Engagement and Performance Operations Center (EPOC)

(Formerly known as ReSEC)

NSF Award #1826994

Year 2 Quarter 4 and Annual Report

1 April 2019 through 31 March 2020

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Summary

The goal of the EPOC project is to provide researchers and network engineers with a holistic set of tools and services needed to debug performance issues and enable reliable and robust data transfers. It supports five main activities: Roadside Assistance and Consulting, Application Deep Dives, Network Analysis using NetSage, the provision of Managed Services, and Training. In Year 2 highlights include forty-four presentations, posters or publications related to the project, forty-six completed Consultation cases, six completed and two ongoing Deep Dive events, partial NetSage deployments for five of the six Regional Networking Partners, and significant work with training, including a new effort to adapt for current travel restrictions. Year 3 plans are detailed for each subject area and include an additional focus on communicating the lessons learned and best practices from across the project.

1. EPOC Overview

The Engagement and Performance Operations Center (EPOC) is a production platform for operations, applied training, monitoring, and research and education support. EPOC is a collaborative focal point for operational expertise and analysis and is jointly led by Indiana University (IU) and the Energy Sciences Network (ESnet). EPOC provides researchers and network engineers with a holistic set of tools and services needed to debug performance issues and enable reliable and robust data transfers. By considering the full end-to-end data movement pipeline, EPOC is uniquely able to support collaborative science, allowing researchers to make the most effective use of shared data, computing, and storage resources to accelerate the discovery process.

EPOC supports five main activities:
- Roadside Assistance and Consulting via a coordinated Operations Center to resolve network performance problems with end-to-end data transfers reactively;
- Application Deep Dives to work more closely with application communities to proactively understand full workflows for diverse research teams in order to evaluate bottlenecks and potential capacity issues;

- Network Analysis enabled by the NetSage monitoring suite to proactively discover and resolve performance issues;
- Provision of Managed Services via support through the IU GlobalNOC and our Regional Network Partners;
- Training to ensure effective use of network tools and science support.

This report details the staffing, collaboration, and focused work in each of the five activities in Year 2, as well as plans for Year 3. Note that at the time of this report, COVID-19 and its associated lock downs and prohibitions on meetings and travel, were in a state of high fluctuation. Because of this, Year 3 plans are less specific.

2. Staffing and Internal Coordination

At the beginning of Year 2, funded project staff included:
- Jennifer Schopf, IU, PI - overall project director
- Hans Addleman, IU, Roadside Assistance and Consulting Lead
- Dan Doyle, IU, system architect - Measurement and Monitoring co-Lead
- Heather Hubbard, IU, Project coordination
- Ed Moynihan, IU, Science Engagement
- Doug Southworth, IU, Partner coordination and Deep Dives

Dave Jent is a co-PI, but due to his position at IU is unable to formally charge the project. The IU Global NOC Software team provides 0.5FTE of developer support for the NetSage deployments. In April, the subaward to LBNL was finally completed to enable Jason Zurawski to charge time on their accounts.

At IU, Scott Chevalier joined the project in Quarter 2 to help with science engagement and training. During Quarter 3 EPOC also started paying the OmniSOC for 0.1FTE for support of its NetSage Archive. In Year 3, IU will add another engineer to help with Roadside Assistance and Consulting support. At LBNL, George Robb joined in Quarter 2 to contribute to the Managed Services efforts. LBNL will be adding additional resources in Year 3, once hiring and onboarding has been completed.

At the end of Year 2, funded project staff included:
- Jennifer Schopf, IU, PI - overall project director
- Jason Zurawski, LBNL, co-PI, Deep Dives and Managed Services Lead
- Hans Addleman, IU, Roadside Assistance and Consulting Lead
- Scott Chevalier, IU, Science engagement and Training
- Dan Doyle, IU, system architect - Measurement and Monitoring co-Lead
- Heather Hubbard, IU, Project coordination
- Ed Moynihan, IU, Science Engagement
- George Robb, LBNL, Managed Services support
- Doug Southworth, IU, Partner coordination and Deep Dive support

The EPOC staff coordinate internally via four primary mechanisms:
- Synchronous and asynchronous communication via an email mailing list and Slack workspace;
- Project management via shared Trello (digital KanBan board) to track ongoing projects, requests, and record outcomes;
- Weekly project team meetings to update the Trello infrastructure and triage new requests; and
- Twice yearly All Hands Meetings for face-to-face discussion on important strategic topics.

An EPOC All Hands Meeting was held on August 27-28, 2019, in Bloomington, IN. Topics discussed in detail included evaluation of internal roadmap for the remainder of 2019 and 2020, communication strategies, meeting participation and priorities for travel, updates to Managed Services, and strategic goals for Project Year 2 and Year 3.

Another EPOC All Hands Meeting was held in Bloomington on February 11-12, 2020, with a slightly different format. Instead of doing strategic planning, we spent the two days in focused blocks of time to move forward several needed components. These included updating the 2-page description documents, re-working how Roadside Assistance and Consultations are tracked, and completing work on a number of other long-standing internal tasks that required collaboration.

Our next formal Team All Hands meeting will take place in the summer and will likely be virtual. However, we are planning to have some shorter, more frequent part-day focus times for the full team as we adjust our approaches for the "new normal" without travel.

3. Collaboration and Travel

EPOC staff participated in various meetings to support ongoing deployment, collaboration, and training. Note that several of these were funded by other sources but relevant to EPOC. The travel for Year 2 Quarters 1-3, detailed in those reports, included:
- Zurawski and Addleman attended KINBERCON, in Philadelphia, PA, on April 1-3, https://kinbercon.org/.
- Schopf attended the Coalition for Network Information(CNI) Spring Meeting and Campus Research Computing Consortium(CARCC) workshop on the Cyberinfrastructure Ecosystem, in St. Louis, MO, on April 8-10, 2019, https://www.cni.org/event/cni-spring-2019-membership-meeting.
- Zurawski visited Prairie View A&M University for a PI meeting to discuss NSF Grant #1827243, in Prairie View, TX, on April 12, 2019.
- Zurawski and Addleman led a campus-wide Deep Dive at the University of Cincinnati in Cincinnati, OH, on April 26, 2019.

- Schopf attended the iLight Members Meeting, in Indianapolis, IN, on May 7-8, 2019, https://ilight.net/members-meeting/.
- Zurawski and Chevalier attended the Linux Cluster Institute (LCI) Workshop, in Norman, OK, on May 13-18, 2019, http://www.linuxclustersinstitute.org/workshops/archive/21st/.
- Schopf and Zurawski attended the Great Plains Network (GPN) Annual Meeting, in Kansas City, MO, on May 20-25, 2019, https://www.greatplains.net/gpn-annual-meeting-2019/.
- Addleman attended the Ohio Academic Resources Network (OARnet) Technical Meeting, in Bowling Green, OH, on May 22-24, 2019, https://www.oar.net/calendar/events/oarnet_member_meeting_ohecc_2019.
- Zurawski led a campus-wide Deep Dive at Trinity University in San Antonio, TX, on May 29, 2019.
- Zurawski, Addleman, Chevalier, and Southworth led a campus-wide Deep Dive at Purdue University, Lafayette, IN, on May 31, 2019.
- Zurawski and Addleman attended the LEARN Annual Meeting, in College Station, TX, on June 11-13, 2019.
- Schopf attended TNC 2019, in Tallinn, Estonia, on June 16-20, https://tnc19.geant.org/.
- Zurawski and Addleman led a campus-wide Deep Dive at the University of Wisconsin, in Madison, WI, on June 17-19, 2019.
- Schopf attended the FRGP/WestNet Summer Meeting, in Salt Lake City, UT, on June 24-30, 2019.
- Zurawski and Schopf attended the NOAA N-Wave Technical Workshop, in Boulder, CO, on July 9-11, 2019, https://noc.nwave.noaa.gov/nwave/public/events.html.
- Moynihan attended the Earth Science Information Partners (ESIP) Summer Meeting in Tacoma, WA, on July 16-19, 2019, https://2019esipsummermeeting.sched.com/info.
- Zurawski attended the Spring 2019 ESnet Site Coordinators Meeting (ESCC), in Berkeley, CA, on July 16-18, 2019.
- Zurawski attended the Training Workshop for Network Engineers and Educators on Tools and Protocols for High-Speed Networks and Cybersecurity in Columbia, SC, on July 22-23, 2019, http://ce.sc.edu/cyberinfra/workshop_2019.html.
- Zurawski attended PEARC19 in Chicago, IL, on July 29-August 2, 2019, https://www.pearc19.pearc.org/.
- Zurawski attended the Navajo Tech University Technical Meeting (NTUStar), in Tempe, AZ, on July 31-August 1, 2019, https://sites.google.com/navajotech.edu/navajotech-cc/ntustar-technical-meeting.
- Moynihan attended the Large Synoptic Survey Telescope (LSST) Global Networking Workshop and the TICAL meeting, in Cancun, Mexico, on September 2-5, 2019, http://tical2019.redclara.net.
- Zurawski attended a side meeting at the Texas Advanced Computing Center (TACC), in Austin, TX, on September 9-10, 2019, to discuss security related initiatives for EPOC.
- Zurawski attended the Southern Crossroads (SoX) Member Meeting in Atlanta, GA, on September 11-12, 2019, http://www.sox.net/events/fall2019/.

- Schopf and Zurawski attended the CC*PI/National Research Platform/Quilt meeting in Minneapolis, MN, on September 22-26, 2019, https://www.thequilt.net/public-event/2019-nsf-nrp-and-the-quilt-workshops-and-meetings/.
- Moynihan attended the eScience and Science Gateways co-located meetings in San Diego, CA, on September 23-27, 2019, https://escience2019.sdsc.edu/.
- Zurawski attended and presented at the NYSERNET Annual Meeting in Syracuse, NY, on Oct 3-4, 2019, https://web.cvent.com/event/8a61d158-6e01-4cf9-828e-3da1cad5eecb/summary.
- Zurawski attended and presented at the PNWGP Board Meeting in Seattle, WA, on Oct 8, 2019.
- Zurawski attended and presented at the Open Storage Network All Hands Meeting in Austin, TX, on Oct 10, 2019.
- Moynihan attended the 2019 NSF Cybersecurity Summit for Large Facilities and Cyberinfrastructure, in San Diego, CA on Oct 15-17, 2019, https://trustedci.org/2019-nsf-cybersecurity-summit.
- Southworth attended the Midwest Big Data Hub, in Chicago, IL, on Oct 28-30, 2019, http://midwestbigdatahub.org/2019-all-hands-meeting/.
- Zurawski, Schopf, Addleman, Chevalier, and Southworth attended SC'19 in Denver, CO, November 17-22, 2019, https://sc19.supercomputing.org/.
- Zurawski and Addleman attended and presented at Internet2 Technical Exchange, in New Orleans, LA, on Dec 8-12, 2019, https://www.internet2.edu/news-events/events/technology-exchange/.

Quarter 4 travel included:
- Zurawski led a campus-wide Deep Dive at Baylor University, in Waco, TX, on January 6-7, 2020.
- Schopf attended the ESIP Winter Meeting, in Bethesda, MD, on January 7-9, 2020, https://2020esipwintermeeting.sched.com. She met with ESIP leadership as well as with researchers supported by NSF, NOAA, NASA, and USGS funding to try to better understand how we can support geoscience data transfers.
- Schopf and Zurawski met with NSF leadership to discuss project status and direction in Alexandria, VA, on January 8-9, 2020.
- Schopf, Addleman, and Moynihan attended the TransPacific Research and Education Networking Workshop and PTC'20 in Honolulu, HI, on January 27-29, 2020, https://www.ptc.org/ptc20/. They presented on TransPAC4, NEAAR, and NetSage, as well as EPOC, and met with the Hawaiian Astronomy partners and IRNC colleagues to discuss current and future collaborations.
- Schopf, Zurawski, Southworth, and Doyle attended the NetSage AHM in Honolulu, HI, on January 19-20, 2020. They met with partners to discuss current and future collaborations.
- Schopf and Zurawski attended and presented at the Quilt Spring meeting in La Jolla, CA, on February 5-7, 2020 https://www.thequilt.net/public-event/2020-winter-member-meeting/. They led a 4-hour session reviewing lessons learned from the EPOC Deep Dives and presented an in-depth live NetSage example using EPOC NetSage data. The

annual meeting with the Regional Networking Partners also took place and featured representatives from current, and potentially future, regional networking partners.
- Zurawski attended the ESnet Site Coordinators Meeting (ESCC), in Berkeley, CA, on March 3-5, 2020.

Nearing the end of Quarter 4, and as we enter into the next time period for EPOC, activities that involve travel have been severely impacted by COVID-19. The EPOC activities will therefore shift significantly from in-person to remote/virtual interactions. Remote participation in Quarter 4 meetings included:
- OARTECH 2020, March 25, 2020, Columbus, OH, https://www.oar.net/calendar/events/oartech_meeting_14. The meeting was converted to virtual, and EPOC participated remotely.

Canceled or rescheduled meetings in Quarter 4 included:
- CENIC 2020, March 16-18, 2020, Monterrey, CA, https://events.cenic.org/march-2020. This event was cancelled.
- Internet2 Global Summit, March 29-April 1, 2020, Indianapolis, IN, https://meetings.internet2.edu/2020-global-summit/update-coronavirus/. This event was cancelled.

Meetings in Year 3 that have been canceled or rescheduled include:
- Ohio Supercomputing Center (OSC) meeting, April 9, Columbus, OH, https://www.osc.edu/calendar/events/2020_04_09-statewide_users_group_conference_spring_2020_postponed. This event was cancelled.
- Global NOC User Meeting, April 2020, Indianapolis, IN. The meeting was converted to virtual, and EPOC will remotely participate.
- Large Scale Networking (LSN) Workshop on Huge Data: A Computing, Networking and Distributed Systems Perspective, April 13-14, 2020, Chicago, IL, https://protocols.netlab.uky.edu/~hugedata2020/. The meeting was converted to virtual, and EPOC will remotely participate.
- FABRIC Community Workshop, April 15-16, 2020, Chicago, IL, https://whatisfabric.net/events/fabric-community-workshop-2020. The meeting was converted to virtual, and EPOC will remotely participate.
- NSF Large Facilities workshop, April 14-16, 2020, Alexandria, VA, https://www.largefacilitiesworkshop.com/. The meeting was postponed until September 1-3, 2020.
- KINBERCON 2020, April 27-29, 2020, Pittsburgh, PA, https://kinbercon.org/. This event was cancelled.
- N-Wave Stakeholders and Science Engagement 2020 Summit, May 5-7, 2020; Silver Spring, MD, https://noc.nwave.noaa.gov/nwave/public/events/2019-n-wave-stakeholders-and-science-engagement-summit . The meeting was postponed until September 22-24, 2020.
- iLight Members Meeting, May 6-7, 2020, Indianapolis, IN. This event was cancelled.

- OHECC 2020, May 20-22, 2020, Athens, OH, https://www.ohio.edu/oit/ohecc2020. This event was cancelled.
- Great Plains Network Annual Meeting, May 19-21, 2020, Kansas City, MO, https://conferences.k-state.edu/gpn/. This event was canceled.
- LEARN Member Meeting, June 1-3, 2020, Nacogdoches, TX. The meeting was converted to virtual, and EPOC will remotely participate.
- WestNet, June 24-26, 2020, Boise, ID. The meeting was converted to virtual, and EPOC will remotely participate.
- eScience 2020, September 8-11, 2020 Osaka, Japan, https://escience2020.cmc.osaka-u.ac.jp. This event was cancelled.

Additionally, EPOC had planned the following engagement activities that will be impacted due to COVID-19. Some have been migrated, others have been postponed:
- KINBER / Arcadia PS Training, March 9-11, 2020, Arcadia University, Glenside, PA. This event has been postponed without a re-schedule date.
- LEARN CC* Coordination event for Managed Services, supporting LEARN CC* award #192553, April 2020. This event has been postponed without a re-schedule date.
- University of Central Florida / Florida LambdaRail Deep Dive, May 2020. This event has been postponed until Fall 2020.
- University South Dakota / GPN Deep Dive, June 2020. This event has been postponed until, tentatively, November 2020.
- Arizona State University / Sun Corridor Network Deep Dive, Sept 2020. This event has been postponed to, tentatively, January 2021.

