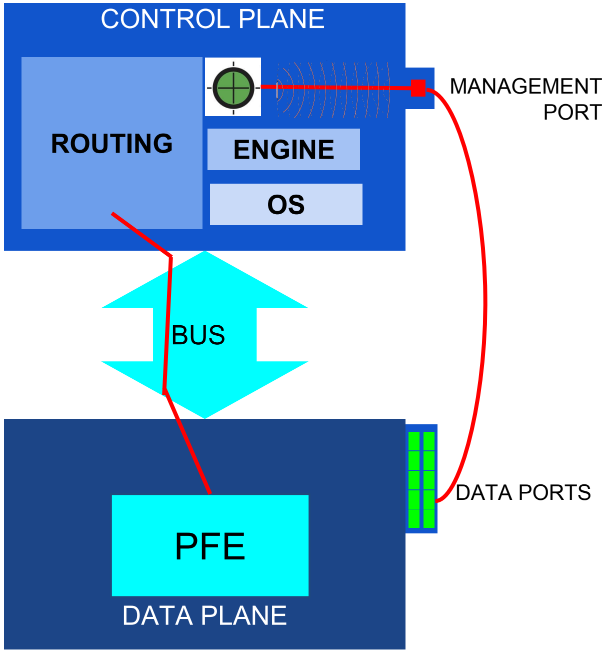
Container Networking: Management Port

- Currently has most throughput performance (~1GBE)
- If Management port limited to copper, could be incompatible with the rest of the switch, bad for “leaf nodes”
- Least desirable from Net Admin perspective
  - Precludes Out-Of-Band Management
- Cable required
  - Outage risk from possible misidentification as a network loop
  - Adds installation complexity



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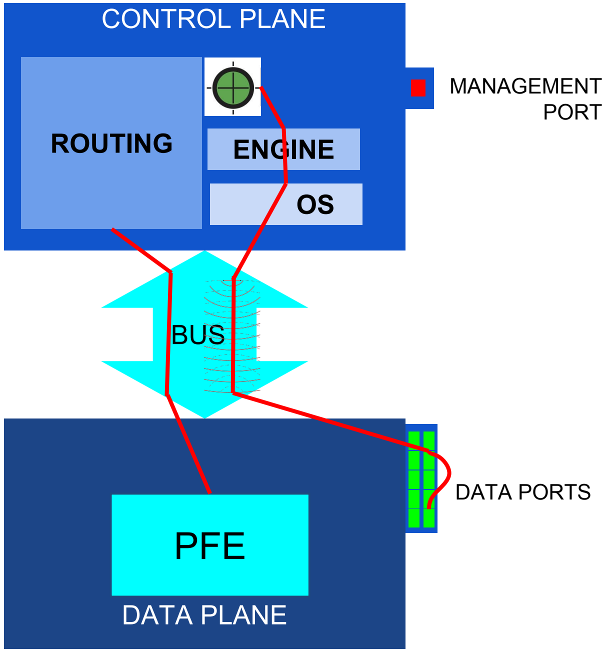
Container Networking: Single Data Port

- Limited throughput performance (<1GBE)
- Bus is shared with routing duties
  - Unknown failure modes
- Cable required
  - Outage risk from possible misidentification as a network loop
  - Adds installation complexity



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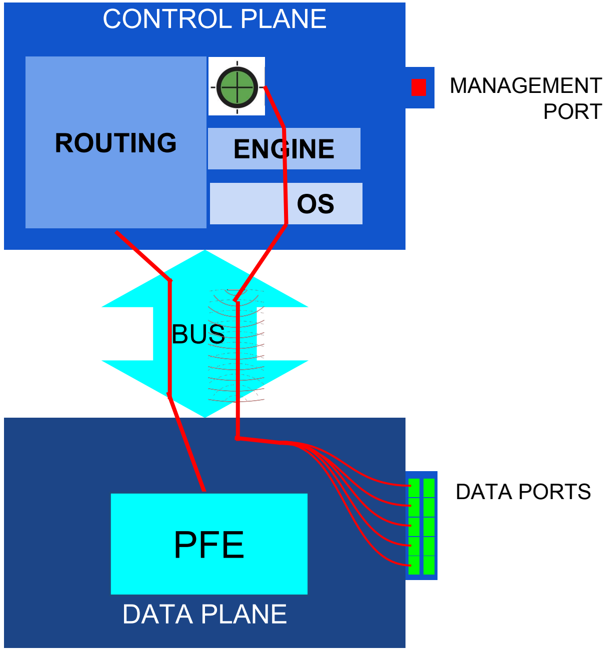
Container Networking: Any Port

- Any data port "cableless"
  - Most desirable
  - Still goes over internal bus
- Bus is shared with routing duties
  - Unknown failure modes
- Ideally, pS container would be bridged to SVI
  - zero touch deployment
  - does not have to consume any ports on the front



