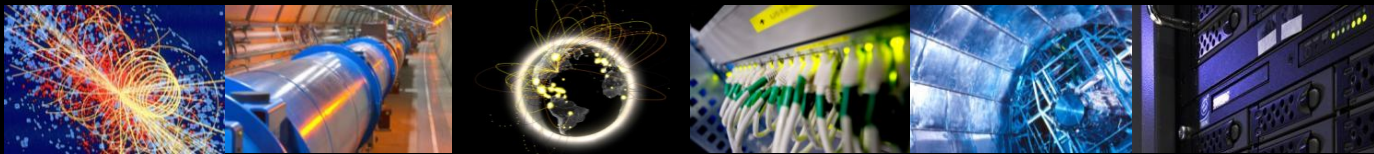


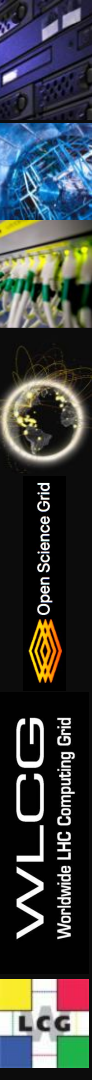
LHCOPN/LHCONE perfSONAR Update

Marian Babik, Shawn McKee
on behalf of WLCG Network Throughput WG



Outline

- News
 - OSG/WLCG activities and WLCG Network Throughput WG
 - perfSONAR community updates
- LHCOPN/LHCONE perfSONAR status
- 100Gbps Testing
- Network Platform Updates
 - OSG Network Monitoring Platform
- Plans
- Summary