Our plan to address these unforeseen cancellations and delays involves a pivot to the use of remote and virtual options when possible, along with delaying in-person events beyond the expected window of the pandemic. Because the cancellations include a number of the Annual meetings of our partners, we will be scheduling additional check-ins with each partner over the summer to ensure progress on various deliverables. At the current time, it is unknown how long the altered travel will last, thus EPOC is remaining nimble to these challenges as well as adjusting our Year 3 plans to accommodate fewer face-to-face meetings.

4. Presentations and Publications

For Year 2, the EPOC team gave 44 presentations, invited posters, and publications. These are referred to throughout the report with the reference number listed here.

1. Zurawski, Jason, "EPOC (Engagement Performance and Operations Center) Services and Activities Supporting Research in PA", Invited Talk, KINBERCON 2019, Philadelphia, PA, April 2, 2019.
2. Zurawski, Jason, and Addleman, Hans, "Determining Technology Requirements for Scientific Innovation", Invited Workshop, KINBERCON 2019, Philadelphia, PA, April 3, 2019.

3. Zurawski, Jason, "The Engagement Performance and Operations Center (EPOC)", Invited Webinar, XSEDE CC Region 7 "Spring Thaw", April 4, 2019.
4. Schopf, Jennifer, "The Engagement Performance and Operations Center (EPOC)", Invited Talk, CNI Spring Meeting 2019, St. Louis, MO, April 9, 2019.
5. Leasure, Jen, Editor, "The Engagement Performance and Operations Center (EPOC)", Article, The Quilt Circle, April 2019.
6. Schopf, Jennifer, "Helping Network Operators Identify Researchers Using Their Resources", Invited Workshop, 2019 I-Light and Indiana GigaPOP Members Meeting, Indianapolis, IN, May 7, 2019.
7. Zurawski, Jason, and Chevalier, Scott "Basic TCP Dynamics/Science DMZ Design", "Network Monitoring via perfSONAR", "Data Movement Hardware/Software", & "Network Security and Local Networking", Invited Talks, Linux Cluster Institute (LCI) Intermediate Workshop - Spring 2019, Norman, OK, May 13-17, 2019.
8. Zurawski, Jason, and Schopf, Jennifer, "EPOC Science Engagement", Invited Workshop, GPN Annual Meeting, Kansas City, MO, May 21, 2019.
9. Zurawski, Jason, "BoF: Ask the CI Engineer", Invited Talk, GPN Annual Meeting, Kansas City, MO, May 22, 2019.
10. Schopf, Jennifer, "What are GPN Folks Doing Internationally and Who's Using my Networks?", Invited Talk, GPN Annual Meeting, Kansas City, MO, May 23, 2019
11. Addleman, Hans, "The Engagement Performance and Operations Center (EPOC)", Invited Talk, Ohio Higher Education Computing Council (OHECC) 2019, Bowling Green, OH, May 23, 2019.
12. Zurawski, Jason, and Addleman, Hans, "EPOC Science and Engineering Deep Dive Workshop", Invited Workshop, LEARN Annual Meeting 2019, College Station, TX, June 12, 2019.
13. Zurawski, Jason, "The Engagement Performance and Operations Center (EPOC)", Invited Talk, LEARN Board Meeting, College Station, TX, June 13, 2019.
14. Schopf, Jennifer, "The Engagement Performance and Operations Center (EPOC)", Invited Talk, TNC 2019 Conference, Tallinn, Estonia, June 16-20, 2019.
15. Schopf, Jennifer, "The Engagement Performance and Operations Center (EPOC)", Invited Talk, FRGP/WestNet 2019, Salt Lake City, UT, June 25, 2019.
16. Zurawski, J., Schopf, J.M., Addleman, H., and Southworth, D. *Arcadia University Bioinformatics Application Deep Dive*. Lawrence Berkeley National Laboratory Technical UCPMS report number 2568399, July 2019. Available online at: https://escholarship.org/uc/item/1196z33x.
17. Zurawski, J., "Demystifying the Science Requirements Review Process for Network Design and Use", Invited Talk, NOAA N-WAVE Technical Workshop, Boulder, CO, July 9, 2019.
18. Schopf, J.M., "Engagement and Performance Operations Center (EPOC) and NetSage", Invited Talk, NOAA N-WAVE Technical Workshop, Boulder, CO, July 10, 2019.
19. Zurawski, J., "Engagement Performance and Operations Center (EPOC) Overview", Invited Talk, Spring 2019 ESnet Site Coordinators Meeting (ESCC), Berkeley, CA, July 17, 2019.

20. Zurawski, J., "Cyberinfrastructure for Big Science Flows: Science DMZs", "End devices in Science DMZs: DTNs", and "Monitoring end-to-end systems: perfSONAR", Invited Talks, Training Workshop for Network Engineers and Educators on Tools and Protocols for High-Speed Networks and Cybersecurity, Columbia, SC, July 22-23, 2019.
21. Zurawski, J., "Demystifying the Science Requirements Review Process for Network Design and Use", Invited Talk, PEARC19, Chicago, IL, July 29, 2019.
22. Zurawski, J. & Schopf, J.M., "The Engagement and Performance Operations Center ", Invited panel presentation, PEARC19, Chicago, IL, July 30, 2019.
23. Moynihan, E., "The Engagement and Performance Operations Center (EPOC)", invited poster presentation, Earth Science Information Partners (ESIP) Summer Meeting, Tacoma, WA, July 16-19, 2019, Available online at: https://drive.google.com/file/d/1E6SKhKgy1RtDLcf8T5k9AjQhe4CH5_NA/view?usp=sharing
24. Zurawski, J., "Best practice: Active Measurement, perfSONAR, and MaDDash", "ScienceDMZ overview Components: DTNs, intrusion detection (BRO)", and "Engagement and Performance Operations Center (EPOC)", Invited Talks, NTUStar Workshop, Tempe, AZ, July 31-August 1, 2019.
25. Zurawski, J., "Engagement Performance and Operations Center (EPOC) Overview, Invited Talk, SOX Member Meeting, Atlanta, GA, September 11-12, 2019.
26. Moynihan, E., "The Engagement and Performance Operations Center (EPOC)", invited poster presentation, eScience and Science Gateway workshop, San Diego, CA, September 23-27, 2019. Available online at: https://drive.google.com/drive/folders/1XDEHbva_IDqQsEDmZ1fmn4m9cXoPOIXZ
27. Zurawski, J., "2019 Data Mobility Workshop", Invited Workshop, CC* PI Meeting/Quilt/NRP, Minneapolis, MN, September 23, 2019. Information available online at: http://fasterdata.es.net/performance-testing/2019-2020-data-mobility-workshop-and-exhibition/
28. Schopf, J.M., "How Regional Partnerships with National Performance Engineering and Outreach Initiatives are Enabling Science", Invited Panel, CC* PI Meeting/Quilt/NRP, Minneapolis, MN, September 24, 2019. Available online at: https://drive.google.com/drive/folders/1k0hlquL2ezWIODqb8x_Xf86b0dgNSGnn
29. Schopf, J., "EPOC Deep Dive Lessons Learned", Lightning Talk, CC* PI Meeting/Quilt/NRP, Minneapolis, MN, September 26, 2019. Available online at: https://drive.google.com/drive/folders/1G33qAqsX3odYgZohG2PUMl3eHIUOlED_
30. Zurawski, J., "Overview: The Engagement and Performance Operations Center", Invited Talk, NYSERNET Annual Meeting, Syracuse, NY, October 3-4, 2019.
31. Zurawski, J., "Overview: The Engagement and Performance Operations Center", Invited Talk, PNWGP Board Meeting, Seattle WA, October 8, 2019.
32. Zurawski, J., "The Engagement and Performance Operations Center", Invited Talk, Open Storage Network All Hands Meeting, Austin TX, October 10, 2019.
33. Southworth, D., "The Engagement and Performance Operations Center (EPOC)", invited poster presentation, Midwest Data Hub, Chicago, IL, October 28-30, 2019. https://drive.google.com/drive/folders/1XDEHbva_IDqQsEDmZ1fmn4m9cXoPOIXZ

34. Zurawski, J., "The Engagement and Performance Operations Center: Fixing Flats and Supercharging Science", Invited Talk, Internet2 TechX, New Orleans, LA, December 8-12, 2019.
35. Addleman, H., Dart, E., Mendoza, N., Zurawski, J., Johnson, T. "It Hurts When IP - Effort to Normalize R&E Routing Policy When There are Too Many Choices", Invited BoF, Internet2 TechX, New Orleans, LA, December 8-12, 2019.
36. Zurawski, J., Addleman, H., Southworth, D., & Schopf, J., "Trinity University Campus-Wide Deep Dive", Report Number LBNL UCPMS ID: 2750469, November 2019, https://escholarship.org/uc/item/3db1k0hf
37. Zurawski, J., Addleman, H., Schopf, J., & Southworth, D., "University of Cincinnati Campus-Wide Deep Dive", Report Number LBNL UCPMS ID: 2751236, November, 2019, https://escholarship.org/uc/item/6t58p052
38. Zurawski, J., Addleman, H., Chevalier, S., Southworth, D., & Schopf, J., "Purdue University Application Deep Dive", Report Number LBNL UCPMS ID: 2751235, November, 2019, https://escholarship.org/uc/item/0x07247x
39. Zurawski, J., Addleman, H., Chevalier, S., Robb, G., & Schopf, J., "Great Plains Network - Kansas State University Agronomy Application Deep Dive", Report Number LBNL UCPMS ID: 2760254, November, 2019, https://escholarship.org/uc/item/472814pk
40. Addleman, Hans, "Iowa State Streaming Data Movement Executive Summary", October 8, 2019, https://epoc.global/wp-content/uploads/2019/10/Roadside-Assitance_-Iowa-State-Case-Executive-Summary.pdf
41. Schopf, Jennifer, "Science Engagement at IN@IU", TPRE Annual Meeting, Honolulu, HI, January 19, 2020.
42. Zurawski, Jason, and Schopf, Jennifer, "Highly Interactive EPOC Deep Dive Outcomes and Researcher Engagement", Invited Workshop, Quilt Winter Meeting, La Jolla, CA, on February 5-7 2020.
43. Zurawski, J., "Engagement Performance and Operations Center (EPOC) Update", Invited Talk, Spring 2020 ESnet Site Coordinators Meeting (ESCC), Berkeley, CA, March 3-5 2020.
44. Zurawski, J., "Engagement Performance and Operations Center (EPOC) Overview", Invited Talk, OARTECH 2020, Virtual Meeting, March 25, 2020.

Throughout the report, we reference these documents and talks by the number listed here.

5. Project Coordination

EPOC has three types of partners: *Regional Networking Partners*, who are deploying the infrastructure EPOC supports and use their members for outreach for EPOC, *Infrastructure Partners*, who are themselves collaborations that support a variety of cyberinfrastructure (CI) services, and *Science Community Partners*.

5.A Regional Networking Partners

EPOC is partnered with the six regional network operators.

- **iLight** is the regional network for Indiana.
  - Meetings: iLight AHM with workshop [6], Fall 2019 CC* PI meeting, SC'19 Meeting, Quilt Winter 2020 meeting
  - Consultations: #24
  - Deep Dive: With Purdue University in May [38]
  - NetSage: Deployment May 2019, http://ilight.netsage.global
  - Future Plans: Updates for NetSage deployment, continued outreach for Roadside assistance.
- **Front Range GigaPop (FRGP)** is the regional collaboration of networks that cover the western states, including Colorado, Wyoming, Arizona, Idaho, Utah, and New Mexico.
  - Meetings: FRGP AHM with invited presentation [15], NOAA NWave meeting with presentations [17, 18], NTUStar Workshop with training [24], Fall 2019 CC* PI meeting, SC'19, Quilt Winter 2020 meeting
  - Roadside Assistance: #14, 76
  - Consultations: #4, 6, 39, 49, 63
  - NetSage: Deployment February 2020, http://frgp.netsage.global. Also, NetSage Tstat deployment at the NCAR Wyoming Data Center.
  - Managed Services: FRGP is in discussions with EPOC staff to see if it would make sense to work with the Tribal Colleges for a wider perfSONAR Managed Service deployment.
  - Other: February meeting with FRGP and Sun Corridor (regional network for Arizona) to discuss NetSage and other partner activities
  - Future: EPOC staff are working with FRGP and WESTNET on possible presentations at Virtual Member Meetings in June, and we expect to attend the rescheduled NOAA meeting in September 2020. The ASU/Sun Corridor Deep Dive is scheduled for January 2021, tentatively. Additional NetSage services are being planned.
- **The Lonestar Education and Research Network (LEARN)** is the regional network for Texas.
  - Meetings: Prairie View to discuss CC* project, LEARN AHM with invited presentation [12], LEARN Board Meeting with invited presentation [13], TACC security visit September 2019, Fall 2019 CC* PI meeting, SC'19, Quilt Winter 2020 meeting.
  - Roadside Assistance: #71
  - Consultations: #14, 23, 31, 36, 62, 66, 69
  - Deep Dives: May 2019 with LEARN member Trinity [36], January 2020 with LEARN partner Baylor, report expected Year 3 Quarter 1.
  - NetSage: In discussions, waiting for time after COVID issues. NetSage Tstat deployment for the TACC data archives in place.

- ○ Managed Services: Interest in joint work for managed services at several LEARN member schools, associated with LEARN NSF CC* funding; Baylor investigating use of Portal service
  - ○ Future: EPOC staff are working with LEARN on possible presentations at Virtual Member Meetings in June or September. The CC*-related coordination event for Managed Services is in planning. Baylor Deep Dive report expected in Year 3.
- **The Ohio Academic Resources Network (OARnet)** is the regional network for Ohio.
  - ○ Meetings: OHECC with Invited presentation [11], Fall 2019 CC* PI meeting, Quilt Winter 2020 meeting, virtual OARTECH Member Meeting with presentation [44]
  - ○ Consultations: #21, 32, 35, 51, 57, 68
  - ○ Deep Dives: With OARnet member University of Cincinnati, April 2019, report published [37].
  - ○ NetSage: Continued discussion at OARTECH in March, possible May-June 2020.
  - ○ Future Plans: Plans to follow up with the new CEO in May to discuss other EPOC services.
- **The Great Plains Network (GPN)** is the regional network that serves North Dakota, South Dakota, Nebraska, Iowa, Minnesota, Kansas, Missouri, and Arkansas.
  - ○ Meetings: LSI training [7], GPN Annual Meeting with workshop and presentations [8, 9, 10], SC19, Fall 2019 CC* PI meeting, Quilt Winter 2020 meeting
  - ○ Roadside Assistance: #27, 59
  - ○ Consultations: #12, 25, 48, 50, 61, 65, 72
  - ○ Deep Dives: With GPN member Kansas State University, report published [39].
  - ○ NetSage: SNMP deployment, http://gpn.netsage.global
  - ○ Training: LCI Workshop support [7]
  - ○ Future Plans: Planned Deep Dive with the University of South Dakota, tentatively scheduled for November 2020, ongoing work with NetSage flow data deployment.
- **The Keystone Initiative for Network Based Education and Research (KINBER)** is the regional network for Pennsylvania.
  - ○ Meetings: KINBERCon 2019 with workshop and presentation [1,2], Fall 2019 CC* PI meeting, Quilt Winter 2020 meeting
  - ○ Consultations: #17, 29, 42, 70, 73
  - ○ Deep Dives: With KINBER member Arcadia, report [16]
  - ○ NetSage: Deployment public in November 2019 at http://kinber.netsage.global
  - ○ Managed Services: We continue to work with Arcadia University and KINBER on deploying a perfSONAR managed service at Arcadia. A training event was planned for March 2020 to educate and install the service but was postponed due to the COVID-19 pandemic.
  - ○ Future Plans: Ongoing work for perfSONAR Managed Service, additional NetSage work for ASN subsetting, continued outreach for Roadside Assistance.

A meeting with the regional networking partners was also held at the Spring Quilt Members meeting. During this session, we gave an update on EPOC activities and walked through

possible coordination points with each partner for the next 12 months. Because many of the partners have had their yearly All Hands Meetings delayed or canceled, we plan to additional check-ins with each partner to ensure progress on various deliverables.

