Network Monitoring Update

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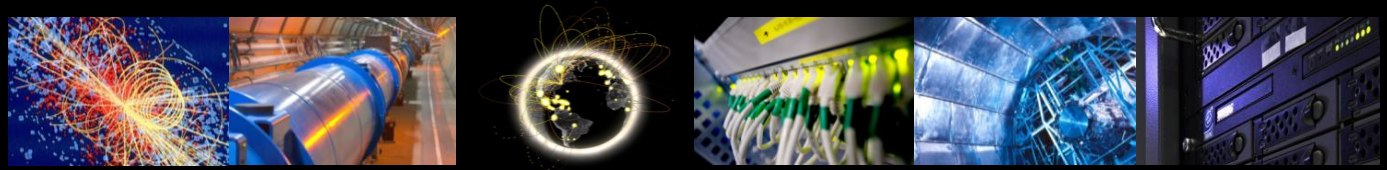
Fall LHCONE/LHCOPN (#57) Meeting, October 1, 2026

on behalf of WLCG Network Throughput WG



WLCG Worldwide LHC Computing Grid

Open Science Grid

Overview

We have a long history of presenting monitoring results from LHCOPN and LHCONE by showing various meshes from MaDDash and tracking changes

For this presentation we will be focusing more on the ongoing and planned transitions:

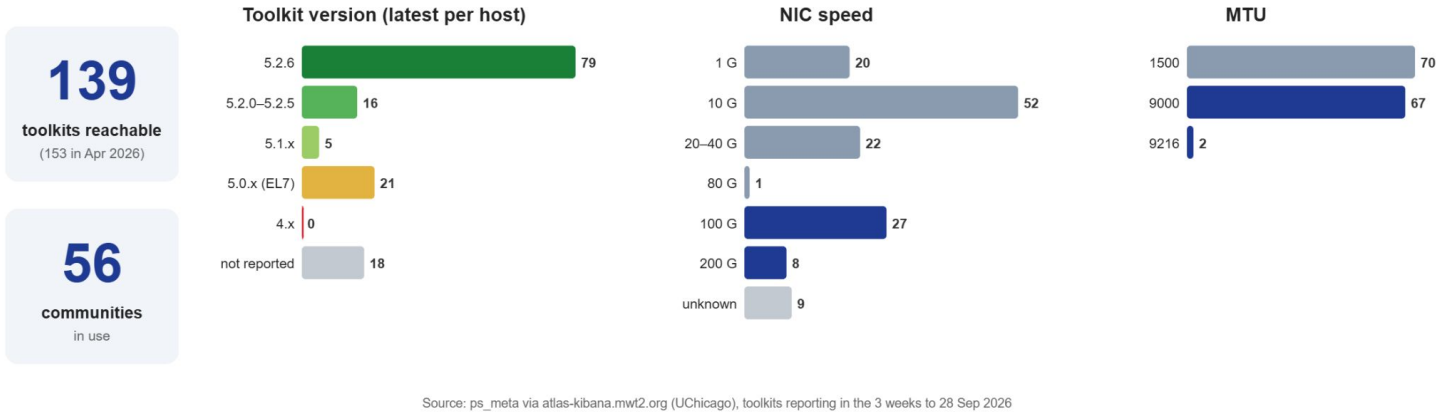
- The perfSONAR deployments are in need of changes (updating hardware and implementing a new type of deployment).
- Containers and deployment campaign
- Defining and tuning our tests is going to be a focus area during this calendar year.
- New analytics and associated alerting & alarming is under very active development

perfSONAR News

- **perfSONAR 5.2.6 is the latest release (Aug 2026); 5.3 still pending**
  - Number of bug-fixes since 5.0; frequent meetings with the developers
  - WLCG/OSG perfSONAR containers ready
    - We're hoping this will resolve long-standing issues with resiliency and reliability
  - Update campaign under way: Tier-1 sites first, then Tier-2s
    - **CentOS7 is no longer supported, sites should update (via redeploy) ASAP**
- **perfSONAR 5.3 will introduce new configuration management (psCompose)**
  - We will migrate from PWA (psconfig) to psCompose once 5.3 is released
- AI network agent in use via Mattermost: perfSONAR, SciTags and site-monitoring data indexed; FTS and GGUS integration starting