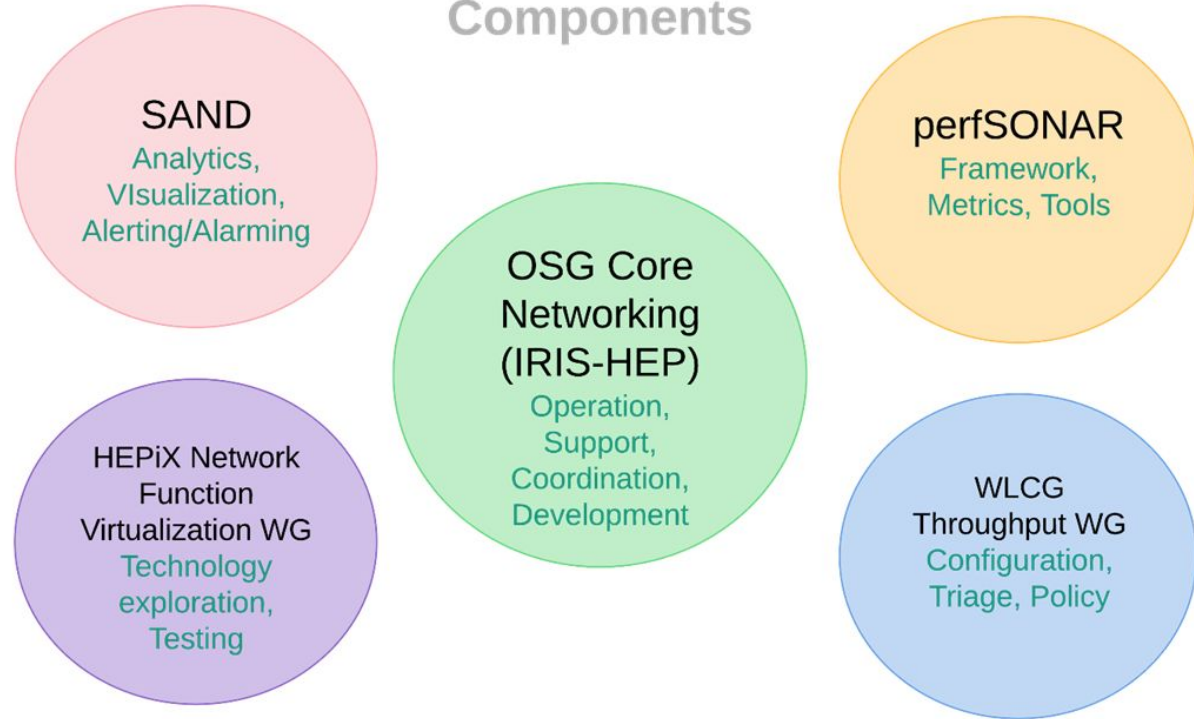


OSG/WLCG networking projects

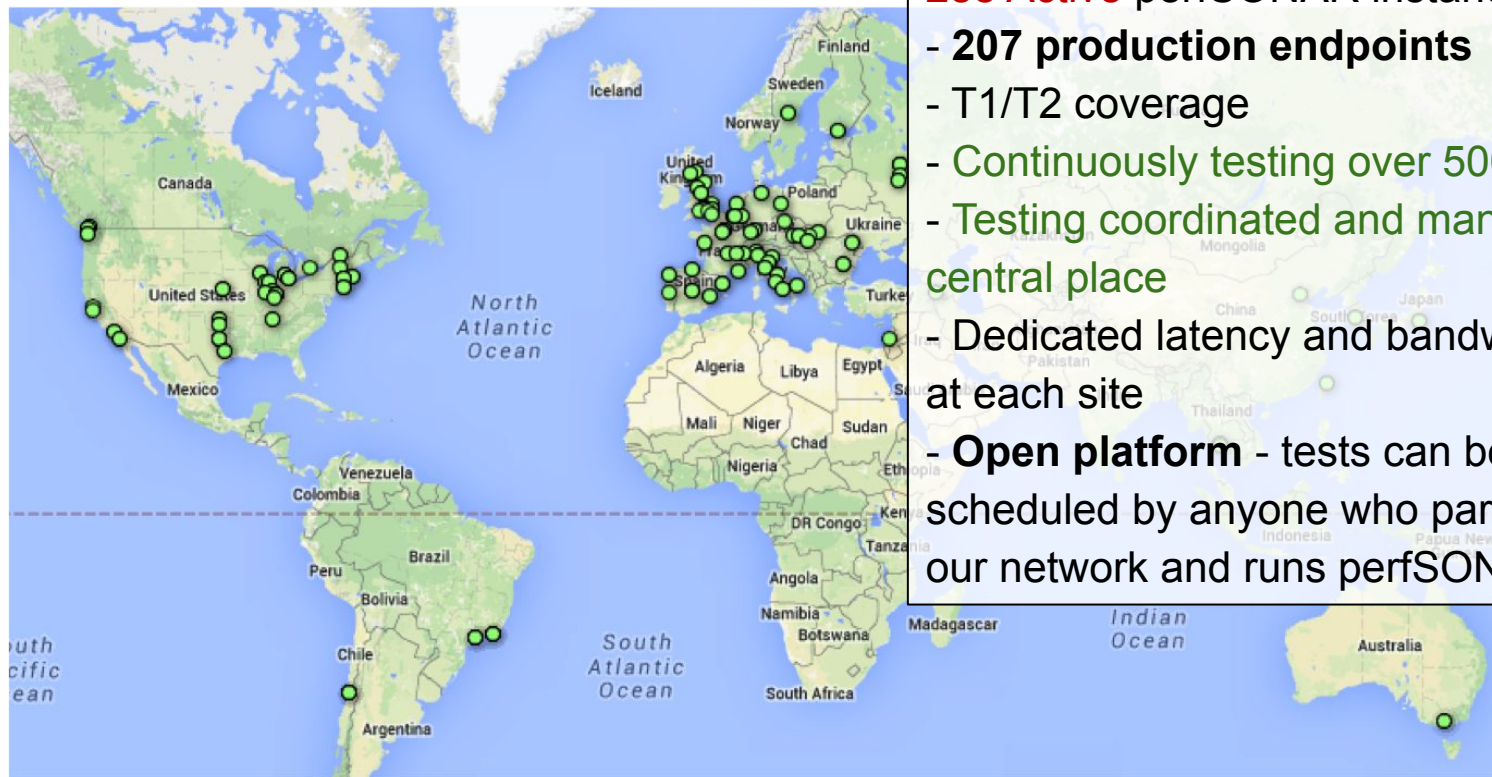
There are 4 coupled projects around the core **OSG Net Area**

1. **SAND** (NSF) project for analytics
2. **HEPiX** NFV WG
3. **perfSONAR** project
4. **WLCG** Network Throughput WG

OSG Networking Components



perfSONAR deployment



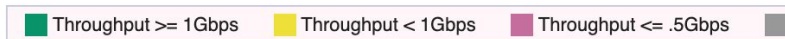
288 Active perfSONAR instances

- **207 production endpoints**
- T1/T2 coverage
- Continuously testing over 5000 links
- Testing coordinated and managed from central place
- Dedicated latency and bandwidth nodes at each site
- **Open platform** - tests can be scheduled by anyone who participates in our network and runs perfSONAR