5.B Infrastructure Partners

EPOC's Infrastructure Partners are used to leverage different kinds of support offered by each group to expand the set of services available to the broader community. The current set of Infrastructure Partner organizations includes:

- **The Campus Research Computing Consortium (CaRCC)** is a consortium of over 30 campuses that facilitates access to cyberinfrastructure. Schopf is the main contact for this group. She is currently tracking many of their mailing lists, participated in their Cyberinfrastructure Ecosystem workshop [4] in St Louis in April, joint with CNI, and met with them at the CC* PI meeting in September, SC'19 in November, and at the February Quilt meeting to ensure coordination between the groups.
- **Trusted CI: The NSF Cybersecurity Center of Excellence** supports cybersecurity for NSF funded projects. Addleman is the main contact for Trusted CI. Zurawski and Von Welch, the Trusted CI lead, spoke on a panel titled "Community Engagement at Scale: NSF Centers of Expertise" at PEARC19 [22]. EPOC staff also attended the NSF CyberSecurity Summit, which Trusted CI helped lead. Over the year, we also engaged Trusted CI for several Consultations, detailed in Section 6.B, with University of Michigan (38), University of Montana (34, 56), and the University of Central Florida (47).
- **Internet2** supports solving common technology challenges for their over 200 educational, research, and community members. Schopf is the main contact for this organization. She met with Internet2 staff members at the CC* PI meeting, SC'19, and PTC'20. At the Technical Exchange, we presented a session on EPOC [34]. We also led a BoF session on mid-level BGP administration to help address the routing issues that are now commonly being seen in NetSage and roadside consultations [35]. In Quarter 4 EPOC met with Internet2, NSRC, TACC, and NERSC and to discuss BGP training opportunities for campuses and regional networks. It was decided that there are 3 levels of training that we can collaborate on. NSRC will lead the BGP Introduction or 101 level training. EPOC will concentrate on helping campuses and regional networks understand how to best optimize their traffic flows and routing to support research data transfers, and Internet2 will work on advanced topics such as RPKI, BGPSEC, and MANRS.
- **The Quilt** provides a central organization for networks to share the best practices to support end user science. Zurawski is the primary contact for the Quilt and has regular meetings with their organization. Zurawski is the primary contact for the Quilt and has regular meetings with their organization. EPOC had a story in the 2019 Quilt Circle Magazine [5] and has submitted for the 2020 addition as well. EPOC staff served on the advisory committee for the Fall Quilt Members meeting. Zurawski and Schopf presented or moderated several sessions at the Fall Quilt meeting, including:
  - The Data Mobility Workshop and Exhibition [27]
  - A Session of "Speed Learning": "Starting a Conversation with the Scientific Community and Strategies to Increasing Adoption & Awareness"

- ○ A Panel entitled: "How Regional Partnerships with National Performance Engineering and Outreach Initiatives are Enabling Science" [28]
        - ○ A lightning talk on EPOC's Deep Dives [29]
    At the Winter 2020 quilt meeting, EPOC led a breakout workshop, "Highly Interactive EPOC Deep Dive Outcomes and Researcher Engagement" [42], that focused on outcomes of Deep Dive activities. In addition, the EPOC Regional Networking Partners meeting took place between current and potentially new EPOC partners.
- **The Science Gateway Community Institute (SGCI)** provides best practice recommendations and support for scientists building and using data portals. Moynihan is the contact for this group and presented a poster on EPOC [26] at their meeting in September. In Quarter 4, EPOC signed a formal partnership agreement with SGCI that outlines areas of collaboration and defines how EPOC and SGCI will work together to promote and provide relevant data transfer services and tools.
- **The Extreme Science and Engineering Discovery Environment (XSEDE)** supports a single virtual system and CI expertise through the Campus Champions. Schopf is the primary contact for this group and has arranged for EPOC to coordinate with their Campus Champion representatives for Roadside Assistance as needed. Meetings were held with the XSEDE leadership team and members of the Campus Champion team at the April CARRC workshop on Cyberinfrastructure Ecosystems and SC'19. Zurawski gave an online webinar [3] to the XSEDE Campus Champions in Region 7 (Northeast US). We presented a workshop on Deep Dives [21] and participated in a panel [22] at the PEARC'19 meeting.

5.C Science Community Partners

EPOC Science Community Partners each consist of a collaboration of scientists which we envisioned would enable us to scale our reach to larger community groups. However, as we end Year 2, we have found out that most of the small to medium sized teams on the campuses we have worked with to date are not heavily involved in these efforts. Most teams are working independently. Because of this, we are decreasing our coordination with several of the less responsive Science Community Partners, and instead will focus more strongly on the science collaborations identified through Consultations and Deep Dives.

For example, Arcadia University, the subject of an EPOC Deep Dive in April 2019, had passing familiarity with the GALAXY (https://usegalaxy.org) effort in that they utilized software developed by the group. Because they were not actively participating in contributing resources, or following regular status, they were unaware of other potential collaborations such as resource sharing. This could be tied to the fully distributed, and not heavily coordinated nature, of the virtual organization. Other larger VOs, such as the LHC experiments require much more in the way of contribution and coordination to fulfill scientific mission space. Participants at Baylor University and University of Cincinnati, both Tier3 sites for LHC science, directly benefited from LHC advancements (software, hardware recommendations) and actively contributed back resources (computational cycles and findings) despite no formal funding to do so.

The Year 2 Science Community Partners include:

- **The Earth Science Information Partners (ESIP)** is a consortium of over 180 members that provides a forum for the Earth science data and technology community. Moynihan is the primary contact point for this collaboration. Schopf met with current president, Karl Benedict, at the CNI meeting during Quarter 1 and discussed possible paths forward for collaboration. Moynihan presented a poster [23] on EPOC at the ESIP Summer Meeting in July. Schopf attended the Winter ESIP Meeting in Bethesda in January and spoke again with several ESIP leaders about how to be more involved.

- **The World Climate Research Programme's International Climate Network Working Group (ICNWG)** supports thousands of scientists through using the Earth System Grid Federation's (EGSF) globally distributed climate data repository sites. Zurawski and Eli Dart, LBNL/ESnet, share the contact point for this group. After two years of trying to engage this group, we feel it is unlikely to be able to make forward progress in a timely fashion. The participants have had significant cuts in base funding, and as such their activities have been limited due to decreased staffing. We will not continue to pursue this collaboration.

- **The IU Grand Challenge Precision Health Initiative** works with a broad set of precision health applications. Schopf is the primary contact for this team and is working with the IU Research Technologies team to re-establish contact. In Quarter 4, we reached out to them with a possible path forward involving using NetSage data to understand their data transfers. This conversation will continue in Year 3. If we are unsuccessful in defining a path forward, we are unlikely to continue to pursue collaborations with this group.

- **The University of Hawai'i System Astronomy Community** supports 15 facilities with hundreds of researchers and experiments every year. Southworth is the primary contact for this group, as they have also been collaborating with the IRNC NetSage team and support a NetSage Tstat deployment. In Quarter 1, the NetSage Tstat deployment for the main Hawai'i astronomy archive was completed and is now part of the collection of NetSage flow data dashboards. In addition, over the year, they contributed data to the NetSage Science Registry to get better coverage for the newly collected data. We also met at the TPRE meeting in January, and worked together for Consultation 57, which is ongoing and detailed further in Section 6.C.

- **The Midwest Big Data Hub (MBDH)** supports the use of data for a variety of applications and end users across twelve states. Southworth presented a poster [33] during their All Hands Meeting in October, 2019 and made contact with users who may be interested in assistance with data movement. We plan to participate in the All Hubs Meeting in Year 3, and hopefully to present at that meeting as we feel that there is potential to work with members on future projects but this will take significant evangelizing and contact points with the group which may or may not be feasible.

- **The Open Storage Network (OSN)** will support dozens of applications across a broad set of application domains. Southworth is the primary contact for this group. This group has made recent progress getting organized and EPOC staff attended their October All

Hands Meeting in Austin, TX. EPOC gave a briefing of activities and advised on some of the outcomes of recent Deep Dive activities that discussed storage requirements [32]. The in-person meeting was heavily focused on infrastructure (software and hardware) and had not progressed to the stages of usability. As such, this team does not have the focus area we had hoped to engage in, and we will not be pursuing this partnership in Year 3.

5.D External Partners

In addition to the partners that were named in the proposal, the EPOC team is coordinating with a number of additional groups.

The "Toward the National Research Platform" (TNRP) project (NSF #1826967), led by Larry Smarr and Tom Defanti, is tasked by NSF to stay in coordination with EPOC as both teams support the other CC* awardees. Current coordination is primarily taking place during the bi-weekly PRP/I2 Engagement calls, or when we jointly attend meetings. A meeting took place at the CC* PI meeting, and Smarr also participated in Schopf's panel on engaging with the NPEO awardees [28], and additional conversations took place at the PNWGP board meeting. We plan to continue this coordination in Year 3.

The EPOC External Advisory Board (EAB) members met in January 2020 (virtually) and were asked to offer feedback on key project goals, including:
- Reporting: How to make quarterly NSF reports more useful
- Roadside Assistance: State of tickets and possible improvements to the process going forward.
- Deep Dives: List of completed events and review of published material.

A meeting is scheduled for April 2020 to discuss actions from the prior meeting, as well as the ways that EPOC is adapting to meet the challenges and difficulties of a COVID-19 impacted world. Of particular interest to EPOC are feedback and experience that the committee can give regarding:
- Virtual meetings (training, lessons learned, etc.)
- Developing services that are 'low touch', but still serve a scientific/research community
- Challenges they are facing, and ways EPOC services (e.g. Deep Dives, Roadside, Training) can be adapted to address

EPOC is working with the CI Engineering Community (https://www.es.net/science-engagement/ci-engineering-brownbag-series/) to catalog the presented webinars from the Brownbag series held from 2017 to present. 70 webinars have been uploaded to the EPOC YouTube channel as of March 2020, and available online at: https://www.youtube.com/channel/UChIaulc1bccif1Dz4cfZl0w. A significant focus for 2020 was to create evergreen talks to educate the CI engineering community in common needs: e.g. routing policy, performance monitoring, system design, etc. EPOC continues to evaluate and

curate possible talks in this space, particularly as we all will change our travel and training behaviors due to COVID-19.

In addition, in Year 2, EPOC was asked to participate in future funding opportunities with a wide variety of partners, as signified by eleven Letters of Collaboration that were submitted as part or proposals to NSF programs CC* and CyberTraining. These requests were so numerous we now have a website directing people to common joint activities (https://epoc.global/proposal-collaborations/). We also consulted with several groups in the process of submitting project proposals. We will continue to provide both pre-proposal and post-award consultations as requested.

6. RoadSide Assistance and Consulting

A key aspect of the EPOC project is the operations center and process pipeline for immediate help, referred to as Roadside Assistance and Consulting. The Roadside Assistance and Consulting approach helps collaborators when data sharing failures occur, since these almost always involve multiple domains and organizations. More information about the Roadside Assistance and Consulting process is available at: https://epoc.global/wp-content/uploads/2019/04/Roadside-Assistance-Description.pdf. Hans Addleman is the lead for this effort.

6.A Activity Growth and Case Management

One of the focus areas for the February All Hands Meeting was to put in place additional tracking for Roadside Assistance and Consultation cases. The growth of these has been much larger than expected, and our success had outpaced our ability to track/report what was taking place in an effective manner. Because of this, we evaluated and implemented new ways to number, track, and report on tickets, which also simplifies the collection of metrics.
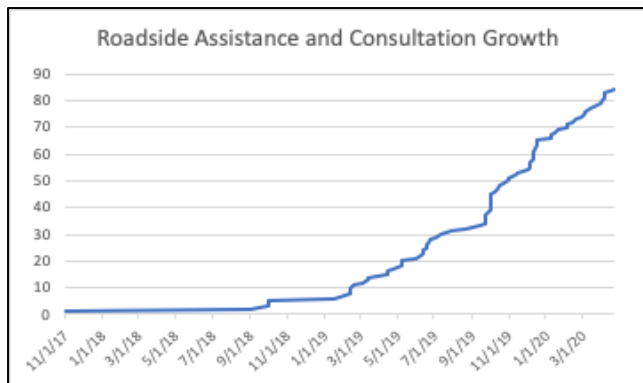

Figure 1: Growth of Roadside Assistance and Consultation cases since start of the activity.

Figure 1 shows the growth of the number of cases handled by EPOC staff in Years 1 and 2. In order to continue to support this effort, both IU and LBNL will be adding staff resources in Year

3. In addition, we are actively evaluating the need to pull in additional partner resources for specific topic areas, for example for the Zeek intrusion detection system or perfSONAR.

6.B Roadside Assistance Cases

In Year 2, we had one completed Roadside Assistance case:

- **27 - Iowa-NCAR:** A climate researcher at Iowa State University contacted us with poor performance when transferring real-time earth observation data files from an NCAR archive to Iowa State. Because of the real-time nature of the data, transfers on the order of at least 80Mbps were needed to keep up with the data flow, and at the time of contact the performance was only 32Mbps. The performance had been intermittently degraded at times over the last 2 years, but recently had become much worse. The researcher was using the NCAR Unidata Local Data Manager (LDM) to move the data, but replicated this behavior using FTP and HTTP. We engaged engineers at the Iowa State campus, engineers with the Great Plains Network (who support Iowa), and additional upstream providers, including NCAR. Iowa State deployed three additional perfSONAR nodes in different parts of their network to help diagnose the issue. Multiple changes were made to the campus, building, core, and wide area networks. One key finding was that the routing policy directed traffic onto a congested 10Gpbs link. The policy was updated so transfers would prefer the 100Gbps route with the regional provider (GPN) instead of the congested 10Gbps link, as well as other adaptations to the network. Overall, the changes improved the file transfer performance for the researcher to greater than 600Mbps. A summary of this Roadside Assistance Case was made available online [40].

In Year 2 Quarter 4, we had three ongoing Roadside Assistance cases:

- **59 - Saint Louis University to Amazon**: A biologist at Saint Louis University (SLU) experiencing very poor file transfer performance reached out to EPOC. Transfers from his office to Amazon's S3 cloud storage servers were so slow he was bringing disks home to upload from there to save time. SLU has outsourced much of its network support to an external contractor, which made finding the correct engineer to contact more challenging. Initial triage discovered that there were multiple firewalls in the path. In addition, some of the switches in the path had not been designed to support high-speed long-distance transfers and were also old enough to no longer be supported by the vendor. The biologist who initially reported the problems has set up several perfSONAR nodes for continued testing. EPOC continues to engage with the biologist, Missouri Research and Education Network (MOREnet), and the Great Plains Network (GPN) to debug this issue. During Quarter 4, the biologist left SLU and referred us to networking staff at the university and contractor for continued engagement. SLU contacts report they are currently in the middle of a campus network refresh and responses may be delayed.
- **71 - Texas Tech Weather Station Data Transfers:** Texas Tech University (TTU) has 130 weather stations spread across the western US that are connected online in a variety of ways, including cellular modem, cable modem, and standard campus

networks. They are polled every 2.5 minutes by two separate servers on the TTU campus and send back a few kilobyte data payload. On Thursday Dec 12th 2019 between twenty and fifty percent of the stations didn't respond between 11:50am-12:35pm and 2:50pm-3:35pm central time. This problem occurred every Thursday until February 13th. The intermittent and complex nature of the problem made it very difficult to troubleshoot. The only change made shortly before February 13th was that the original collection server was retired and replaced by new hardware running the same collection program. Due to the intermittent nature of this problem, we are holding this engagement open to ensure it does not recur on another Thursday for at least 10 weeks.

- **76 - NCAR/UCAR Multicast Performance:** NCAR/UCAR distributes scientific weather data from instruments and simulations to 250 consortium member institutions using the Local Data Manager (LDM). LDM is trying out a new version of their file transfer protocol that is based on UDP multicast for a 5-site testbed, including UCAR, University of Virginia (UVA), University of Wisconsin Madison (UW-M, University of Washington (UW) in Seattle, and University of California San Diego (UYCSD). In the current setup, UCSD and UCAR are having issues with packet loss when sending and receiving from the other three sites, and UW-M, UVA, and UW are able to transmit and receive data as expected from each other. Table 1 shows a chart of successful vs problematic data transfers across the 5 sites. Troubleshooting is ongoing between EPOC, engineers for each institution, and a suite of regional network engineers associated with the end points.