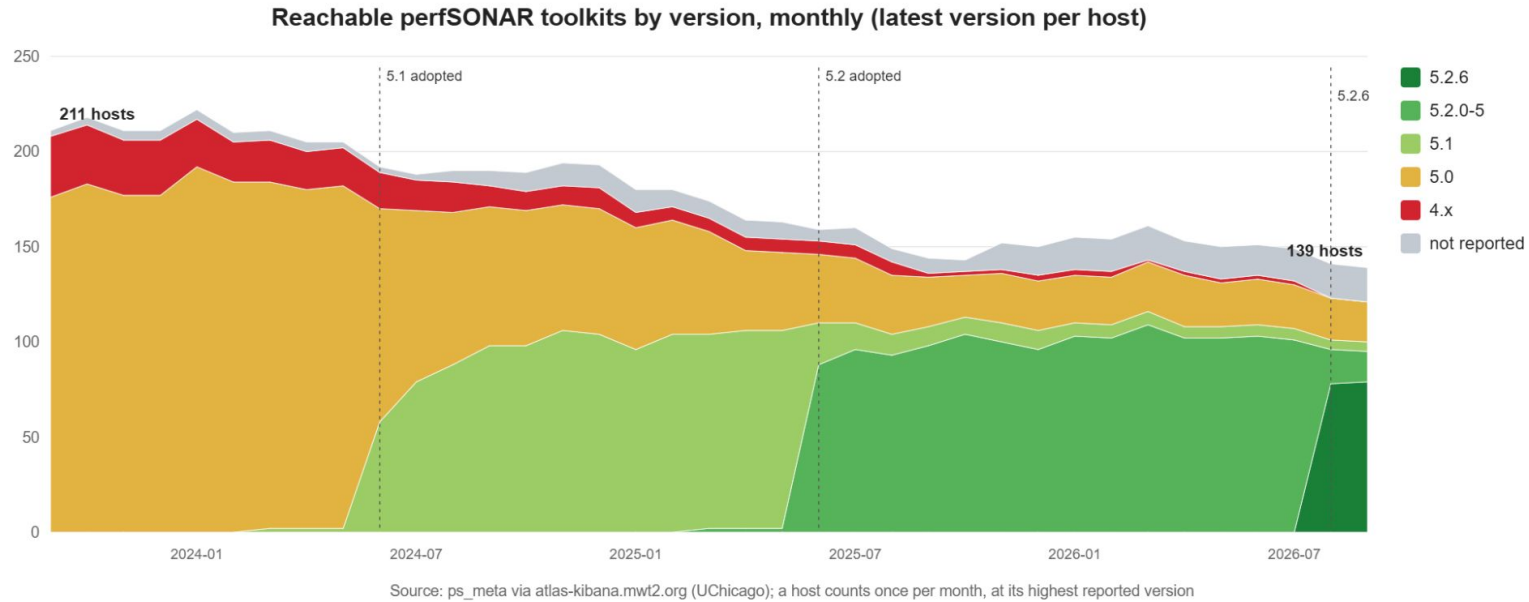
- **DC27: last week of Feb into first week of Mar 2027?**
  - We will have a focused discussion this afternoon on DC27
  - We need to make sure we're able to update the infrastructure and be ready to find and fix any network issues before it starts

perfSONAR Infrastructure



- All reporting toolkits now on 5.x (last 4.x host gone in Aug 2026)
  - 5.2.6 already on 79 hosts, six weeks after release
  - 21 hosts (~15%) still on 5.0.x / EL7 (these need updates!)
- Most hosts still 10 Gbps (52), but 25% now at ≥100 Gbps
  - For WLCG/OSG testing purposes 10Gbps is still sufficient
  - 8 hosts at 200 Gbps and there is recent renewed interest in 100G+ testing/config
  - **Important to refresh HW along with the update to EL9**
- MTU - around 50% on jumbo frames (9000), rest is on standard frames (1500)