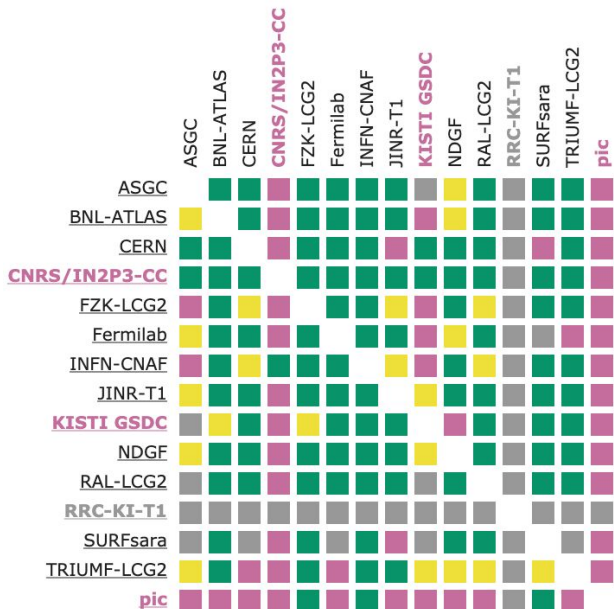
- 4.2.4 is the latest version (last one before 4.3)
 - This release fixes some of the performance issues (seen @CERN and other places)
 - Developers now continue to pursue more frequent incremental updates
- 4.3.0 - not yet released (4.3.0b still in the works)
 - Python3 support
 - psconfig/PWA enhancements related to configuring publishing directly from the toolkits
- Traces were added to all our latency meshes
 - This way we have full coverage, which makes it easier to correlate with other data
- Communities that have joined recently or plan to use our infrastructure in the near-term:
 - WLCG ALICE, EU ESCAPE, EU ARCHIVER, DUNE, SLATE
- perfSONAR F2F developers meeting took place in June
 - Plan to move to ELK stack (ElasticSearch/Grafana)
- perfSONAR session at TechExtra Nov 2nd
 - Plan is to demo some of the ELK stack capabilities, PWA, WIFI and Cloud monitoring

LHCOPN - 11th May 2020

OPN Mesh Config - OPN IPv6 Bandwidth - Throughput



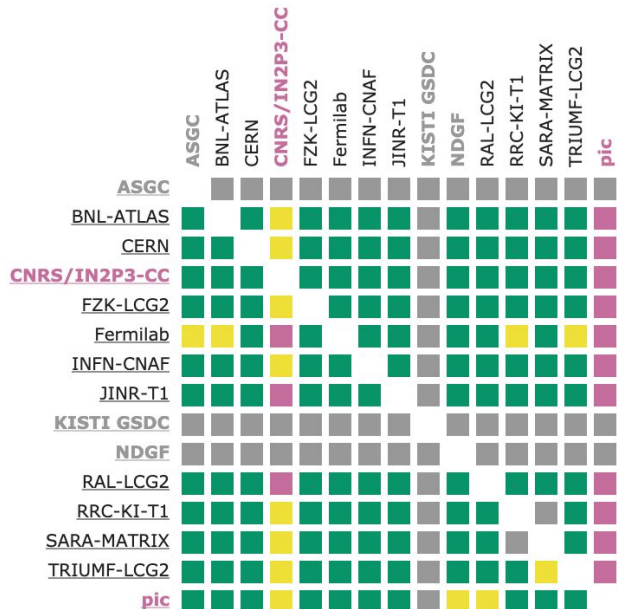
! Found a total of 5 problems involving 4 hosts in the grid