Table 1: Data transfers for RoadSide Assistance case #76 indicating successful versus problematic data transfers across the five-site testbed.

			Receiver				
			UCAR	UW-M	UVA	UW	UCSD
Sender	UCAR						
	UW-M						
	UVA						
	UW						
	UCSD						

6.C Consultation Cases

In Year 2, we had forty-six completed, thirteen ongoing consultations, and seven overtaken by events (OBE) consultations. The primary topics were Science DMZ architectures, data transfer strategies, and routing issues.

Completed consultations included:
- **04 - Colorado School of Mines:** EPOC staff members provided advice on perfSONAR, ScienceDMZ, firewall architecture, and switch buffers.

- **06 - Tribal Colleges:** Gil Gonzales reached out to EPOC for advice on deploying a small-scale Science DMZ for the Tribal colleges he is working with. This advice was used as input to a funding proposal.
- **07 - American Museum of Natural History (AMNH):** EPOC and ESnet staff discussed ScienceDMZ architecture and firewall configurations and determined that their performance issues were caused by an egress filter.
- **09 - Louisiana State University (LSU) Health:** EPOC staff had a call with staff members from LSU Health who are working on a proposal to seek funding for cyberinfrastructure training. Information was provided for the available training materials from the EPOC team.
- **11- Pacific Northwest National Laboratory (PNNL):** PNNL staff asked for assistance with a network performance assessment for external sites. This consultation was shifted in Quarter 4 to an ESnet internal engagement.
- **14 - Prairie View A&M University (PVAMU):** EPOC staff visited PVAMU along with LEARN engineers to discuss their CC* infrastructure design and tried to learn about their scientific drivers. LEARN continues to engage them to offer architectural help.
- **15- University of California Merced (UCM):** A professor who recently moved from the University of Massachusetts Amherst to UCM needed to transfer a large amount of bat CAT scan data from her old university to her new lab. EPOC worked with engineers at both locations to move the data efficiently.
- **17 - Franklin & Marshall College(F&M):** Staff at F&M reached out to EPOC with questions about top of the rack switches and buffering. EPOC and Pennsylvania State University (PSU) staff provided pointers and advice on what attributes to consider when designing a data center and what features to consider for a switch in this setting.
- **18 - Louisiana State University (LSU) Health:** EPOC provided templates for LSU to start work on internal Application Deep Dives independent of the EPOC team.
- **19 - Duquesne University:** EPOC provided advice and feedback on a new ScienceDMZ architecture. A meeting was held at PEARC'19 and additional requirements were discussed, followed by a call in September where the ScienceDMZ design was reviewed. There was additional discussion regarding lab testing, vendor selection, and buffer requirements.
- **20 - Vanderbilt University:** EPOC was asked about perfSONAR regular testing and its impact on network performance and consulted with staff from the perfSONAR development effort to fully address the question.
- **21 - University of Cincinnati (UC):** EPOC worked with UC engineers to define use cases and recommendations for file transfer nodes with help from Indiana University Research Technologies staff.
- **23 - Texas A&M University (TAMU):** Before the LEARN All Hands Meeting, EPOC staff met with researchers at TAMU. Some questionable routes were identified when evaluating a transfer between TAMU and University of Nebraska. After investigation with LEARN, the problems were discovered to be fully internal to the LEARN network, so the issue was handed off to their staff. If additional problems are found, we will revisit this issue.

- **24 - Indiana University (IU)-NOAA:** When the NetSage NOAA Tstat server was set up to collect statistics from a NOAA archive, an ongoing jumbo frame issue was discovered as part of the data flow between NOAA in Boulder and IU Bloomington. IU campus networks were contacted and several errors were corrected, with the penultimate one being a maximum transmission unit (MTU) mismatch within the campus network.
- **25 - University Of Wisconsin Madison (UWM):** A network researcher needed dark fiber for testing seismic reactions on data transmission through fiber. EPOC put him in touch with executives at the Oklahoma state network, OneNet, and the Great Plains Network (GPN). They will be working together to further this research.
- **28 - University of California Merced (UCM):** A UCM staff member contacted EPOC on behalf of a researcher who was having trouble downloading data sets from NASA Goddard. We worked with groups at NASA to facilitate a solution for a temporal network performance problem.
- **29 - Arcadia:** After the May Deep Dive, KINBER staff, on behalf of Arcadia University, contacted EPOC and ESnet staff to better understand possible choices in border routers. EPOC staff offered suggestions for a requirement evaluation to enable KINBER and Arcadia to make this selection.
- **30 - South African National Research Network (SANReN):** A network engineer from SANReN contacted ESnet and EPOC staff with questions about asymmetric performance behavior across a switch and how best to configure a DTN. Configuration suggestions were offered and the problem was resolved.
- **31 - Trinity:** In a follow-up to the Trinity Deep Dive, the IT team and a local researcher contacted EPOC for assistance on network-attached storage devices. Two solutions were proposed: one that was scalable for long term use but more expensive and a second that was less expensive but unlikely to scale past the initial needs. The university will make a choice based on the available funding and prepare for submission of a CC* proposal.
- **32- Ohio Supercomputing Center (OSC):** OSC stood up a new perfSONAR node in August and requested that they be added to the Large Facilities ESnet perfSONAR dashboard. A number of routing anomalies and MTU issues were keeping performance low. EPOC brought together perfSONAR developers, ESnet engineers, and OARnet engineers to resolve the routing issues and the performance improved to near 10 Gbps.
- **33- American Museum of Natural History (AMNH):** EPOC staff were contacted about problems setting up perfSONAR tests between AMNH and NyserNet. The perfSONAR tools were missing from the NyserNet data transfer node. After the tools were installed, tests were set up successfully.
- **34- University of Michigan (UM):** EPOC staff were contacted by a researcher at UM to discuss their NetBasilisk security project to better understand any data transfer implications. EPOC staff brought in experts from Trusted CI to assist with the evaluation. UM researchers reported that they have the information needed to proceed.
- **36 - Prairie View A&M University (PVAMU)**: EPOC staff followed up with PVAMU after an initial engagement in mid-2019. PVAMU requested a follow-up call to discuss Science DMZ network design, which included specific questions about perfSONAR,

Science DMZ switch selection, and Zeek. After the call, PVAMU was provided with documentation.

- **37- University of North Carolina Greensboro (UNCG):** As part of their Science DMZ redesign, UNCG engineers contacted EPOC staff for feedback on their designs and options for both a DMZ and a possible DTN deployment. Discussions also explored options with intrusion detection systems. UNCG reports that they have plans set based on our consultations and are waiting on equipment deliveries.
- **38 - University of Michigan (UM):** A network researcher from UM reached out to EPOC for guidance on building HIPAA compliant Science DMZ. EPOC engineers brought in a Trusted CI resource who shared some information about specialized Medical DMZ's.
- **39 - American Indian Higher Education Consortium (AIHEC) / Network Startup Resource Center (NSRC):** EPOC Staff met AIHEC staff at the CC* PI meeting and sent an introduction to EPOC email and informed them we were available to help. No action was needed at this time.
- **42 - Pennsylvania State University (PSU)**: A network engineer at PSU contacted EPOC for advice on setting the MTU on his DTNs and ScienceDMZ. EPOC staff, consulting along with members of TACC with related expertise, advised to always set MTU to its largest possible setting on switching and server infrastructure to allow for Jumbo frames and more efficient file transfers and pointed to the documentation on fasterdata.es.net.
- **43 - Massachusetts Green High Performance Computing Center (MGHPCC):** EPOC staff answered questions about using the cyberinfrastructure engineering (CI-ENG) email list for the Ask.CI "Questions of the week". Permission to use the list was granted. In addition, MGHPCC staff agreed to present on the weekly CI-ENG call.
- **45 - Wayne State:** EPOC staff met Wayne State staff at the 2019 CC* PI meeting and sent an introduction to EPOC email and informed them we were available to help. No action was needed at this time.
- **46 - University of Wisconsin (UW):** A UW network engineer reached out for advice on right sizing switch buffers in a ScienceDMZ. EPOC staff consulted and recommended using switches with deeper buffers than they had originally planned when connecting to the campus DTNs.
- **47 - University of Central Florida (UCF):** UCF engineers reached out for a Science DMZ consultation that included discussions of supporting Federal data controlled by the Federal Information Security Management Act (FISMA), as well as working with data identified as Controlled Unclassified Information, which is regulated by the Defense Federal Acquisition Regulation Supplement (DFARS) guidelines. EPOC staff brought in experts from Trusted CI to assist and UCF has applied for a separate Trusted CI engagement.
- **49- Arizona State University (ASU):** The ASU network architect reached out to EPOC staff to discuss smaller 1G or 10G based DTNs. EPOC supplied the requested information. ASU decided to pursue a solution that will be provided by FRGP.
- **52- University of Montana (UM):** As part of a CC* proposal submission, staff from UM consulted EPOC staff on ScienceDMZ architecture, DTNs, network hardware

specifications, and management networks. UM submitted the proposal with modifications based on the consultation.

- **53- CalTech:** The CIO of CalTech asked EPOC to review their upcoming research network / ScienceDMZ. EPOC staff participated in multiple calls and provided input on a wide range of topics including ScienceDMZs and the evaluation of switching hardware for high speed file transfers.
- **54 - Globus:** A Globus developer asked questions about interactions with perfSONAR at an operating system level. EPOC staff put them in touch with perfSONAR developers who answered their questions.
- **55- University of Montana (UM):** Engineers at UM inquired about the availability of the EPOC Viavi Network Testing Device. They will contact us in the future when their lab is ready for testing.
- **56- University of Montana (UM):** Engineers at UM contacted EPOC staff as part of their preparation for submitting to the NSF CC* program to get information about using Zeek. EPOC staff connected them with Trusted CI, OmniSOC, and a security engineer from the Indiana University Security Office for further information.
- **60- University of South Carolina (USC)**: EPOC staff are working with a professor in the College of Engineering and Computing at USC to review the BGP training material and hands-on lab exercises he has developed. These labs will be used in college-level networking classes and also by the R&E networking community to learn BGP fundamentals and best practices. We reviewed the training material and discussed possible future additions. Engineers from the community will help review the labs moving forward.
- **61 - University of Missouri (UM):** The Director of Research Computing Support Services at UM sent a question to EPOC about installing perfSONAR nodes in wiring closets. EPOC staff suggested they email the question to the cyberinfrastructure engineer list for community discussion.
- **63 - National Oceanic and Atmospheric Administration (NOAA):** NOAA staff reached out to EPOC to request help and materials to run their own Deep Dive. EPOC staff provided materials and guidance. Their first Deep Dive is scheduled for May 5-7, 2020. EPOC will track progress and help if requested.
- **64 - University of Southern California (USC):** USC staff asked for guidance on selecting a ScienceDMZ as part of their preparation for submitting to the NSF CC* program. EPOC held two calls with their staff and provided a Letter of Collaboration for possible future EPOC-led training for Deep Dives.
- **65 - Kansas Research and Education Network (KanREN)**: An engineer with KanREN shared their CC* project summary and asked for a letter of collaboration. EPOC provided a Letter of Collaboration.
- **66 - Baylor:** EPOC discussed performance differences between running PerfSONAR in a virtual machine or on a bare metal server with engineers from Baylor University.
- **68 - University of Cincinnati (UC)**: The associate director for Research Computing at UC asked for Open Science Grid (OSG) contact information. EPOC provided introductions and they are working together to add HPC resources from UC to the OSG offerings.

- **70 - Duquesne University:** EPOC engineers discussed best practices for using perfSONAR and network testing hardware to test evaluation hardware from vendors. Duquesne plans to request a loan of the Viavi Testset in Quarter 1 of Year 3.
- **79 - Massachusetts Institute of Technology (MIT):** Network latency researchers at MIT asked for a list of physical locations for various ESnet equipment. EPOC put them in touch with ESnet engineers.

Ongoing Consultations in Quarter 4 included:
- **35 - Kent State University (KSU)** - KSU engineers reached out to EPOC staff for feedback on their draft plans of their upcoming network redesign (including equipment options) and performance issues with their current DTN. A discussion followed that included examining possible issues with buffering and better understanding their use cases. This consultation is ongoing and will be picked up during Year 3 Quarter 1 as KSU configures equipment and works with their Internet Service Provider to bring up new links.
- **50 - Mississippi State University (MSU):** MSU staff are interested in doing a Deep Dive or an EPOC-lead Deep Dive Training Event in Year 3 and have reached out to discuss options. We will engage again in Year 3 Quarter 1.
- **51 - Kent State University (KSU):** KSU engineers inquired about borrowing the EPOC Viavi Network Testing Device in early 2020. They will follow up when their deployment is ready for testing.
- **57 - University of Hawaii (UH):** UH Astronomy staff are seeing poor file transfer performance to and from the Ohio State University (OSU). UH network engineers are working jointly with EPOC staff to troubleshoot the UH DTNs for configuration errors.
- **62 - Lonestar Education and Research Network (LEARN):** LEARN engineers are asking for help designing a low cost but powerful DTN. They are currently reviewing the information EPOC staff have provided them and will get back to us with additional information and questions.
- **67 - Veterans Administration (VA):** EPOC and ESnet staff discussed via a video call and email the basics of SDN with engineers from the VA. The FAUCET SDN and Network to Code teams were also engaged. We are following up in Year 3 Quarter 1 to ensure all questions have been resolved.
- **69 - University of Texas San Antonio (UTSA):** EPOC and UTSA staff discussed ScienceDMZ architecture, possible bottlenecks, policy, security, and the effect of switch buffer sizes on data transfers. We are following up in Year 3 Quarter 1 to ensure all questions have been resolved.
- **72 - Great Plains Network Cyber Team:** EPOC staff met with the newly funded GPN CyberTeam awardees to give an overview of the EPOC project, the Roadside Assistance and Consulting process, and information on the upcoming University of South Dakota Deep Dive, and roadside process. We are following up in Year 3 Quarter 1 to ensure all questions have been resolved.
- **73 - Duquesne University:** Engineers from Duquesne and EPOC staff discussed testing methodologies for equipment loaned by vendors for evaluation of the Duquesne ScienceDMZ use cases. We also discussed the Viavi test sets that EPOC can loan for

evaluation and network troubleshooting. When Duquesne staff can return to campus, they will request a loan of the testset.

- **74 - Allen Institute (AI):** EPOC exchanged emails with a systems engineer at the Allen Institute about the basics of ScienceDMZ architecture, network hardware, and file transfer nodes. The systems engineer is interested in further engagement, however, he is currently busy working through the pandemic.
- **75 - Reed College (RC):** A researcher at RC was writing a grant for a high-end microscope that produces 4TB datasets. EPOC answered questions on file transfer nodes, Globus, and ScienceDMZ. The proposal was submitted in early March. We are following up in Year 3 Quarter 1 to ensure all questions have been resolved.
- **77 - Compute Canada:** EPOC and ESnet staff consulted with Compute Canada about Zeek architecture, switch characteristics, server decisions, and storage requirements. We are following up in Year 3 Quarter 1 to ensure all questions have been resolved.
- **80 - University of Central Florida:** EPOC met with a researcher at UCF who had previously developed a test for Zika and wants to use a similar test for COVID-19. This test should assist in asymptomatic testing and data collection. We discussed strategies for data movement, storing, sharing, and visualization. EPOC will follow up in Q1 of year 3 for further engagement.