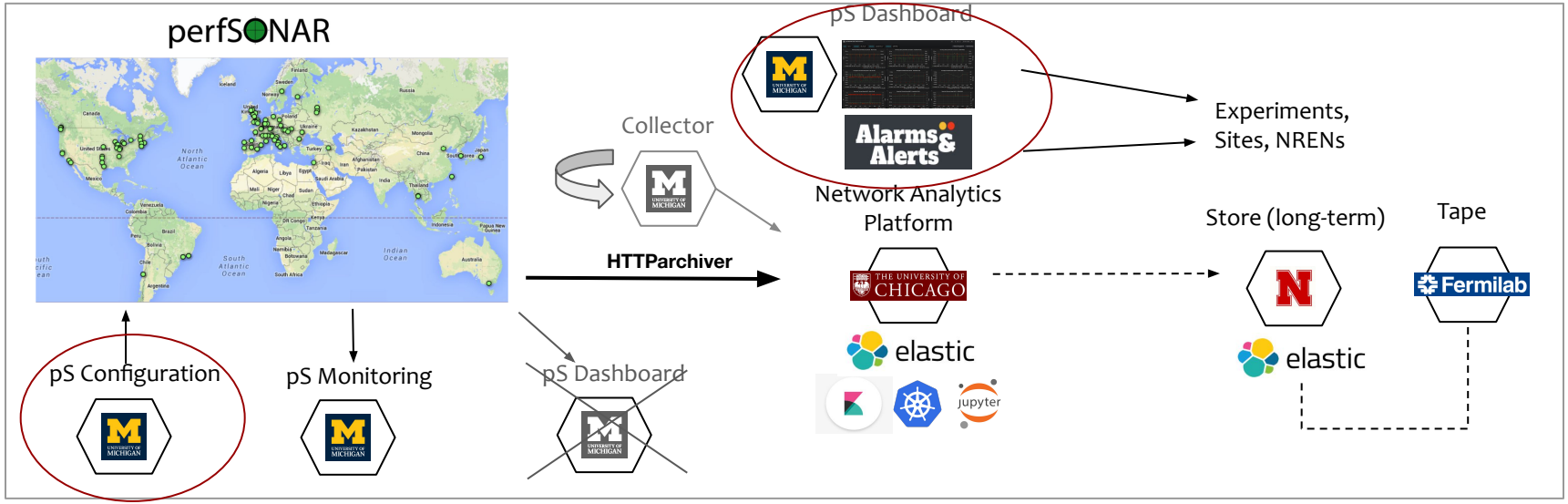
perfSONAR Infrastructure Evolution



- Long-term trend of perfSONAR releases adoption shows a steady downtrend
  - Only reachable “toolkit version” installations are shown (stacked plot)
  - Stability and reliability of the releases clearly playing a role
- **Deployment vs Time: 139 reachable toolkits, down from 153 in April and 211 in Sep 2023**
  - Containers + Tier-1/Tier-2 campaign should reverse the decline before DC27