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Obstacles: Hardware Limitations

- High performance platforms, no budget solution yet
- Discreet solution currently has some performance advantages
- Historically switches didn’t require a lot of storage:
    - Storage quickly becomes an issue with the larger images required to run
    - Typical flash might not have the space
    - External USB storage a possibility
        - Speed / bandwidth / performance concerns
- Shared bus = shared bandwidth

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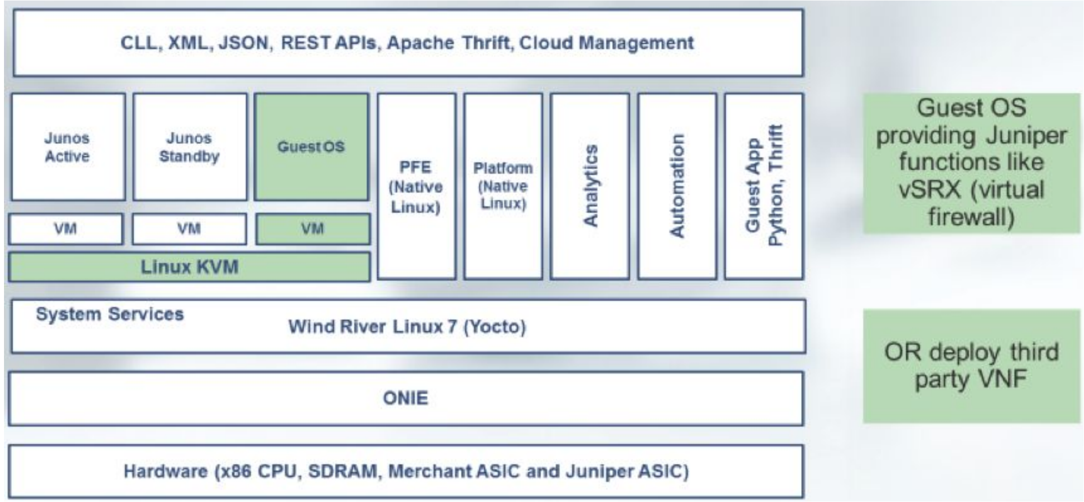
Juniper History

- perfSONAR demo at SC17
  - Ran on KVM
  - Management Port Networking
- Non-EVO experiments (2018)
  - Learning experience
  - Container Networking

    Limitations prevented

    Successful pilot program



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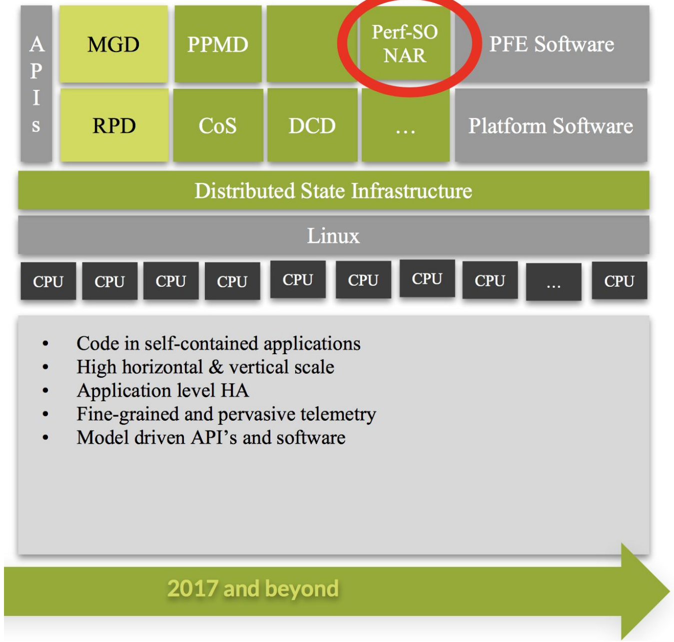
Juniper EVO + perfSONAR

Current Issues

- Complicated container process
  - LXC with distrobuilder, chroot, no systemd, etc.
  - Currently Ubuntu only
  - Privileged vs unprivileged container security model
  - Requires perfSONAR REST interface re-development
- EVO on 5200
  - Experimental Release, Only in Juniper's Lab