When a consultation does not respond to multiple attempts to move it forward over a 6+ week time frame, we consider those consultations Overtaken by Events (OBE). In Year 2, OBE Consultations included:

- **10 - South African National Research Network (SANREN) (2/14/19-12/30/19):** EPOC received a report of poor file transfer performance from Wits University in Johannesburg, South Africa, to John Hopkins University and the American Museum of Natural History from an engineer at SANREN. EPOC staff and the SANREN engineer tried more than 10 times to contact the engineers or researchers at Wits University but did not receive any replies, so were unable to troubleshoot the issue.
- **12 - Washington State University (WSU) (3/6/19-7/1/19):** EPOC staff have been discussing perfSONAR best practices, achievable real world bandwidth results, and expectation level setting with WSU engineers. Multiple attempts were made to contact the engineers to continue the engagement, however, no response was received.
- **26 - University of Wisconsin (UW)-Michigan State University (MSU) (6/18/19-12/30/19):** Users moving data from University of Wisconsin in Madison, WI, to Michigan State University in East Lansing, MI, contacted EPOC staff for assistance in resolving poor performance for some data transfers. EPOC started a dialog between engineers at both universities, and the initial investigation revealed some odd routes between the two sites. Six attempts were made to contact the engineers to resolve this issue, but they stated they did not wish to pursue troubleshooting at this time.
- 40- Alabama A&M University (AAMU) (10/2/19-12/18/19): EPOC staff met with AAMU staff at the NSF CC* PI meeting where assistance was requested but not for a specific problem. EPOC staff sent additional introductory information, but no response was received for any specific assistance needs after 4 tries.

- **41- University of California, Davis (UCD) (10/2/19-12/6/18):** EPOC staff met with UCD staff at the NSF CC* PI meeting where assistance was requested but not for a specific problem. EPOC staff sent additional introductory information, but no response was received for any specific assistance needs after 4 tries.
- **44- American Museum of Natural History (AMNH) (10/2/19-2/19/20):** Engineers from AMNH contacted EPOC to work with staff at University of California San Diego (UCSD), Caltech, and AMNH to determine the best way to transfer data from a remote telescope to a DTN at the bottom of the mountain and on to researchers. The engineer asked to pause the discussion over the winter holidays, however, they have not responded to multiple requests to pick up troubleshooting since.
- **48- North Dakota State University (NDSU) (10/16/19-2/25/20):** NDSU staff reached out to request more information on the EPOC Deep Dive process and possible training opportunities. A call was held to discuss options in October and NDSU asked that we get back to them in Quarter 4 to discuss scheduling options. However, they have not responded to multiple additional requests for engagement.
- **58- Ocean State Higher Education Economic Development and Administrative Network (OSHEAN) (12/10/19-3/25/20)**: OSHEAN reached out to EPOC staff at the Internet2 Technology Exchange conference and asked that EPOC consult on training and provide materials in Year 3. There was no response to repeated requests for engagement.

6.C Year 3 Plans

The Roadside Assistance and Consultation program is well positioned to continue work during the pandemic. The program makes use of video conferencing, email, and shared google documents that allow for virtual interactions and rarely requires in person interaction. Already in Year 3 we have met with one researcher working towards a solution for COVID-19 and we plan to continue making our services available and prioritize related work.

Year 3 work for Roadside Assistance and Consultations will also focus on communicating lessons learned and best community practices more broadly. This will include not only updates to http://fasterdata.es.net, but also additional in-depth write ups for common questions and materials online. Note adaptation of the Roadside Assistance and Consultation process was included as part of several submissions to the NSF International Research Network Connections (IRNC) program.

6.E Metrics

Table 2: A summary of Year 2's Roadside Assistance and Consultation Cases. Green rows are completed, orange rows are OBE, and no color indicates an ongoing case.

ID	Main site	EPOC Partner	Type	Start Date	End Date	Area of request	Asked by: Eng, Sci(entist), O(ther)	Science Domain	Primarily R(ch), E(du), O(ther)	Size S, M, L
04	Mines	FRGP	C	10/3/18	8/14/19	PS, DMZ, arch	Eng	Infra	R	S
06	Tribal	FRGP	C	1/17/19	5/1/19	DMZ	O	Infra	E	S
07	AMNH	-	C	2/5/19	7/9/19	Trans perf, DMZ, Security	Eng	Infra	O	-
09	LSU Health	-	C	2/13/19	4/1/19	Grant, Train	Eng	Med	E	L
10	SANReN	-	C	2/14/19	12/30/19	Trans Perf	End	infra	O	-
11	PNNL	ESnet	C	2/19/19	3/25/20	NW Asmt	Eng	Infra	R	L
12	WSU	GPN	C	3/6/19	7/1/19	PS	Eng	Infra	E	L
14	PVAMU	LEARN	C	3/15/19	5/5/19	Arch	Eng	Infra	E	S
15	UC Merced	-	C	4/15/19	12/17/19	Trans Perf	Sci	Bio	E	L
17	F&M	KINBER	C	4/25/19	4/29/19	Arch, DTN	Eng	Infra	E	M
18	LSU Health	-	C	5/9/19	5/13/19	Deep Dive	Eng	Med	R	L
19	Duquesne	KINBER	C	5/10/19	11/6/19	DMZ	Eng	Infra	E	S
20	Vanderbilt	-	C	5/10/19	5/10/19	PS	Eng	Infra	E	L
21	UCinn	OARnet	C	5/31/19	8/7/19	Trans Perf	Eng	Infra	E	L
23	TAMU	LEARN	C	6/14/19	12/11/19	Routing	Eng	Infra	E	L
24	IU-NOAA	iLight, FRGP	C	6/14/19	9/11/19	Trans Perf	Eng	Infra	E	L
25	Uwisc-OneNet	GPN	C	6/18/19	6/22/19	Research	Sci	Geo	R	L
26	UWisc-MichSU	-	C	6/18/19	12/30/19	Trans Perf, Routing	Eng	Bio	E	L
27	Iowa-NCAR	GPN	RA	6/21/19	10/3/19	Trans Perf	Sci	Geo	E	L
28	UCM	-	C	6/24/19	7/18/19	Trans Perf	Eng	Geo	E	L
29	Arcadia	KINBER	C	7/3/19	7/12/19	Arch	Eng	Infra	E	S
30	SANReN		C	7/31/19	8/15/19	DTN, Arch	Eng	infra	O	-
31	Trinity	LEARN	C	7/12/19	8/28/19	DTN	Eng	Infra	E	S

32	OSC	OARnet	C	8/21/19	11/4/19	Trans Perf	Eng	Infra	E	L
33	AMNH	-	C	9/16/19	11/8/19	PS	Eng	Infra	O	-
34	UMich	TrustedCI	C	9/24/19	2/12/20	Research	Sci	CS	R	L
35	Kent	OARnet	C	9/24/19		DTN	Eng	Infra	R	S
36	PVAMU	LEARN	C	9/24/19	2/5/20	DMZ, PS, IDS	Eng	Infra	E	M
37	UNCG	-	C	9/24/19	2/10/20	DMZ, DTN	Eng	Infra	E	S
38	UMich	TrustedCI	C	9/25/19	12/17/19	HIPPA DMZ	Sci	CS	R	L
39	AIHEC	-	C	10/2/19	11/7/19	Intro	O	-	E	S
40	AAMU	-	C	10/2/19	12/18/19	Intro	Eng	infra	E	L
41	UCDavis	-	C	10/2/19	12/6/19	Intro	Eng	Infra	E	L
42	PSU	KINBER	C	10/2/19	10/21/19	DTN, DMZ	Eng	Infra	E	L
43	MGHPCC	-	C	10/2/19	10/2/19	CI-Eng	Eng	Infra	O	-
44	ANMH	-	C	10/2/19	2/19/20	Trans Perf	Sci	Astro	O	-
45	Wayne		C	10/3/19	11/6/19	Intro	O	-	E	L
46	UWisc	-	C	10/9/19	11/6/19	DMZ	Eng	Infra	E	L
47	UCentralFL	TrustedCI	C	10/15/19	10/30/19	Security	Eng	Infra	E	L
48	NDSU	GPN	C	10/16/19	2/25/20	DD, Training	Eng	Infra	E	L
49	ASU	FRGP	C	10/23/19	10/24/19	DTN	Eng	Infra	E	L
50	MissState	GPN	C	11/1/19		DD, Training	Eng	Infra	E	L
51	Kent	OARnet	C	11/1/19		Tester	Eng	Infra	R	S
52	UMontana		C	11/11/19	2/10/20	DMZ	Eng	Infra	E	L
53	Caltech	-	C	11/14/19	2/25/20	DMZ, DTN	Eng	Infra	E	S
54	Globus	-	C	12/3/19	12/4/19	PS	Eng	Infra	O	-
55	UMontana		C	12/5/19	2/11/20	Tester	Eng	Infra	E	L
56	UMontana	TrustedCI	C	12/5/19	2/10/20	IDS	Eng	Infra	E	L
57	UHawaii	HI Astro, OARnet	C	12/6/19		Trans Perf	Sci	Infra	E	L
58	OSHEAN	-	C	12/10/19	3/25/20	Training	Eng	Infra	O	-
59	SLU-Amazon	GPN	RA	12/11/19		Trans Perf	Sci	Bio	E	S
60	USCal	-	C	12/12/19	2/11/20	BGP, Training	Eng	Infra	E	L
61	UMissouri	GPN	C	12/12/19	12/12/19	PS	Eng	Infra	E	L
62	LEARN	LEARN	C	12/13/19		DTN	Eng	Infra	O	-
63	NOAA	FRGP	C	12/16/19	2/11/20	DD	Eng	Infra	O	-
64	USCal	-	C	12/16/19	2/10/20	DMZ, DD	Eng	Infra	E	L
65	KanREN	GPN	C	12/18/19	1/13/20	Grant	Eng	Infra	O	-

66	Baylor	LEARN	C	1/9/20	3/11/20	PS	Eng	Infra	E	L
67	VA	-	C	1/9/20		SDN	Eng	Infra	O	-
68	UCinn	OARnet	C	1/14/20	1/28/20	OSG	Eng	Infra	E	L
69	UTSA	LEARN	C	1/21/20		DMZ, Security	Eng	Infra	R	L
70	Duquesne	KINBER	C	2/6/20	2/6/20	PS	Eng	Infra	E	S
71	Texas Tech	LEARN	RA	2/6/20		Trans Perf	Eng	Climate	E	L
72	GPN	GPN	C	2/13/20		Intro, DD	Eng	Infra	E	L
73	Duquesne	KINBER	C	2/20/20		Tester	Eng	Infra	E	S
74	Allen Inst		C	2/28/20		DMZ, DTN	Eng	Bio	R	S
75	Reed	XSEDE	C	3/5/20		DMZ, DTN, Globus	Eng	Bio	E	S
76	NCAR	FRGP	RA	3/6/20		Trans Perf	Eng	Climate	R	L
77	Comp CA		C	3/13/20		IDS	Eng	Infra	R	L
79	MIT	ESnet	C	3/25/20	3/25/20	ESnet	Eng	Infra	E	L
80	UCentralFL		C	3/31/20		Arch	Eng	Bio	R	L

7. Deep Dives

Deep Dives aim to understand the full research pipeline for collaborative teams and suggest alternative approaches for the scientists, local CI support, and national networking partners as relevant to achieve the long-term research goals via workflow analysis, storage and computational tuning, and identification of network bottlenecks. We have adapted the ESnet facilities approach for work with individual science groups, which is documented at: https://epoc.global/wp-content/uploads/2019/04/Application-Deep-Dive-Description-1.pdf. Jason Zurawski is the lead for this area.

Several EPOC Deep Dive reports were completed this year, with only two remaining to be published from Project Year 2. We note that some of the Deep Dive events were primarily meant as training exercises to demonstrate the Deep Dive technique to an audience, while others were localized for specific campuses to work directly with their researchers, often to give feedback to higher administrators about general CI needs.

7.A Completed Application Deep Dives

The following Deep Dive activities are complete and published:
- **KINBER and Arcadia University**: KINBER requested a Deep Dive training event for their annual meeting, using an example from Arcadia University related to bioinformatics research. During the session, the research team highlighted the ongoing challenges that they have supporting a class that involves accessing data from a remote data source and using remote Galaxy compute resources. The lack of available local compute and

storage resources meant that they could not fully demonstrate modern research techniques with students. Several updates to the campus cyberinfrastructure were identified, including a DMZ that is supported by recent NSF funding. The final report was published in July, 2019 [16]. Consultation 29 resulted from this Deep Dive.

- **OARnet and University of Cincinnati:** OARnet, with member institution University of Cincinnati (UC), requested an on-site campus-wide Deep Dive at UC to focus on several campus science drivers. EPOC staff traveled to Cincinnati, OH, in April and worked with researchers from high energy physics, medicine and bioinformatics, mathematics, aerospace, and criminal justice. The final report was published in November 2019 [37].
- **GPN and Kansas State University:** The Great Plains Network requested an EPOC Deep Dive training event, to take place their annual meeting, to take place with an agronomy researcher. The driving factor behind the research was the likely upcoming food scarcity due to changing climate. The team was measuring a broad set of environmental variables for actual crops and then working with a variety of researchers who build models to estimate likely outcomes. Identified pain points included challenges with storage and changing file formats, which made sharing the data more challenging. The final report was published in November 2019 [39].
- **LEARN and Trinity University:** LEARN, with member institution Trinity University, requested a campus-wide Deep Dive to focus on several campus science drivers. LEARN and Trinity were planning for an upcoming grant submission, and wanted assistance understanding the CI needs for researchers in geology, classical studies, archaeology, computer science, biology, physics, and neuroscience. They found that almost all of the researchers had strong storage requirements that were not being met with existing technology, and that computation resources were currently sufficient but would require growth in the coming years. The final report was published in November 2019 [36]. Consultation #31 resulted from this Deep Dive.
- **Purdue University:** Purdue University requested a campus-wide Deep Dive training event, focusing on two emerging use cases involving high-performance computing resources on campus - both from the college of agriculture with a focus on biology. One goal of this review was to perform many steps in front of a number of research and IT staff so that university staff could repeat the approach with other researchers. We found that the strongest concern was that the research storage support was lacking for the two profiled groups. Purdue research computing has the technology and support staff to supply the researchers needs, however the gap that was identified was in working with the researchers so they could better understand the time/technology investment would be worth the time away from their core research. The final report was published in November 2019 [38].
- **PEARC 2019:** EPOC performed a Deep Dive training event at PEARC 2019 in Chicago, Illinois on July 29, 2019 [21]. EPOC profiled the work completed at Purdue University as the research profile by discussing bioinformatics. No additional report will be generated.

7.B In Progress Application Deep Dives

There are two ongoing Deep Dive reports that are expected in Year 3:
- **University of Wisconsin:** The University of Wisconsin requested a campus-wide Deep Dive to assist campus leadership in understanding upcoming CI needs by researchers in high energy physics, space sciences (including support for several NASA and NOAA missions), polar studies (including the IceCube project), bioinformatics, and high throughput computing. The findings of this report are still being drafted but focus on the need for upgraded science DMZ networking, research support for computing and storage, and a more frequent review of science drivers campus-wide. The final report was shared with university staff in January, and we are awaiting their edits.
- **LEARN and Baylor University:** In June 2019, EPOC began a conversation with Baylor University about a campus-wide Deep Dive to be jointly run with the LEARN regional network. This event occurred January 6-7 2020 in Waco TX. The findings of this report are still being drafted but focus on a growing number of data-centric use cases, all of which are heavy users of campus and regional HPC/HTC resources, will help to justify future networking requirements.

7.C Related Activities

With six completed Deep Dives this year, we are now using a set of data regarding CI preparedness at this set of institutions to help us scope future activities. This will include documenting:
- Best common practices (BCP) for how these institutions support specific kinds of research;
- Lessons learned, both positive and negative, for research and technology intersections;
- Common technology gaps; and
- Emerging trends for scientific and research use cases.

The first discussion of these points was held at the Quilt Winter Meeting in February 2020. The roundtable discussion helped to motivate potential services that the R&E networking community had been considering. This documentation, when complete, will be published and shared with the greater R&E community to better influence the design and support strategy that technology can offer to R&E use cases.

7.D Year 3 Plans

Deep Dive planning typically involves a series of meetings and conversations over several months with the target institutional leadership and research community. After the event, the EPOC team, joint with the participants, produces a report of the events that can be used by the campus and/or regional network to influence future directions of technology support.