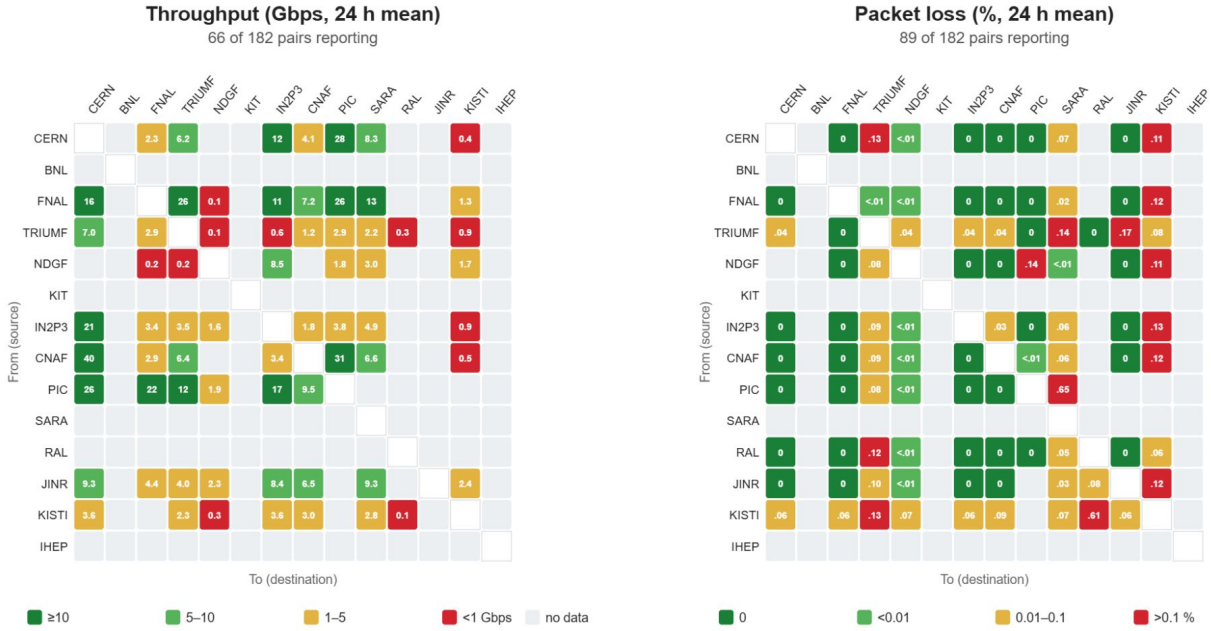
Platform Updates

- Our platform/pipeline is evolving, with some components replaced or retired.
  - Forwarding to UNL and backup to FNAL still to be implemented
  - **pS Monitoring - psetf containers rebuilt with SSO; CheckMK 2.5 in October?**
  - **ps Dashboard** - integrate with Analytics Platform/Grafana (MaDDash retired)
  - **ps Configuration - to be replaced with psCompose (once perfSONAR 5.3 is released)**



perfSONAR Dashboard Updates

- New dashboard service replacing previous MaDDash
  - Running on EL9 maddash.aglt2.org using ESnet perfSONAR grafana plugin
- Working to replicate all features of the old MaDDash
- **MaDDash Replacement:** https://maddash.aglt2.org/dashboards (below: OPN-ALL mesh, 27–28 Sep 2026)



No throughput results from BNL, KIT, SARA, RAL, IHEP as sources; no latency results from BNL, KIT, SARA, IHEP. Data: OPN-ALL mesh, maddash.aglt2.org, 27–28 Sep 2026

perfSONAR Dashboard Updates

From the dashboard shown in the previous slide, you can click on any box to get more details =>

This allows easy exploration of test results and is useful for site debugging.

We plan to continue tuning and tweaking this interface to better optimize for our most common use-cases.

perfSONAR Testpoint Containers

- **WLCG/OSG Containers are now available from OSG Harbor repo**
  - **Documentation updated (Sep 2026): registration now via WLCG CRIC only**
  - We have developed and tested numerous helper scripts available from the link
    - Basic node setup: firewalls, multi-NIC, podman, selinux, health-checks, etc.
    - ESnet Fasterdata tuning (details in host tuning talk later today)
      - The script supports auditing, configuration saving and restore, tuning for measurement (perfSONAR) and dtn (storage) hosts and other options.
- **Supported deployment models:**
  - Simple testpoint or full-toolkit - just simple testpoint with OSG/WLCG tunings
  - Testpoint/Full-Toolkit + Let's Encrypt - adds let's encrypt certificate setup and renewal
  - Testpoint/Full-Toolkit + flowd-go (in progress)
    - Adds flowd-go as a separate container, different configurations possible, including changing flow labels, extension headers, sending fireflies, adding TCP/IP low level socket data to fireflies
    - Tristan Sullivan tested adding extension headers to iperf3 packets, currently facing issues if path MTU is not coherent

perfSONAR Testpoint Containers

Deploy: Use testpoint container for all perfSONAR installs **UNLESS** you want local plotting and result storage.