OPN Mesh Config - OPN Latency - Loss



! Found a total of 5 problems involving 5 hosts in the grid

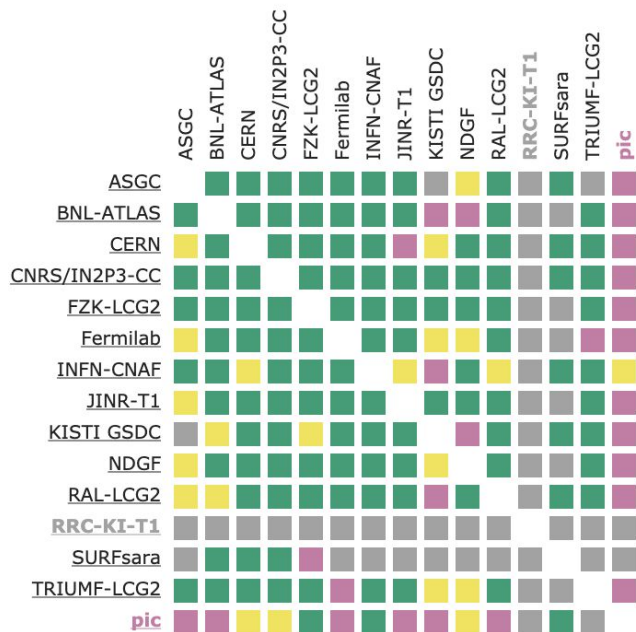


LHCOPN 14th Sept 2020

OPN Mesh Config - OPN IPv6 Bandwidth - Throughput



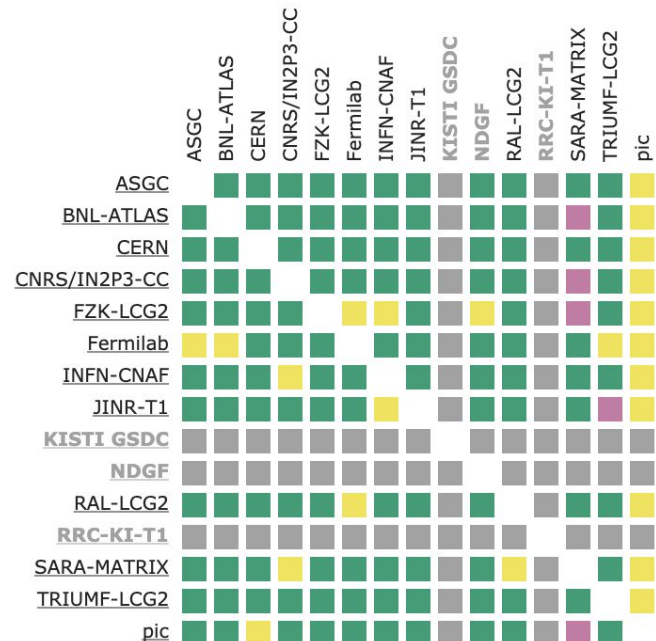
! Found a total of 3 problems involving 2 hosts in the grid