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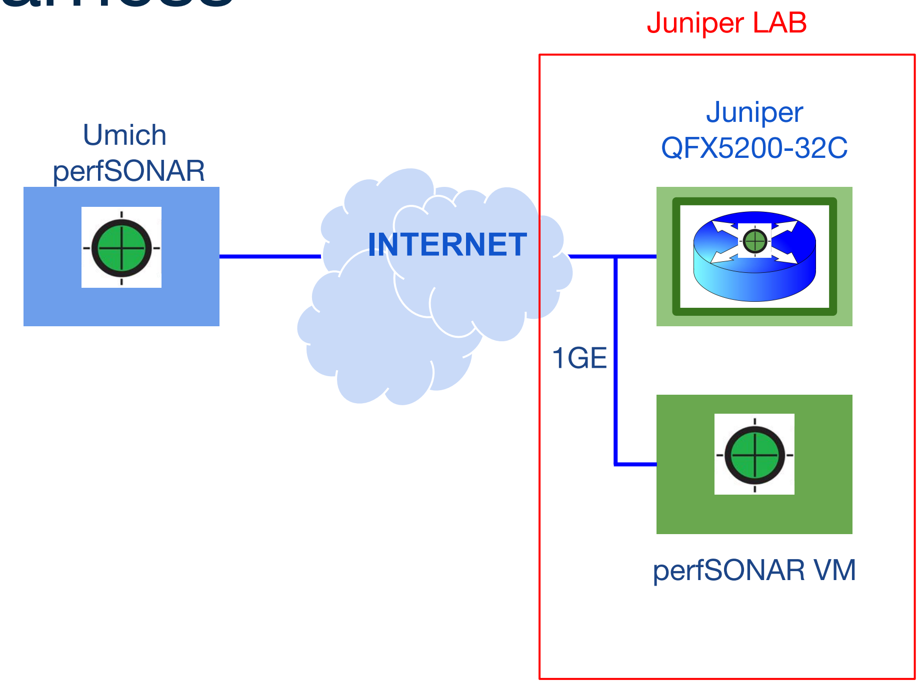
Test Harness

- perfSONAR pscheduler was able to communicate from 5200 to UM over port 80
- Firewall issues prevented further perfSONAR testing to UM
- Proof-of-concept throughput and latency testing done in Juniper's lab



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Performance Results: RTT

- 1GE Lab connection
- Expected low latency

1	CentOS-TP.juniper.net	64 Bytes	TTL 64	RTT	0.3580 ms
2	CentOS-TP.juniper.net	64 Bytes	TTL 64	RTT	0.3720 ms
3	CentOS-TP.juniper.net	64 Bytes	TTL 64	RTT	0.4640 ms
4	CentOS-TP.juniper.net	64 Bytes	TTL 64	RTT	0.3770 ms
5	CentOS-TP.juniper.net	64 Bytes	TTL 64	RTT	0.4740 ms

Performance Results: Latency

- Useful Latency statistics
  - 1GE Lab connection
  - Expected low latency scenario

```
One-way Latency Statistics
--------------------------
Delay Median ......... -1.97 ms
Delay Minimum ........ -2.07 ms
Delay Maximum ........ -1.84 ms
Delay Mean ........... -1.97 ms
Delay Mode ........... -1.96 ms -1.95 ms
Delay 25th Percentile ... -2.00 ms
Delay 75th Percentile ... -1.95 ms
Delay 95th Percentile ... -1.89 ms
Max Clock Error ...... 4.84 ms
Common Jitter Measurements:
    P95 - P50 ........ 0.08 ms
    P75 - P25 ........ 0.05 ms
    Variance ......... 0.00 ms
    Std Deviation .... 0.04 ms
```

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Performance Results: Throughput

- Useful 1GE performance
  - 943.54 Mbps
  - 1GE copper interface
  - Potentially useable for 1GE link throughput analysis

```
* Stream ID 6
Interval       Throughput     Retransmits    Current Window
0.0 - 1.0      953.64 Mbps    0              377.93 KBytes
1.0 - 2.0      942.48 Mbps    0              395.30 KBytes
2.0 - 3.0      941.44 Mbps    0              414.13 KBytes
3.0 - 4.0      950.62 Mbps    0              474.94 KBytes
4.0 - 5.0      940.56 Mbps    0              498.11 KBytes
5.0 - 6.0      941.93 Mbps    0              498.11 KBytes
6.0 - 7.0      935.20 Mbps    0              524.18 KBytes
7.0 - 8.0      943.51 Mbps    0              524.18 KBytes
8.0 - 9.0      944.59 Mbps    0              524.18 KBytes
9.0 - 10.0     941.39 Mbps    0              524.18 KBytes

Summary
Interval       Throughput     Retransmits
0.0 - 10.0     943.54 Mbps    0
```