Configure:

Centralized management via https://psconfig.osg-htc.org (currently)

psCompose (with perfSONAR 5.3, still pending) will replace PWA

WLCG upgrade campaign has started:

v5.2.6 container promoted to production Sep 9; Tier-1s first, Tier-2s next

Site support available for troubleshooting; contact us:
wlcg-perfsonar-support '@' cern.ch

Connecting perfSONAR and SciTags (Plans)

- **Why**: perfSONAR test traffic should be visible to NREN SciTags collectors like real WLCG traffic, and can check that marking survives end-to-end
- **How**: flowd-go runs next to the testpoint container and marks iperf3 and OWAMP traffic (IPv6 flow label, optionally extension headers), sends fireflies and can add TCP socket stats
- **First use case:** can IPv6 extension headers cross R&E networks? Jisc already sends marked packets from two perfSONAR hosts; extension headers break when path MTU is inconsistent
- **Needed**: perfSONAR 5.3 test configs must allow setting the flow label (iperf3 already can); Pablo (see tomorrow's flowd-go presentation) is working with the perfSONAR developers
- **Data**: fireflies now sit next to perfSONAR and FTS in UC Elasticsearch, but ~50% lack a CRIC network prefix, **so sites must register their networks** (DC27 goal: ≥80% of traffic identified)

Analytics Core Team

We have a number of people who meet weekly to discuss network analytics and our measurement and analysis platforms.

The core group is comprised of Marian Babik, Shawn McKee, Petya Vasileva, Ilija Vukotic and Yuval Shavitt.

We often have others join our meetings from ATLAS, CMS, R&E networks, the perfSONAR team and site or network admins. (Previous notes available here)

Through **IRIS-HEP** (NSF funded institute) we have also managed to bring in a few fellows who have worked on specific projects identifying network issues or creating alerts and alarms.

Analytics Summary

Network Analytics has been a long-term effort for our small group.

We want to better exploit the large complex network information we gather.

There are four general areas of work here:

- **Data-preprocessing**, e.g.
  - Train neural networks to predict network paths, e.g. help us fill the gaps in traceroute(s)
- Build **model(s)** that represents our network(s)
  - Network measurements are inherently noisy and therefore require robust models
- Use ML models for **anomaly detection** (for alerts & alarms)
  - Graph Neural networks, Bayesian/probabilistic approaches
  - Detect anomalies in network paths and bandwidth measurements
  - Compare with the existing heuristic algorithms that we have developed
- **Correlation** with other data
  - Traceroutes with throughput for example, but also outside of perfSONAR, e.g. FTS
  - New types of data appearing (high-touch, scitags, in-band telemetry, etc.)

Petya will cover all this in her talk tomorrow!!

AI Network Agent on CERN Mattermost

- **“networkbot”**: an OpenClaw agent on Claude Sonnet 4.6, run by Ilija Vukotic/UChicago; in the AI Ops team, #net channel since June 2026
- Reads the data we already collect: perfSONAR (latency, loss, traceroute, throughput, meta/status), FTS transfers, SciTags fireflies, site SNMP traffic, GGUS tickets
- **Scheduled work:** daily data-health check of every index (since June) and a daily FTS-issues report that separates site from network causes (since Sep 10)
- **On demand:** @networkbot in #net or by direct message (mattermost.web.cern.ch/atlas/messages/@networkbot) for tables, plots and investigations (example follows)
- Currently learns only from Shawn and Marian: corrections go into its long-term memory (e.g. throughput tests run far less often than latency tests)

Example Net Agent daily check output on Mattermost

https://mattermost.web.cern.ch/test-ai/channels/net
Network agent
07:00
📡 Daily Index Health — 2026-10-01

Docs ingested (last 24h):

ps_throughput: 1,759
ps_owd: 1,303,511
ps_trace: 832,885
ps_rtt: 269,029
ps_packetloss: 1,303,502
ps_status: 3,518
ps_meta: 128
fts (last 24h): 6,668,892
wlcg_sitenetwork: 68,739
fireflies: 26,449,920
✅ All indices healthy — no gaps detected.