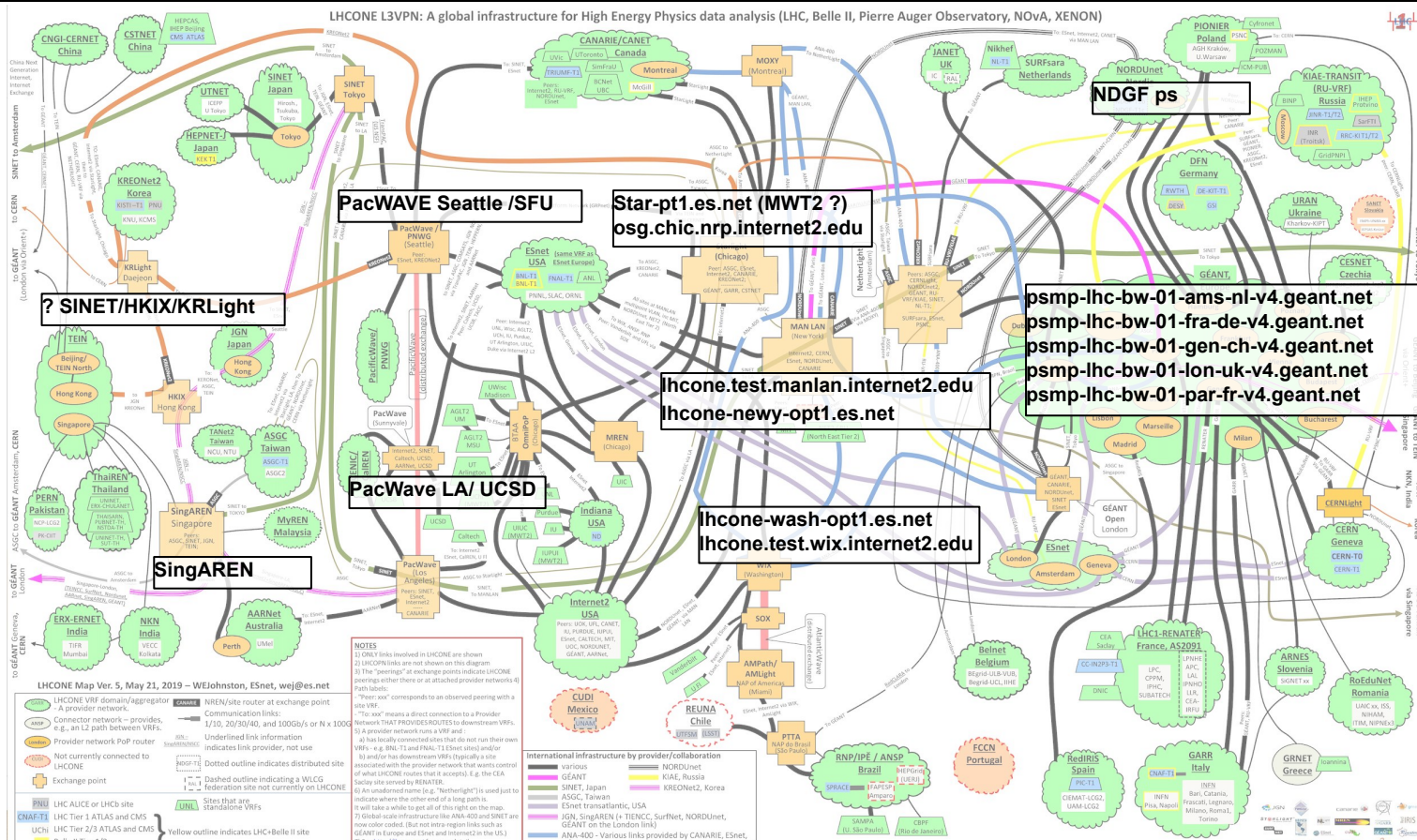
OPN Mesh Config - OPN Latency - Loss



! Found a total of 3 problems involving 3 hosts in the grid



New LHCONE mesh



LHCONE - 11th of May 2020

LHCONE - LHCONE Bandwidth IPv4 - Throughput



⚠ Found a total of 28 problems involving 21 hosts in the grid



LHCONE 14th Sept 2020

LHCONE - LHCONE Bandwidth IPv4 - Throughput

■ Throughput \geq 1Gbps
 ■ Throughput $<$ 1Gbps
 ■ Throughput \leq .5Gbps
 ■ Unable to find test data
 ■ Check

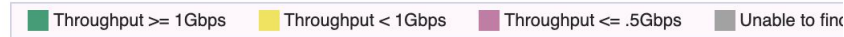
⚠ Found a total of 34 problems involving 27 hosts in the grid



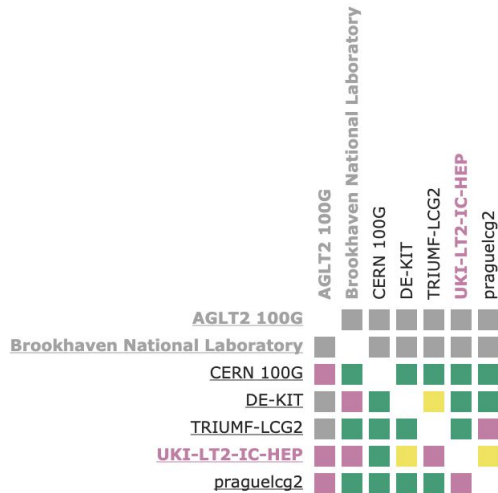
100Gbps Testing

- LHCOPN/LHCONE 100Gbps mesh was created

WLCG 100G Mesh - WLCG 100G IPv4 Bandwidth - Throughput



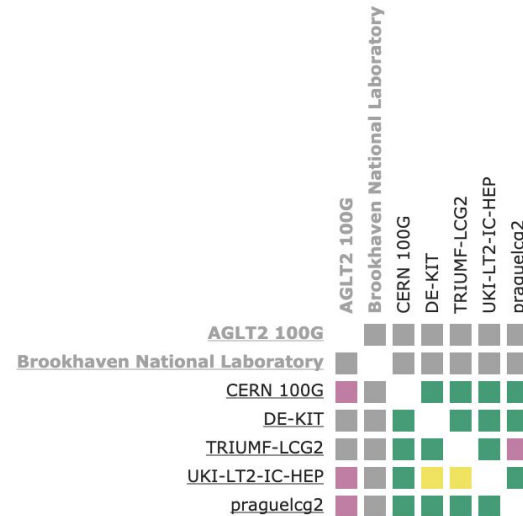
! Found a total of 3 problems involving 3 hosts in the grid