The outbreak of COVID-19 in March, 2020, resulted in significant additional workload for our Regional Networking partners and their member institutions to support required (and unplanned)

distance learning, in addition to the requirement to work from home and restrictions on travel. This has resulted in a radical shift for our planned Deep Dives in Year 3. The three Dee4p Dives that had started planning activities at the end of Year 3 include:

- **Arizona State University / Sun Corridor Network**: In August, 2019, Arizona State University reached out to EPOC to host a potential Deep Dive of campus and regional requirements to take place during Spring, 2020, now tentatively scheduled for January 2021. The previously separate Northern University event has been combined with this event.
- **University of Central Florida (UC)**: Staff from UCF approached EPOC to stage a Deep Dive for the campus, now tentatively scheduled for Fall 2020.
- **University of South Dakota (USD)**: Staff from USD approached EPOC to stage a Deep Dive for the campus, now tentatively scheduled for November 2020.

Additional discussion surrounding to other events started, but due to the pandemic have been stalled indefinitely:

- **Oregon State University:** In April 2019, members of Oregon State University contacted EPOC staff about a possible EPOC Deep Dive to profile their campus research and the regional network for the state, LinkOregon. Dates and focus areas were discussed but have stalled due to COVID-19.

EPOC has begun a number of conversations internally, with community members, and with our advisory board, to evaluate strategies to adjust our approach to Deep Dives in light of the current restrictions. We are considering experimenting with one-on-one Deep Dives, more limited in scope, via video conferencing. consultations over video conferencing, however the Deep Dive process has always relied heavy on the synergies that occur when CI engineers and researchers are in the same room, so it is unclear how successful this approach will be. In any case, we will continue to create additional training materials, including but not limited to video discussions, lecture materials, and templates, that can be adopted by campus or regional network staff to conduct Deep Dive interviews on their own.

7.E Metrics

*Table 3: Metrics for Deep Dive activities in Year 2. All * dates are tentative.*

Meet Date	Appl name	Public/ Private	Audience	Offered or Req	Head Count	Issues Identified	Complete Date
4/3/19	Arcadia Univ Bioinformatics	Pub	KINBER staff & members	Req	9	Storage, computation, training	11/1/2019
4/26/19	University of Cincinnati - 6 Use cases	Priv	University of Cincinnati faculty & staff, OARnet staff	Req	28	Storage, computation, local networking, data privacy	11/2/2019
5/21/19	KSU Agronomy Research	Pub	GPN staff, GPN AHM attendees, KSU faculty & staff	Req	36	Connectivity, workflow assistance	11/11/2019

5/29/19	Trinity University - 5 Use cases	Priv	Trinity University faculty & staff, LEARN staff	Req	16	Storage, local networking, computation	11/1/2019
5/31/19	Purdue University- 2 Use cases	Pub	Purdue University faculty & staff	Req	39	Storage, workflow assistance	11/1/2019
6/17-19/19	University of Wisconsin- 10 Use cases	Priv	University of Wisconsin faculty & staff	Req	24	Storage, workflow assistance, performance problems	Expected Y3Q1
7/29/19	PEARC	Pub	PEARC19 Attendees	Off	15	Training exercise	No report
1/6-7/20	Learn, Baylor - 7 Use Cases	Priv	LEARN staff & Baylor faculty and staff	Req	25	Campus capacity upgrades, storage, wide-area data transfer assistance	Est. Y3Q1
Fall 2020*	Univ Central Florida	Priv	University Researchers & Staff, Florida Lambda Rail	Req			
11/20*	Univ South Dakota	Priv	Staff from GPN, USD, SDSU, Black Hills State, and other guests	Req			
1/21*	Arizona State Univ, Sun Corridor	Priv	ASU, UofAZ, NAU, and Sun Corridor Network staff	Req			
On hold	Oregon State Univ	Priv	TBD	Req			

8. NetSage Deployments and Analysis

Understanding application performance and network measurement are two sides to a single coin - one doesn't make sense without the other. The EPOC project uses the NetSage tool (http://www.netsage.global) to collect and evaluate common network measurement data. The initial NetSage software was developed and deployed on the NSF-funded international networks. It was meant to work with sparse, international circuits, and for end users primarily consisting of circuit owners and operators. EPOC has expanded the use of this software to work with more densely defined networks and to support additional analysis and visualizations, and data for all of the NetSage deployments are now available online at http://all.netsage.global. More information about NetSage and EPOC is online at https://epoc.global/wp-content/uploads/2019/09/Network-Analysis-2-pager.pdf. Jennifer Schopf and Dan Doyle jointly lead this activity.

8.A Current Status

Different components of NetSage can be deployed in different ways, depending on the requirements of the customer. This quarter, the NetSage development team released NetSage 1.2.0, which was deployed on all of the EPOC partner deployments. NetSage 1.2.0 included

better linking between dashboards to ease navigation as well as a general cleanup and unifying of the look and feel of the dashboards.

The status of the current deployments for NetSage network-related dashboards for the EPOC partners includes:

- **Great Plains Network:** The NetSage SNMP dashboard for the GPN associated circuits (http://gpn.netsage.global) was initially deployed in October, 2018, and remains stable and supported. Discussions are ongoing to extend the deployment to include flow data collection, although this will likely not move forward until Year 3 due to GPN's preference that a containerized approach be used for the data gathering. In late December 2019, the links and map data were updated to account for hardware changes made to GPN's core router.
- **iLight/Indiana GigaPop:** Flow data collection for the five Indiana GigaPop routers began in mid-April, and a dashboard was presented to iLight members at their All Hands Meeting in May 2019. This is publicly available at http://ilight.netsage.global.
- **KINBER:** After some discussions earlier in the year with KINBER management, including at the CC* PI meeting, collection of flow data for the PennREN network began at the end of October 2019. The dashboard was presented to KINBER engineers and approved to go public in mid-November. This data is publicly accessible at https://pennren.netsage.global/. A training session was provided for KINBER staff in January 2020 to better familiarize them with the newer capabilities and to answer questions they had.
- **LEARN:** At their All Hands Meeting, LEARN staff expressed an interest in moving forward to deploy NetSage for the state of Texas network. At SC'19, it was decided this activity would need to wait until the new CEO came on board, which is expected for early 2020.
- **FRGP**: The FRGP Technical Advisory Board approved the sending of de-identified flow data to the NetSage Archive in December 2019. A VPN connection between Indiana University and the FRGP collection point was successfully established and flow data started being collected. Work on the NetSage instance was completed in mid-January 2020 and shared back with shareholders at FRGP. This data was made public in early February and is now publicly accessible at https://frgp.netsage.global/. Conversations have started about expanding data collection to include SNMP based link utilization and are expected to continue into Year 3.
- **OARnet**: OARnet is expected to hire a new CEO to start in early 2020. At that time, discussions of a NetSage deployment for the state of Ohio network will take place.

The Archive site deployment is funded by the NSF IRNC NetSage project but is also being used by the various EPOC partners. NetSage uses a software package called Tstat to collect flow data as well as retransmits from the archives. The deployments include:

- **TACC/LEARN:** The TACC deployment remains active, though sometimes requires working with them to restart it based on changes in their environment. No major changes have been made on the EPOC side and this work is running in a stable state.

- **University of Hawai'i Astronomy:** A temporary installation of Tstat for the Astronomy archives was replaced with a permanent solution early in Year 2. The data is now being fed to the various flow dashboards. This work is running in a stable state.
- **NOAA/FRGP:** NOAA deployed the Tstat software to the head node of a backup archive at NOAA Boulder early in Year 2, and that data was fed to the appropriate dashboards. There were originally some discussions to extend this deployment to additional science archives as it was only on a backup site, but these conversations have been pushed back into Year 3 with changing of staff and priorities. The existing deployment has been shut down due to lack of use of the node.
- **NCAR/FRGP:** A Tstat archive was sent to the lab at NCAR's site in Wyoming in early 2019 and was up and running in July. It has since been running and providing data stably. This work is running in a stable state.
- **National Energy Research Scientific Computing Center (NERSC):** NERSC was the first deployment for IRNC NetSage and the Tstat software. This archive is widely used internationally and domestically for energy science related data sets. This work continues to run in a stable state.

8.B Year 3 Plans

In Year 3, we aim to work with LEARN and OARnet to deploy NetSage into their networks. Additionally, work in the NetSage project has progressed on containizering parts of the data collection framework that will allow us to work with GPN to begin collecting flow data.

There are several releases of NetSage expected during Year 3, all of which will require some work in EPOC to keep the instances updated and communicate these changes to relevant stakeholders. Several of the anticipated new features, such as being able to identify organizations within their own AS numbers and to have them listed separately, are a direct result of working with EPOC partners and responding to their needs. This may require additional training or discussions to ensure that elements such as documentation are up to date. We will also work with the IRNC NetSage development team to understand adaptations to use NetSage for additional network disturbance detection. Several dashboards have been discussed, such as one that identifies significant differences in file transfer behavior between two defined endpoints.

8.C Metrics

Table 4: Metrics for NetSage activities for Year 2.

Where Regional	Data	Date Live	Data Type	# Monitored Devices	# Large Flows	# Unique Src Orgs	# Unique Dest Orgs
GPN	SNMP	10/18	SNMP	2 routers	N/A	N/A	N/A
iLight	Flow	4/19	Flow	5 routers	331,159,086	12,764	27.005
KINBER	Flow	11/19	Flow	2 routers	75,762,199	7,470	10,145
FRGP	Flow	1/20	Flow	1 router	44,982,216	5,077	6,716
TACC (LEARN)	Tstat	1/19	Tstat	4 head nodes	10,429,565	251	335

UHawaii Astro	Tstat	5/19	Tstat	1 DTN	673,324	240	1272
NOAA (FRGP)	Tstat	Discont.	Tstat	1 head node	1,888	2	216
NCAR (FRGP)	Tstat	7/19	Tstat	1 DTN	9,200,169	1,271	3,742
NERSC	Tstat	3/18	Tstat	11 head nodes	7,897,947	309	291

9. Managed Services (aka "In a Box")

EPOC is tasked with developing a set of service definitions for common R&E infrastructure components that could be run by a third party as a managed service. The goal of these definitions is to provide guidance for our Regional Networking Partners to implement, maintain, and operate (potentially for a fee) the service as a benefit for downstream connectors. In doing so, the costs associated with design, specification, and installation could be ameliorated for a larger population than would otherwise have access to this technology due to the burdens of entry which may include not having knowledgeable staff or enough compelling use cases to invest time and money. EPOC previously targeted four examples of Managed Services:

1. **perfSONAR**: a widely deployed test and measurement infrastructure that is used by science networks and facilities around the world to monitor and ensure network performance.
2. **Science DMZ**: Dedicated network infrastructure specifically configured for the security and performance implications required for scientific use cases.
3. **Data Transfer Hardware & Software**: PC-based Linux servers built with high-quality components and configured specifically for wide area data transfers along with software layers that can facilitate easier forms of data sharing
4. **Network Testset**: Specialized hardware used to provision and validate network infrastructure.

A fifth service, based on the Modern Research Portal, is now under development and described in Section 9.A. More information about the Managed Service activity is available online at https://epoc.global/wp-content/uploads/2019/09/Managed-Services-2-pager.pdf. Jason Zurawski is the lead for this area.

9.A New Service Development - Modern Research Data Portal

Data portals provide a way for scientists to search for, discover, access, download, analyze, and publish scientific data. They are incredibly valuable for large collaborations, research groups, and indeed for entire fields. Historically, a science data portal consisted of little more than a web server, a database, and some storage. In most cases, a web browser provided the graphical interface for the portal and the resulting capability was far better than the previous state of the art, which was command-line File Transfer Protocol (FTP). However, data sets have grown in size as well as the number of data objects contained, and many legacy data portals, and their model, have been unable to scale for size or performance.

The Modern Research Data Portal (MRDP), as detailed at http://es.net/science-engagement/technical-and-consulting-services/modern-research-data-portals/, is a design

pattern that makes use of the Science DMZ model and DTNs to scale up the data transfer functionality of a data portal. When the data portal gives the user references to data objects, the references point to a well-configured DTN (or DTN cluster) in a Science DMZ, typically using a data transfer platform that can perform job management, fault recovery, and other modern functions. A paper describing the MRDP design pattern, written in collaboration with members of the Globus team, was published in PeerJ in 2017 (https://peerj.com/articles/cs-144/).

EPOC is experimenting with the concept of a self-contained data portal to assist scientific data sharing needs. The goal is to create an easy to install set of software that can be run on campus or regional hardware and exposes a set of scientific data. The EPOC portal is based on the MRDP and uses Docker to containerize the functionality for easier deployment. Initial investigation of this work started in early 2020, and pilot sites at the University of Hawaii Astronomy group, the Great Plains Network (GPN), and LEARN member Baylor have been identified for testing to start in Y3Q1.

This pilot will dovetail with the ongoing work to address data mobility, including being able to predictably and efficiently move scientific data between experimental source, processing facilities, long term storage, and collaborators. Current and previous CC* awardees, along with the greater R&E community, are being encouraged to participate in the Data Mobility Exhibition, described in Section 10.B and presented at the 2019 and 2020 CC* PI Meetings. Using reference data sets and existing campus CI components, participants will download, measure, and potentially improve their scientific data movement capabilities. The portal can be an add-on tool to integrate scientific data sets after the fact to make sharing easier in this context.

9.B Current Status of Managed Service Deployments

EPOC regional partners have expressed interest in working on managed services. Some of these are to be deployed/managed centrally, others are targeted directly at a member school. Engagements include:

- **FRGP:** With their collaborators in the Tribal College consortium and WestNet, FRGP staff members are evaluating the perfSONAR Managed Service. In 2019, EPOC sent six small perfSONAR nodes to be used for a measurement and monitoring deployment for the Tribal Colleges who are in a joint project with FRGP, which are now part of a MaDDash available online. EPOC has been asked to assist with a future training activity, but it is possible that a more effective approach would be to work with FRGP to run the perfSONAR nodes as a Managed Service deployment on behalf of the Tribal Colleges, especially as the deployment expands. This is a topic of ongoing discussion.
- **GPN:** GPN member KanREN has submitted a proposal to the NSF to work with the DTN service. If awarded, EPOC has committed to help with a design and deployment. GPN has also committed to be a pilot site for the data portal service and is working with EPOC to deploy the software for a member in Y3Q1.
- **iLight:** iLight has not requested any Managed Services work to date.
- **KINBER:** Starting in late 2019, EPOC, KINBER, and member institution Arcadia University worked to create a perfSONAR managed service. The service reached partial

deployment in March of 2020, before being stalled due to the COVID-19 pandemic. It is expected that work will resume in Y3 to complete this deployment and evaluate the usefulness. KINBER member institution Duquesne University is also working with EPOC to initiate a loan of network testing gear (Consultation #73). This work is currently stalled due to COVID-19 travel restrictions.

- **LEARN:** LEARN received a CC* award (https://www.nsf.gov/awardsearch/showAward?AWD_ID=1925553) in 2019 that is exploring the installation of several managed services. As such they have worked with EPOC to investigate the installation of DMZ, perfSONAR, and DTN hardware at 5 pilot sites in 2020 and 2021. A Coordination Event is in the planning phases. In addition, LEARN member site Baylor University is exploring the deployment of a portal with EPOC assistance for Y3Q1.
- **OARnet:** OARnet submitted a proposal to the NSF to explore several managed services. If awarded, EPOC has committed to help with a design and deployment. In addition, OARnet member Kent State University is working with EPOC to initiate a loan of network testing gear (Consultation #51). This work is currently stalled due to the COVID-19 pandemic.

In addition to the deployments with the Regional Networking Partners, we are working with the University of Hawaii Astronomy team, one of our Science Community Partners, as an additional pilot site for the data portal service.

9.C Year 3 Plans

The deployment of some of these service offerings does not require extensive human-to-human interaction (e.g. deployment of software), others may require shipment and configuration of hardware. EPOC is evaluating what will be possible in Year 3, as the world adjusts to COVID-19 restrictions, including:

- Creation/deployment of more hands-off solutions such as data portals and measurement infrastructure
- Use of existing hardware when possible Data Transfer or DMZs
- Publishing Best Common Practice guides to facilitate deployment of similar services outside of direct EPOC involvement

EPOC will be consulting with community members, partners, and the EPOC advisory board on a set of solutions in Year 3.