Agent in Action: Examples (Aug–Sep 2026)

- **FTS triage**: 18 daily reports so far, e.g. BNL CRL/TLS failure, Freiburg HTTP 401, KISTI HTTP 403, Manchester disk full; flags when no GGUS ticket exists and drafts one
- Network-attributed failures (week of Sep 2–9): 267k FTS connection time-outs in 4 events, e.g. GRIF outbound outage Sep 3–4 (~72k) and INFN-ROMA3 unreachable (~51k)
- PIC→KIT weekly routing anomaly: matched to GEANT tickets for a failing Madrid–Villarejo fibre repair (next attempt Oct 6)
- CNAF↔IN2P3 path asymmetry (IPv6 via LHCOPN, IPv4 via LHCONE): a valid setup with no effect on FTS
- **Monitoring health**: UK→RAL IPv6 loss localised to one JANET segment; frozen SNMP counters for WLCG Sites (CSCS, JINR, TRIUMF); gaps in perfSONAR indices

Agentic Operations: Lessons and Plans for DC27

New WG led by Dmytro Kovalskyi/MIT and Ilija Vukotic/UC exploring this

Lessons so far: 1) **Answers need checking by an expert**. User interaction confirmed the CNAF asymmetry is a valid setup, and clarified where one specific number came from. 2) **Scheduled jobs are fragile** (query bugs on Aug 23, Aug 26 and Sep 4, all fixed by the agent once pointed out); the knowledge it needs must be written down (skill and md docs)

Status and plans:

- WLCG Agentic Operations project (Jira, Sep 22): GGUS MCP, FTS MCP and network-monitoring tasks; a shared DC27 AI-support environment is preferred over separate agents
- **Next data sources**: SciTags fireflies (now in UC Elasticsearch), CRIC topology (just needs more complete data), CheckMK/psetf status, triage-dashboard summaries; multi-user access coming
- **Goal for DC27**: first-line triage that spots problems, correlates FTS with perfSONAR and SciTags, and drafts tickets; people decide what to do (discovery only, no automated repair)

Summary and Plans

- Updates to perfSONAR and OSG/WLCG network measurement platform
  - Container deployment in production (v5.2.6); Tier-1 refresh campaign under way
- Core analytics and alarms in production; routing-anomaly triage dashboard live (details tomorrow)
- AI network agent now in use: found UK→RAL IPv6 loss and stuck SNMP counters (Sep 2026)
  - Use of AI/ML to extract signatures of real network issues from the measurements
  - Next: FTS and GGUS integrations (WLCG Agentic Operations, Sep 2026); fireflies now in UC Elasticsearch
  - Agent that can take actions in order to evaluate a network issue:
    - Understands our network topology and infrastructure
    - Checks ElasticSearch stream, run on-demand tests
    - Help/assist users investigating network problems
- We have to continue to watch our network monitoring infrastructure as it is a complex system with lots of areas for issues to develop.
- **Path coverage is only ~25% of expected**: fix Tier-1s, then Tier-2s, before DC27

Question or Comments?

Acknowledgements

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Useful URLs

- OSG/WLCG Networking Documentation
  - https://opensciencegrid.github.io/networking/ (old, being updated soon)
- perfSONAR Infrastructure Dashboard
  - https://atlas-kibana.mwt2.org:5601/s/networking/goto/9911c54099b2be47ff9700772c3778b7
- perfSONAR Dashboard and Monitoring
  - Dashboard: http://maddash.aglt2.org/maddash-webui
    CheckMK service monitoring) https://psetf.opensciencegrid.org/etf/check_mk
- perfSONAR Central Configuration
  - https://psconfig.osg-htc.org/
- Toolkit information page (and new Lookup Service stats: https://stats.perfsonar.net/)
  - https://toolkitinfo.opensciencegrid.org/
- ATLAS Alerting and Alarming Service: https://aaas.atlas-ml.org/
- Network incident triage: https://ps-triage.atlas-ml.org/ ; The pS Dash application: https://ps-dash.uc.ssl-hep.org/
- ESnet Stardust WLCG DC Dashboard: https://public.stardust.es.net/d/lkFCB5Hnk/lhc-data-challenge-overview?orgId=1

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