WLCG 100G Mesh - WLCG 100G IPv6 Bandwidth - Throughput



! Found a total of 2 problems involving 2 hosts in the grid

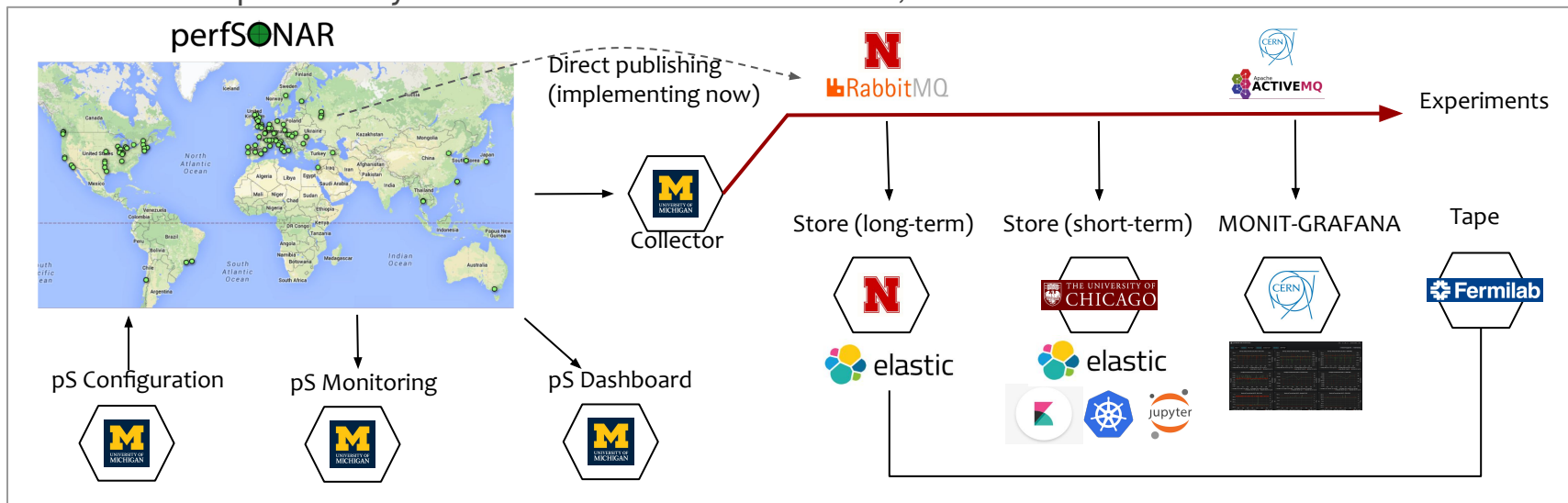


- 100Gbps mailing list

- <http://cern.ch/simba3/SelfSubscription.aspx?groupName=wlcg-perfsonar-100g>

Network Platform Overview

- Collects, stores, configures and transports all network metrics
 - Distributed deployment - operated in collaboration
- All perfSONAR metrics are available via **API, live stream or directly on the analytical platforms**
 - Complementary network metrics such as ESNNet, LHCOPN traffic also via same channels



Network Platform News

- Updated set of dashboards created in UC ES/Kibana
 - <https://atlas-kibana.mwt2.org/s/networking/goto/20dd25907d61df98a0b85b1dfaed54e1>
 - Provides high-level overview of latency, loss, traces and throughput
 - Implementation of the result of student projects to provide new user tools in our production system
 - Path analytics - Identify common hops between multiple src and dst pairs; detect path symmetry; find all unique paths across a period (Manjari Trivedi/UM)
 - Site summaries and reports of problematic node pairs (Petya Vasileva/UM) - blacklisting the problematic nodes (outliers) from the analytics
 - Use machine-learning to lay the foundations for a performance anomaly detection service (Edris Qarghah/UC)
- TRACer - [Path visualisation tool](#) developed by MEPHI
 - Still in [Beta](#), but already provides very interesting views into perfSONAR traces
 - Video of next release available at <https://yadi.sk/i/tyhiA-e3GGKqDQ>
- Updated toolkit info web page
 - <https://toolkitinfo.opensciencegrid.org/toolkitinfo> (Tommy Shearer/IRIS-HEP)

Network Platform News

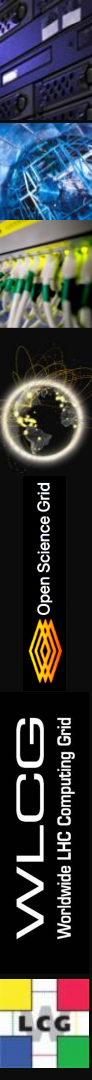
- Added **new data sources** to the messaging
 - Re-established SNMP from ESNet and added HTCondor transfer metrics
- **Directly publishing (push-mode)** from perfSONAR toolkit
 - Most of the developments are ready, testing has started (US region for now)
 - Developed in collaboration with perfSONAR developers
- **Infrastructure monitoring** - updates and new capabilities coming this fall:
 - Updates to **CheckMK version 1.6.x**, including plugin updates
 - Improvements to the configuration system to make it useful for other communities (dependent only on the perfSONAR ecosystem)
 - **Self-subscription for alerts** to toolkit contact, based on joining a particular community (using perfSONAR lookup service/information system)
 - **Migration to CRIC for topology** as well as working with CRIC team on potential improvements related to mapping perfSONARs to WLCG experiment site names
 - LHCONE Grafana dashboards based on newly established LHCONE mesh
 - New metric to track overall toolkit utilisation (for throughput tests)

Summary

- OSG in collaboration with WLCG are operating a comprehensive network monitoring platform
- Platform has been used in a wide range of activities from core OSG/WLCG operations to Cloud testing and IPv6 deployment
- Providing feedback to LHCOPN/LHCONE, HEPiX, WLCG and OSG communities
- IRIS-HEP and SAND are already contributing to the R&D in the network area
- Current focus is on analytical studies that would lead to a production level network alerting service
- We also expect 100 Gbps mesh to grow with potential to contribute to the network data challenges and network performance studies