10. Training

EPOC is continuing the successful training that ESnet and IU lead as part of the Operating Innovative Networks (OIN) program. This includes training for network engineers to be coordinated with existing cyberinfrastructure support teams. While training programs like OIN emphasized the design and deployment of technology, we have pivoted to train staff on the use

of these tools and the improvement of scientific use of networks through them. In addition to training on tools such as perfSONAR, we offer training for network engineers on interacting with their researchers through teaching them how to perform Application Deep Dives. All EPOC training materials are available online, including lecture materials, exercises, and recorded sessions when possible.

10.A Year 2 Training Events

In Year Two, we were involved in both technical training and engagement training. These events included:

- **KINBERCON, Philadelphia PA, April 1-3, 2019, Deep Dive w/ Arcadia University [2,16]]:** This event was attended by 8 people and lasted 4 hours.
- **iLight, Indianapolis, IN, May 7, 2019, Identifying your Researchers [6]:** This 3 hour, semi-hands on event was new material requested by the iLight management team to introduce iLight member engineers to ideas on how to find out what research was taking place on campus, in part to help motivate new deployments of cyberinfrastructure. Twelve people attended, and the slides are being turned into smaller articles to be shared more broadly.
- **LCI Workshop, Norman OK, May 13-18, 2019 [7]:** This multi-day session covered TCP, science DMZ design, perfSONAR, data movement strategies and network security. There were approximately 40 attendees.
- **GPN Annual Meeting, Kansas City, MO, May 20-25, 2019, Deep Dive Workshop w/ Kansas State University [8,39]:** Discussed in Section 7.A. This event was attended by 36 people. The results of the survey indicated that participants enjoyed the discussion and felt the event would be useful in other venues.
- **LEARN Annual Meeting, College Station TX, June 11-13, 2019 [12]:** The training sessions included perfSONAR, network design, and data transfers. There were approximately 35 attendees consisting primarily of engineers from educational institutions. In the follow-on survey from LEARN, 91% would recommend this training to other people, and comments from the post-workshop survey included:
  - Good workshop overall
  - Very nice and sorely needed in TX.
  - Liked the presenters and the pace and organization of the program.
  - I enjoyed it and plan on engaging EPOC for our University.
- **Training Workshop for Network Engineers and Educators on Tools and Protocols for High-Speed Networks and Cybersecurity, Columbia, SC, July 23-24, 2019 [20]:** Training Workshop with University of South Carolina and other invited attendees. This event was attended by 33 participants, and featured presentations on Science DMZ, DTNs, perfSONAR, and engagement strategies.
- **PEARC Deep Dive Training, Chicago, IL, July 29, 2019 [21]:** This event was attended by 15 participants and featured education in the process to conduct a Deep Dive within a campus environment. Purdue University assisted as the use case that was profiled.
- **NTUStar Technical Workshop, Tempe AZ, July 31-August 1, 2019 [24]:** Technical Talk on ScienceDMZ concepts and EPOC Overview with FRGP and Tribal College staff.

This event was attended by 45 participants and featured presentations on Science DMZ, DTNs, perfSONAR, and engagement strategies.
- **2019 Data Mobility Workshop, part of the CC* PI Meeting/Quilt/NRP, Minneapolis, MN, September 23, 2019 [27]:** Technical talks on Science DMZ, DTNs, perfSONAR, and data movement. This event was attended by 50 participants, and featured presentations on Science DMZ, DTNs, perfSONAR, and engagement strategies.
- **KINBER/Arcadia PS Workshop, Arcadia, University, Glenside, PA, planned for March 2020:** This event had planned to offer training for the perfSONAR managed service, but was postponed due to COVID-19 and has not yet been rescheduled.

10.B Data Mobility Exhibition

Data mobility is a critical component of the process of science. Being able to predictably and efficiently move scientific data between experimental sources, processing facilities, long term storage, and collaborators is a common use case that transcends the boundaries of research disciplines. The Data Mobility Exhibition is using reference data sets and existing campus CI components to highlight actual data speeds experienced by R&E institutions. Participants download, measure, and potentially improve their scientific data movement capabilities as part of this activity. More information is available at: https://fasterdata.es.net/performance-testing/2019-2020-data-mobility-workshop-and-exhibition/2019-2020-data-mobility-exhibition/. While not traditional training, we include this as an EPOC training activity because of its emphasis on community discovery and learning

On September 23, 2019, EPOC staged a Data Mobility Workshop [27] as part of the CC* PI Meeting/Quilt meeting held in Minneapolis, MN. The event had two major components:
- Technical talks on Science DMZ, DTNs, perfSONAR, and data movement
- The launching of a year-long effort to measure and improve data movement at participating universities.

The latter is meant to create usable/operational infrastructure that science groups can routinely use to transfer data sets; not just a single testpoint to prove capability. This initial event was attended by 50 participants, and approximately 15 sites had performed tests as of December 2019. EPOC will be working with sites that request assistance to understand and improve data architecture, tuning, and usability of the resources for science use cases.

EPOC will continue this activity for Year 3, including:
- Webinars to explain the activity, its status, and next steps;
- Virtual training opportunities in hardware and software support strategies; and
- Addressing Roadside cases related to this effort for sites that request assistance.

10.C University of South Carolina Cyber Training

EPOC continues to work with members of the University of South Carolina Cyber Training team who received funding from NSF for "CyberTraining CIP: Cyberinfrastructure Expertise on High-

throughput Networks for Big Science Data Transfers" (#1829698). EPOC staff are assisting with a set of workshops on high performance networking technologies. Zurawski is also serving on the advisory committee for this award.

The audience of this workshop includes IT educators, IT professionals, CI engineers, high performance computing specialists, research systems administrators, and security professionals. Topics include science DMZs, TCP, BGP, perfSONAR, and Zeek. One facet that makes this training unique is the use of a virtual laboratory environment. This environment allows for easy set-up, scaling, and quick creation of custom training scenarios using open source tools. Students engage in hands-on training exercises that simulate real world networking leading to better understanding of complex topics. There are over 50 virtual labs associated with the live lectures which are meant to be completed by attendees at their own pace after the workshop ends. The workshops were originally planned for 2-5 days of in-person meetings and are being adapted for virtual instruction.

EPOC staff are working to review online labs specifically associated with BGP. EPOC staff are bringing in additional experts from the broader community to assist the USC team in reviewing the materials that they have produced.

Year 3 plans with USC include two events:
- Virtual Workshop, planned for May 2020 (http://ce.sc.edu/cyberinfra/workshop_2020.html)
- Physical Workshop, tentatively planned for July 2020

EPOC staff will be involved in presentations related to Science DMZs, perfSONAR, and BGP.

10.D New Focus Area: Border Gateway Protocol (BGP)

R&E networks are designed, built, and operated to enable high performance connections to a limited number of sites for use by the research community, while commodity (commercial) networks generally focus on the greatest amount of connectivity between any end point and security for its customers. Most educational institutions connect to both R&E networks and commercial networks. However, having several connectivity options can mean it is difficult for an institution to put in place the proper routing configuration, which should prefer R&E-related network paths for research collaborations, not commodity paths.

EPOC has received a number requests for Roadside Assistance or Consultations that have involved correcting the configuration and management of Border Gateway Protocol (BGP), particularly when an institution is balancing traffic between R&E networks and commodity networks. The problems our end users are experiencing are not related to setting up an initial instance of BGP, but in making the correct adaptations to the BGP tables as capacity is added in order for data flows to still be routed effectively. While EPOC will continue to work with sites on a case-by-case basis to explain and fix this type of configuration and operational issue, it was determined that a more focused effort was needed to support the development and dissemination of educational materials to instruct and explain BGP adaptations.

EPOC led a birds of a feather (BOF) session at the Internet2 Technology Exchange in December, 2019, to receive feedback on areas of interest related to BGP training [35]. During this session, staff from EPOC, ESnet, GlobalNOC, Texas Advanced Computing Center (TACC), and National Energy Research Scientific Computing Center (NERSC) collaborated to:

- Present examples of poor routing in the R&E community that affect research data transfers.
- Present examples of best routing practices in a production environment.
- Lead a discussion on community interest around BGP best practices and possible future training events and needed materials.

There were more than 25 people in attendance, who expressed an interest in seeing additional material related to:

- BGP best practice documentation for the R&E community;
- Ongoing Birds of a Feather sessions for community discussion; and
- Training materials for BGP topics from beginner to advanced.

EPOC staff are working with partners from ESnet, GlobalNOC, and TACC to define an overall strategy for best practices and training for BGP adaptations for the R&E community. EPOC continues to solicit feedback on the best forms of training. There were plans to lead a panel at the upcoming Internet2 Global Summit to continue the discussion and present the material to the leaders of the regional networks and campuses, however that meeting was canceled due to COIVD 19, so this outreach is delayed.

We have also engaged with the Network Startup Resource Center (NSRC) to review their BGP video training series and to incorporate pointers to this material when appropriate. In most cases, the NSRC material focuses on the initial setup and deployment of BGP, while EPOC plans to focus on tuning and ongoing support of BGP configurations for effective use of R&E networks.

During Year 3 Quarter 1, the EPOC team will be designing an overall BGP engagement strategy that may include videos, best practices documentation, frequently asked questions, training material, and configuration examples.

10.E Additional Year 3 Training Plans

EPOC staff have started the internal work to adjust our training to adapt to these circumstances with a set of expanded training modules to meet community needs. The goals we have identified around the extended training include:

- Creation of new online content that can be shared beyond pandemic;
- Address known areas of confusion or popular areas that are not articulated well;
- Involve a large population (600+) of the CI engineering community through use of the CI-ENG mailing list;

- Work with regional and application partners to both advertise these sessions as well as understand needs for content; and
- Motivate a large population of R&E sites to adopt best community practices around CI technology approaches;

We envision creating a series of short (20 minutes to 1 hour) taped content pieces that can be held live but also shared via YouTube for asynchronous viewing. We are identifying content areas by analyzing our Consultation cases and the results of Deep Dives but will also be discussing areas of interest with the community more broadly in future quarters. Our plan is that EPOC staff will coordinate this effort, but we might not always be the presenters. In fact, our preference will be to involve external speakers and voices whenever possible. And while we envision getting these activities up and running regularly while travel restrictions are in place, if they are successful, we would continue them indefinitely.

We have identified three types of virtual sessions with associated content areas:
- ***Traditional Training***: Traditional Training sessions would use existing resources from OIN (or other related training materials on CI technology) and adapt them to "how to" videos. In addition, we will continue our work with the Network Startup Resource Center (NSRC) to curate and create a set of materials that target known educational needs for their communities.
- ***Deep Dive Findings***: Deep Dive Findings will consist of a set of "Fireside" discussions of topics identified through precious EPOC Deep Dives, with guests that will speak to a problem or solution in this space.
- ***Roadside Findings***: Roadside Findings will involve videos that discuss debugging activities to solve common problems found via the Roadside Assistance and Consultation cases. These sessions will paraphrase an existing case question, then walk through the steps to understand, investigate, and resolve the issue.

Each of these session types will include pointers to related materials, both written and video.

11. Data Privacy and Security

No PII is shared in the Roadside Assistance or Consultation summaries or reports, which are made public. There may be PII in other documents in a Roadside Assistance Case Folder, for example IP addresses, but this information is locked down and access is controlled and only shared with specific staff working on a particular issue.

In addition, NetSage does not collect PII. The IRNC NetSage privacy docs were updated for EPOC and are available online at https://epoc.global/wp-content/uploads/2019/02/EPOC-Data-Privacy-Policy-21919.pdf.

Basic security measures are being maintained and there were no security incidents to report for Year 2.

12. Year Three Plans

As mentioned previously, Year 3 is expected to be challenging as we continue to adjust activities in light of COVID-19 and its associated lock downs and prohibitions on meetings and travel. Because of this, Year 3 plans are less specific to accommodate upcoming unknown circumstances, and we plan to be nimble as we respond to ongoing needs and changing situations. Year 3 had been planned to include additional staff time to focus on communicating the lessons learned and best practices, which will be expanded as well.

12.A Staffing

We do plan to add additional staff resources, at both IU and LBNL. At IU, this resource will consist in part at least of a new hire primarily be focused on the overload from the growth of the Roadside Assistance and Consulting support. At LBNL, additional resources are likely to be pulling in staff from other projects to fill gaps as needed.

12.B Travel/Meetings

We anticipate ongoing and sustained changes in travel and meetings, even our own. Our summer All Hands Meeting will likely be virtual, although as many of our prior meetings have been at least in part virtual we do not see this affecting the activity greatly. Section 3 lists the large number of workshops and conferences we had planned to attend that have been canceled or postponed. Because these include a number of the Annual meetings of our partners, we will be scheduling additional check-ins with each partner over the summer to ensure progress on various deliverables. We will continue to participate in the meetings that have been shifted to virtual as much as possible. The various meetings that we were running that have been postponed are being reconsidered for rescoping to virtual meetings or rescheduling beyond the expected window of the pandemic. At the current time, it is unknown how long this will last.

12.C Roadside Assistance and Consultations

We expect to continue to advertise the Roadside Assistance and Consultation service, with the resulting ongoing growth expected. We hope to formally pull in additional partner resources for specific topic areas, for example for the Zeek intrusion detection system or perfSONAR. Our general approach already works in a virtual environment for non-local participants, so we don't see a need to change the basic formats.

Year 3 work will also focus on communicating lessons learned and best community practices more broadly. This will include not only updates to http://fasterdata.es.net, but also additional in-depth write ups for common questions and materials online.

12.D Deep Dives

We expect to finish the two Deep Dive reports that are in progress early in Year 3. The University of Wisconsin report was shared with university staff in January, but we are awaiting their edits. The Baylor report is still in the process of being drafted.

For the Deep Dives that were in planning, this situation is less clear. Each has been rescheduled out to Fall 2020 or later, but we will watch and reschedule as needed. Unfortunately, adapting the in-person portion of the Deep Dives may not be feasible as they rely quite heavily on the serendipitous discussions that having the CI engineers and application groups in a room together, and replicating that in a virtual environment has not worked out the few times it was tried in the past. We will consider examining this option.

That said, in Year 3, we will also focus on documentation and communication of the Deep Dive lessons learned, both positive and negative, common technology gaps, and emerging trends for scientific and research use cases.

12.E NetSage

Since most aspects of deploying NetSage is based around software, not hardware, installation, we do not expect current travel restrictions to impact EPOC's use of the tool with partners. Both LEARN and OARnet experienced recent changes in leadership, and we plan to pick up conversations with those partners when the appropriate staff is in place to evaluate their use of NetSage. We will also continue our work on a containerized solution for flow data for GPN.

As part of the February partners meeting, several groups requested the ability to identify organizations within their own AS numbers listed separately in the dashboards, which we expect to be part of the NetSage 1.5 release in June 2020. We will continue meeting with partners and getting feedback on their needs and expanded use cases.

We will also work with the IRNC NetSage development team to understand adaptations to use NetSage for additional network disturbance detection. Several dashboards have been discussed, such as one that identifies significant differences in file transfer behavior between two defined endpoints.

12.F Managed Services

The Managed Services activities are likely to need to adapt significantly in Year 3 due to travel restrictions. The deployment of the service offerings that do not require extensive human-to-human interaction (e.g. deployment of software) will still be possible, but for others, such as the perfSONAR managed service, it is likely they will be delayed or canceled.

In part because of this, Year 3 plans include additional development and deployment of the developing Portal service. Initial deployments include pilot sites at the University of Hawaii

Astronomy group, the Great Plains Network (GPN), and LEARN member Baylor. After these test cases, we will expand deployments to the broader community. This pilot will dovetail with the ongoing work to address data mobility, and our ongoing support of the Data Mobility Exhibition.

Managed Services will also have an increased communication aspect, including publishing Best Common Practice guides to facilitate deployment of similar services outside of direct EPOC involvement.

12.G Training

Using data from the Roadside assistance and Consultation cases, the Deep Dives, NetSage deployments, and our work with Managed Services, in Year 3 we will revamp our approach to training to adapt to the current travel restrictions. We have started a process to identify not only traditional training, but also discussion and how-to approaches which will vary with content. Content will be delivered not only by EPOC staff but also by subject matter experts as needed from across the CI ecosystem.

The Data Mobility Exhibition part of training will continue to support webinars and virtual training opportunities, especially in hardware and software support strategies, as this activity continues.