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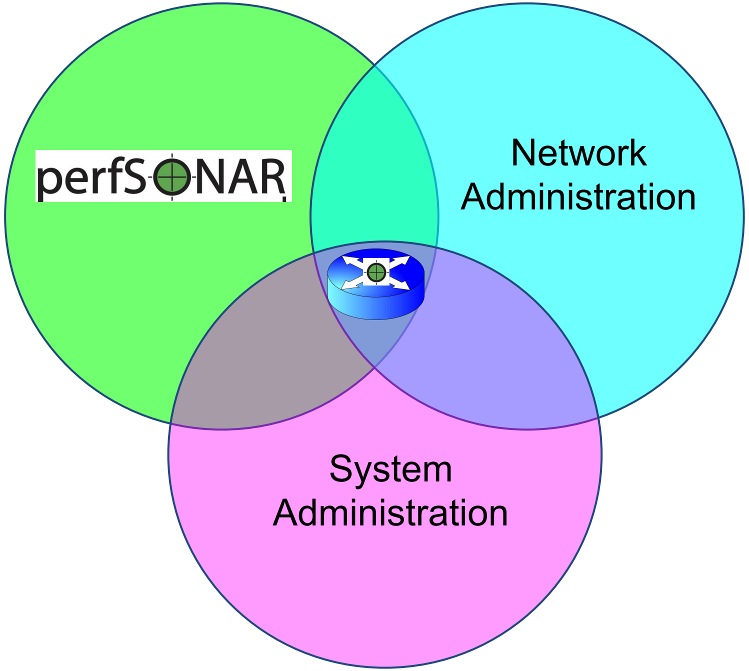
Lessons Learned: Staff Proficiency

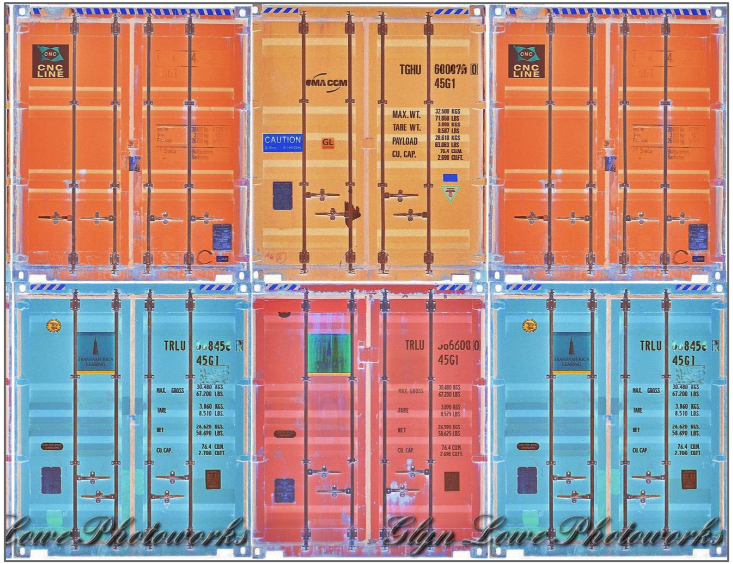
Necessary Breadth and Depth of Skills

- perfSONAR Administrator
  - deploy / maintain perfSONAR nodes & meshes
- Network Administrator
  - Switch configuration
  - Network Architecture
- System Administrator
  - Operating System Expertise: UNIX
  - Containers: Docker, LXC, proprietary, etc.
  - NTP / Security / System Tuning



Advice for Next Generation Appliances

- Throughput speeds = max line speed
  - Faster / parallel bus?
  - Application specific ports?
- Implement container architecture
  - Docker, LXC, etc.
- Simple & powerful container networking
  - Reduce configuration complexity
  - Route through any data port ("wireless")



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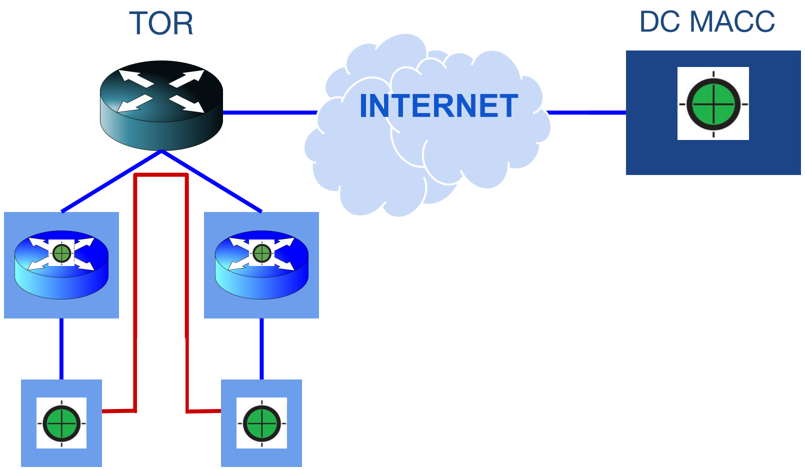
Next Steps

- Deploy perfSONAR in Umich Lab
  - EVO on 5200
- Enhance documentation
- Automate container creation
- Explore container security architecture
- Further testing
  - Add traffic, more hosts
  - Inclusion in test meshes



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Credits

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