References

- OSG/WLCG Networking Documentation
 - <https://opensciencegrid.github.io/networking/>
- perfSONAR Stream Structure
 - http://software.es.net/esmond/perfsonar_client_rest.html
- perfSONAR Dashboard and Monitoring
 - <http://maddash.opensciencegrid.org/maddash-webui>
 - https://psetf.opensciencegrid.org/etf/check_mk
- perfSONAR Central Configuration
 - <https://psconfig.opensciencegrid.org/>
- Toolkit information page
 - <https://toolkitinfo.opensciencegrid.org/>
- Grafana dashboards
 - <http://monit-grafana-open.cern.ch/>
- ATLAS Analytics Platform
 - <https://indico.cern.ch/event/587955/contributions/2937506/>
 - <https://indico.cern.ch/event/587955/contributions/2937891/>



Backup Slides Follow

WLCG Network Throughput Support Unit

Support channel where sites and experiments can report potential network performance incidents:

- Relevant sites, (N)RENs are notified and perfSONAR infrastructure is used to narrow down the problem to particular link(s) and segment. Also [tracking past incidents](#).
- Feedback to WLCG operations and LHCOPN/LHCONE community

Most common issues: MTU, MTU+Load Balancing, routing (mainly remote sites), site equipment/design, firewall, workloads causing high network usage

As there is no consensus on the MTU to be recommended on the segments connecting servers and clients, LHCOPN/LHCONE working group was established to investigate and produce a recommendation. (See coming [talk](#) :))

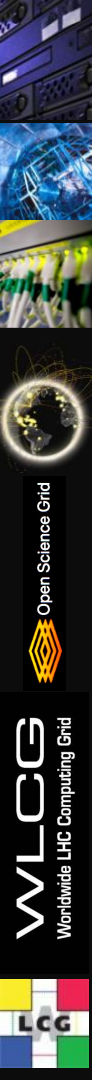
IRIS-HEP

The Institute for Research and Innovation in Software in High Energy Physics (**IRIS-HEP**) project has been funded by National Science Foundation in the US as grant OAC-1836650 as of 1 September, 2018.

The institute focuses on preparing for **High Luminosity (HL) LHC** and is funded at **\$5M** / year for 5 years. There are three primary development areas:

- Innovative algorithms for data reconstruction and triggering;
- Highly performant analysis systems that reduce 'time-to-insight' and maximize the HL-LHC physics potential;
- Data organization, management and access systems for the community's upcoming Exabyte era.

The institute also funds the **LHC part of Open Science Grid, including the networking area** and will create a new integration path (the **Scalable Systems Laboratory**) to deliver its R&D activities into the distributed and scientific production infrastructures. **Website for more info:** <http://iris-hep.org/>



The NSF funded SAND Project

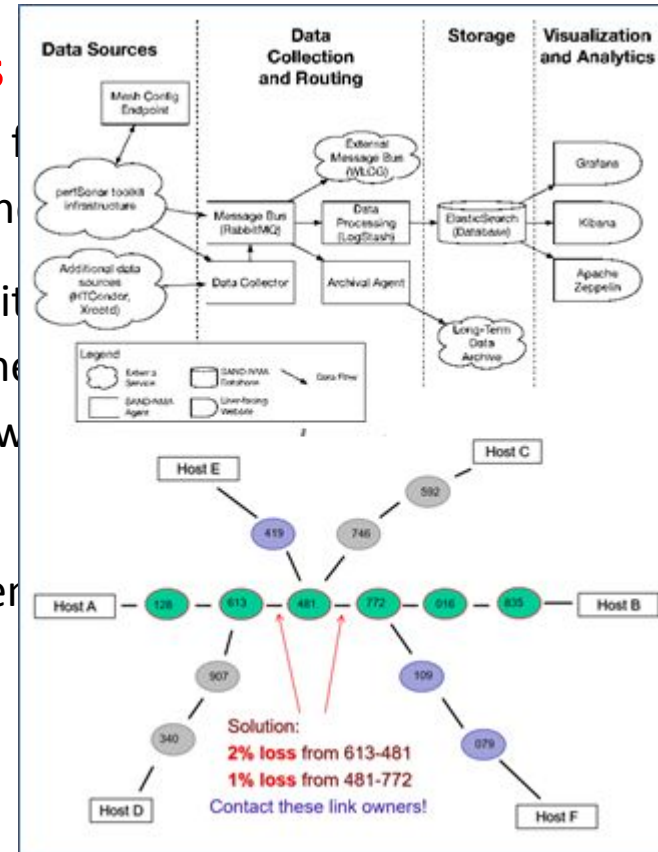
SAND: Service Analysis and Network Diagnosis

This is a newly funded NSF project (award #1827116) focused on visualizing, and analyzing disparate network monitoring and