Year 3 will also see continued work with members of the University of South Carolina Cyber Training team, and to offer live lectures on science DMZs, TCP, BGP, and perfSONAR, as part of their offerings. Currently, a virtual workshop is planned for May and an in-person workshop is tentatively planned for July.

And lastly, as part of Year 3, the EPOC team will be designing an overall BGP engagement strategy that may include videos, best practices documentation, frequently asked questions, training material, and configuration examples.

13. Reporting Against Deliverables

Table 5 lists the deliverables for Year 2 with current status, plus plans for Year 3.

WBS #	Deliverables	Status
RA	**ROADSIDE ASSISTANCE AND CONSULTATIONS**	
RA.1	Adaptation of IN@IU, ESnet science engagement, and IRNC NOC PET process with expanded focus	Compl Y1
RA.2	Advertising roadside assistance and consulting	Ongoing
RA 3	Assist with ongoing RAs - Partners	
RA 3.1	iLight RA/C	

RA 3.1.1	C - IU-NOAA (24)	Started Y2Q1, Compl Y2Q2
RA 3.2	FRGP RA/C	
RA 3.2.1	C - Mines (4)	Started Y1, Compl Y2Q2
RA 3.2.2	C - Tribal (6)	Compl Y1
	See also RA 3.1.1 (24)	
RA 3.2.3	C - AIHEC (39)	Started Y2Q3, Compl Y2Q3
RA 3.2.4	C-ASU (49)	Started Y2Q3, Compl Y2Q3
RA 3.2.5	C - NOAA (63)	Started Y2Q3, Ongoing
RA 3.2.5 (NEW)	RA - NCAR (76)	Started Y2Q4, Ongoing
RA 3.3	LEARN RA/C	
RA 3.3.1	C - PVAMU (14)	Started Y1Q4, Compl Y2Q1
RA 3.3.2	C - TAMU (23)	Started Y2Q1, Compl Y2Q3
RA 3.3.3	C- Trinity (31)	Started Y2Q2, Compl Y2Q2
RA 3.3.4	C- PVAMU (36)	Started Y2Q2, Compl Y2Q3
RA 3.3.5	C- LEARN (62)	Started Y2Q3, Ongoing
RA 3.3.6 (NEW)	C - Baylor (66)	Started Y2Q4, Compl Y2Q4
RA 3.3.7 (NEW)	C- UTSA (69)	Started Y2Q4, Ongoing
RA 3.4	OARnet RA/C	
RA 3.4.1	C - UCinn (21)	Started Y2Q1, Compl Y2Q2
RA 3.4.2	C- OSC (32)	Started Y2Q2, Compl Y2Q3
RA 3.4.3	C- Kent (35)	Started Y2Q2, Ongoing
RA 3.4.4	C - Kent (51)	Started Y2Q3, Ongoing
RA 3.4.5	C - UHawaii-OSU (57)	Started Y2Q3, Ongoing
RA 3.4.6 (NEW)	C- UCinn (68)	Started Y2Q4, Compl Y2Q4
RA 3.5	GPN RA/C	
RA 3.5.1	C - WSU (12)	Started Y1Q2, OBE Y1Q3
RA 3.5.2	C - UWisc-OneNet (25)	Started Y2Q1, Compl Y2Q1
RA 3.5.3	RA - Iowa-NCAR (27)	Started Y2Q1, Compl Y2Q3
RA 3.5.4	C- NDSU (48)	Started Y2Q3, OBE Y2Q4
RA 3.5.5	C- MSU Deep Dive (50)	Started Y2Q3, Ongoing
RA 3.5.6	RA SLU-Amazon (59)	Started Y2Q3, Ongoing
RA 3.5.7	C- U Missouri (61)	Started Y2Q3, Compl Y2Q3
RA 3.5.8	C- KanREN (65)	Started Y2Q3, Compl Y2Q4

RA 3.5.9 (NEW)	C- GPN (72)	Started Y2Q4, Ongoing
RA 3.6	KINBER RA/C	
RA 3.6.1	C - F&M (17)	Started Y2Q1, Compl Y2Q1
RA 3.6.2	C - Duquesne (19)	Started Y2Q1, Compl Y2Q3
RA 3.6.3	C- Arcadia (29)	Started Y2Q2, Compl Y2Q2
RA 3.6.4	C- Penn State (42)	Started Y2Q2, Compl Y2Q2
RA 3.6.5 (NEW)	C- Duquesne (70)	Started Y2Q4, Compl Y2Q4
RA 3.6.6 (NEW)	C- Duquesne (73)	Started Y2Q4, Ongoing
RA 3.7	ESIP RA	Ongoing
RA 3.8	ICNWG RA	OBE
RA 3.9	IU GC RA	Ongoing
RA 3.10	UHawaii RA	Ongoing
RA 3.10.1	PANStarrs (1)	Compl Y1; 3x improvement
	See also RA 3.4.6	
RA 3.11	MWBDH RA	Ongoing
RA 3.12	OSN RA	OBE
RA 4	Other RA/C	
RA 4.1	LHC Pakistan (2)	Compl Y1; 10x improvement
RA 4.2	C - New York University School of Medicine (5)	Compl Y1
RA 4.3	C – AMNH (7)	Started Y1, Compl Y2Q2
RA 4.4	C- UF (8)	Compl Y1
RA 4.5	C- LSU Health (9)	Started Y2Q1, Compl Y2Q1
RA 4.6	C- SANReN (10)	Started Y2Q1, OBE Y2Q3
RA 4.7	C- PNNL (11)	Started Y2Q1, Y2Q4
RA 4.8	C - Compute Canada (13)	Compl Y1
RA 4.9	C- UC Merced (15)	Started Y2Q1, Compl Y2Q3
RA 4.10	C - LSU Health Deep Dive Templates (18)	Started Y2Q1, Compl Y2Q1
RA 4.11	C- Vanderbilt PS (20)	Started Y2Q1, Compl Y2Q1
RA 4.12	C - UWisc - MichSt (26)	Started Y2Q1, OBE Y2Q3
RA 4.13	C - UC Merced (28)	Started Y2Q1, Compl Y2Q1
RA 4.14	C- SANReN(30)	Started Y2Q2, Compl Y2Q2
RA 4.15	C- AMNH (33)	Started Y2Q2, Compl Y2Q3
RA 4.16	C- U Mich (34)	Started Y2Q2, Compl Y2Q4

RA 4.17	C- UNCG (37)	Started Y2Q2, Compl Y2Q4
RA 4.18	C- U Mich (38)	Started Y2Q3, Compl Y2Q3
RA 4.19	C- AAMU (40)	Started Y2Q3, OBE Y2Q3
RA 4,20	C- UC Davis (41)	Started Y2Q3, OBE Y2Q3
RA 4.21	C-MGHPC (43)	Started Y2Q3, Compl Y2Q3
RA 4.22	C-AMNH (44)	Started Y2Q3, OBE Y2Q4
RA 4.23	C - Wayne (45)	Started Y2Q3, Compl Y2Q3
RA 4.24	C- U Wisc (46)	Started Y2Q3, Compl Y2Q3
RA 4.25	C-UCentral FL (47)	Started Y2Q3, Compl Y2Q3
RA 4.26	C- U Montana (52)	Started Y2Q3, Compl Y2Q4
RA 4.27	C- CalTech (53)	Started Y2Q3, Compl Y2Q4
RA 4.28	C-Globus (54)	Started Y2Q3, Compl Y2Q3
RA 4.29	C- U Montana (55)	Started Y2Q3, Compl Y2Q4
RA 4.30	C- U Montana (56)	Started Y2Q3, Compl Y2Q4
RA 4.31	C-OSHEAN (58)	Started Y2Q3, OBE Y2Q4
RA 4.32	C-U Southern Carolina BGP (60)	Started Y2Q3, Compl Y2Q4
RA 4.33	C-U Southern California DMZ (64)	Started Y2Q3, Compl Y2Q4
RA 4.34 (NEW)	C - VA (67)	Started Y2Q4, Ongoing
RA 4.35 (NEW)	C - Allen Inst (74)	Started Y2Q4, Ongoing
RA 4.36 (NEW)	C - Reed (75)	Started Y2Q4, Ongoing
RA 4.37 (NEW)	C - Compute Canada (77)	Started Y2Q4, Ongoing
RA 4.38 (NEW)	C - MIT (79)	Started Y2Q4, Compl Y2Q4
RA 4.39 (NEW)	C - UCentral FL (80)	Started Y2Q4, Ongoing
DD	**DEEP DIVE**	
DD.1	Adaptation of ESnet facility deep dive process for use with applications	Compl Y1
DD.2	Over project period, goal is to offer at least 2 deep dives per regional partner	Ongoing
DD.2.1	iLight Deep Dives	Ongoing
DD 2.1.1	Purdue University	Compl - Event Y2Q1, report Y2Q3
DD.2.2	FRGP Deep Dives	Ongoing
DD 2.2.1	NOAA and NASA Deep Dive (with Training)	Compl Y1
DD 2.2.2	Arizona State/Sub Corridor	Tentative Jan'21 (COVID)
DD 2.2.2	Northern Arizona Univ	OBE

DD 2.3	LEARN Deep Dives	Ongoing
DD 2.3.1	Trinity University	Compl - Event Y2Q1, report Y2Q3
DD 2.3.2	Baylor	Ongoing - Event Y2Q4, report est Y3Q1
DD 2.4	OARnet Deep Dives	Ongoing
DD 2.4.1	University of Cincinnati	Compl - Event Y2Q1, report Y2Q3
DD 2.5	GPN Deep Dives	Ongoing
DD 2.5.1	Training - KSU Agronomy	Compl - Event Y2Q1, report Y2Q3
DD 2.5.2	University South Dakota	Tentative Nov'20 (COVID)
DD 2.6	KINBER Deep Dives	Ongoing
DD.2.6.1	Arcadia Bioinformatics (with training)	Compl - Event Y2Q1, report Y2Q2
DD 2.7	ESIP DD	Ongoing
DD 2.8	ICNWG DD	OBE
DD 2.9	IU GC RDD	Ongoing
DD 2.10	UHawaii DD	Ongoing
DD 2.11	MWBDH DD	Ongoing
DD 2.12	OSN DD	OBE
DD.3	Other Deep Dives	Ongoing
DD.3.1	QUILT/University Maryland (with Training)	Compl Y1
DD.3.2	University of Wisconsin	Event Y2Q1, report expected Y3Q1
DD 3.3	PEARC'19	Compl (no report)
DD 3.4	Oregon State Univ	On hold (COVID)
DD 3.5	Quilt Briefing	Compl Y2Q4
DD 3.6	University Central Florida	Tentative Fall'20 (COVID)
NS	**NETSAGE**	NOTE: Renumbering took place in Y2Q2
NS.1	NetSage prototypes for regional partners	Ongoing
NS1.1	NetSage for iLight	Ongoing
NS 1.1.1	SNMP for iLight	May not be needed
NS 1.1.2	Flow for iLight	Compl Y2Q1, Updated Y2
NS 1.2	NetSage for FRGP	Discussion Y2
NS 1.2.1	SNMP for FRGP	Discussion Ongoing
NS 1.2.2	Flow for FRGP	Compl Y2Q4

NS 1.2.3	Tstat for NOAA	Compl -Deployed Y2Q1, OBE
NS 1.2.4	Tstat for NCAR	Compl Y2Q2
NS 1.3	NetSage for LEARN	Ongoing
NS 1.3.1	SNMP for LEARN	Discussion Year 3
NS 1.3.2	Flow for LEARN	Compl
NS 1.3.3	Tstat on TACC archives	Compl Y1, updated Y2
NS 1.4	NetSage for OARnet	Ongoing
NS 1.4.1	SNMP for OARnet	Discussion Year 3
NS 1.4.2	Flow for OARnet	Discussion Year 3
NS 1.5	NetSage for GPN	Ongoing
NS 1.5.1	SNMP for GPN	Compl Y1
NS 1.5.2	Flow for GPN	Planned for Year 3
NS 1.6	NetSage for KINBER	Ongoing
NS 1.6.1	SNMP for KINBER	Discussion Ongoing
NS 1.6.2	Flow for KINBER	Compl Y2Q3
NS 2	NetSage deployments related to other partners	Ongoing
NS 2.1	University Hawaii	Ongoing
NS 2.1.1	Tstat on Astronomy Archive	Compl Y2Q1
NS 3	Adaptation of NetSage analysis for network disturbance detection	Planned for Year 3
MS	MANAGED SERVICE	Note: Numbering reworked Y2Q3
MS 1	Define Managed Services	Ongoing
MS 1.1	Define perfSONAR Managed Service (PS MS)	Started Y1, Ongoing
MS 1.2	Define DMZ Managed Service (DMZ MS)	Delayed (COVID)
MS 1.3	Define Data Transfer Managed Service (DT MS)	Delayed (COVID)
MS 1.4 (NEW)	Tester Managed Service	Definition Compl Y2
MS 1.5 (NEW)	Portal Managed Service	Development begun Y2
MS2	MS deployments	Ongoing
MS 2.1	iLight MS	TBD
MS 2.2	FRGP MS	TBD
MS 2.2.1	PS MS for Tribal Colleges	Under discussion
MS 2.3	LEARN MS	Underway Y2

MS 2.3.1	LEARN DMZ MS	Delayed (COVID)
MS 2.3.2	LEARN DT MS	Delayed (COVID)
MS 2.3.3 (NEW)	LEARN Portal MS with Baylor	Under discussion, deployment expected Y3
MS 2.4	OARnet MS	TBD
MS 2.4.1	OARnet DT MS	On hold Year 3
MS 2.4.2 (NEW)	Testset Loan to Kent State	Expected Y3 (COVID)
MS 2.5	GPN MS	TBD
MS 2.5.1	GPN and KanREN DT MS	On hold Year 3
MS 2.5.2 (NEW)	Portal MS with member	In discussion Y2Q4, ongoing Y3
MS 2.6	KINBER MS	Started Y1, Ongoing
MS 2.6.1	KINBER and Arcadia PS MS	Deployment and Training postponed (COVID)
MS 2.6.2 (NEW)	Testset Loan to Duquesne	Expected Y3 (COVID)
MS 2.7	Other MS Deployments	Ongoing
MS 2.7.1 (NEW)	U Hawaii Astronomy Data Portal MS	In discussion Y2Q4, ongoing Y3
T	**TRAINING**	
T 1	Set up public site for training materials	Compl Y1
T 2	Technical training	Ongoing
T 2.1	SOX - perfSONAR	Compl Y1
T 2.2	GPN LCI - perfSONAR, DMZ	Compl Y2Q1
T2.3	LEARN - PS, DMZ, DTN, Security	Compl Y2Q1
T 2.4	NWT Star/FRGP - PS, DMZ, DTN, Security	Compl Y2Q2
T 2.5	CyberTraining w/USC -PS, DMZ, DTN, Engagement	Compl Y2Q2
T 2.6	Managed Service PS with KINBER, Arcadia	Delayed (COVID)
T 2.7	CyberTraining w/USC - BGP, PS, DMZ	Changed to virtual, May'20 (COVID)
T 2.8	CyberTraining w/USC - BGP, PS, DMZ	Delayed until Jul'20 (COVID)
T 3	Deep Dive training	Ongoing
T3.1	NOAA DD Training	Compl Y1
T 3.2	QUILT DD Training	Compl Y1
T 3.3	KINBER DD Training	Compl Y2Q1
T 3.4	GPN DD Training	Compl Y2Q1

T 3.5	PEARC DD Training	Compl Y2Q2
T 3.6	Quilt DD Training	OBE (changed to overview on request)
T 3.7	DD Training 6	TBD (COVID)
T 3.8	DD Training 7	TBD (COVID)
T 4	**Other Related General Activities**	**TBD as requested by community**
T 4.1	Finding Researchers	iLight - Compl Y2Q1
T 4.2	Data Mobility Expo	Compl Y2Q2
T 4.3 (NEW)	BGP BOF at I2 TechEx	Compl Y2Q3
T 4.4 (NEW)	BGP BOF at I2 Global Summit	Delayed (COVID)
T 4.5 (NEW)	PS NSRC Updates	Ongoing
T 5 (NEW)	**Reworking Training during COVID**	**Ongoing**
T 5.1 (NEW)	New plan development	Started Y2Q4, ongoing