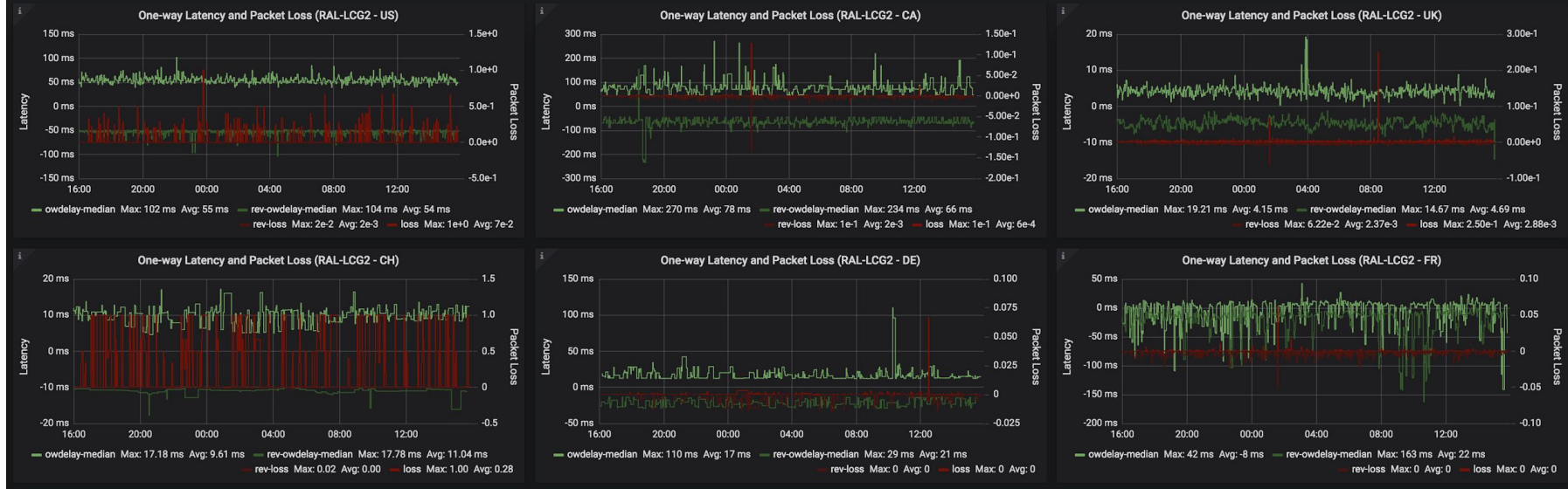
It will **extend** and **augment** the **OSG networking** efforts with extracting useful insights and metrics from the wealth of network data from perfSONAR, FTS, R&E network flows and related network monitoring tools like HTCondor and others.

Website <https://sand-ci.org/> (Project just started in September 2018)

PI: **Brian Bockelman**, Co-PIs: **Shawn McKee**, **Rob Gardner**



Grafana - Inter-Regional Latency Dashboard



Networking Challenges

There are number of challenges in the networking, which will require improved collaboration with other sciences as well as HEP-focused R&D:

- **Capacity/share for data intensive sciences**
 - No issues wrt available technology, however
 - What if N more HEP-scale science domains start competing for the same resources ?
- **Remote data access proliferating in the current DDM design**
 - Promoted as a way to solve challenges within experiment's DDM
 - Different patterns of network usage emerging
 - Moving from large streams to a mix of large and small frequent event streams
- **Integration of Commercial Clouds**
 - Impact on funding, usage policies, security, etc.
- **Technology evolution**
 - Software Defined Networking (SDN)/Network Functions Virtualisation (NFV)



Network Evolution Areas

The following are some of the key areas for HEP Networking R&D:

- Improving efficiency of data transfers
 - TCP BBR - version 2 is in the works with promising improvements
 - Exploring alternative protocols for transfers (UDP)
- Caching
 - Data caches co-located with network hubs in a similar way as on commercial CDNs
- Federations/Clouds
 - Overlay networks spanning multiple domains
 - Multi-clouds - expanding DC networking via L3VPNs
- Technology
 - SDN/NFV approaches - currently looked at by HEPiX NFV WG
 - Compute - Agile service delivery on Cloud Infrastructures (OpenStack, Kubernetes)
 - Data Transfers - Network resource optimisation - dynamically optimising the network based on its load and state (more in Shawn/Ilija)
 - SD-WAN approaches - <https://www.mode.net/>

Importance of Measuring Our Networks

- **End-to-end network issues are difficult to spot and localize**
 - Network problems are multi-domain, complicating the process
 - Performance issues involving the network are complicated by the number of components involved end-to-end
 - Standardizing on specific tools and methods focuses resources more effectively and provides better self-support.
- **Network problems can severely impact experiments workflows and have taken weeks, months and even years to get addressed!**
- **perfSONAR provides a number of standard metrics we can use**
 - Latency, Bandwidth and Traceroute
 - These measurements are critical for network visibility
- **Without measuring our complex, global networks we wouldn't be able to reliably use those network to do science**

