

Engagement and Performance Operations Center (EPOC) (Formerly known as ReSEC)

NSF Award #1826994

Year 3 Quarter 1

1 April 2020 through 30 June 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 six main activities: Roadside Assistance and Consulting, Application Deep Dives, Network Analysis using NetSage, Data Mobility Exhibition/Portal, the provision of Managed Services, and Training. Year 3 Quarter 1 highlights include formally adopting the Data Mobility Exhibition/Portal as its own activity, defining a procedure to incorporate additional partners, completing the University of Wisconsin Deep Dive report, and closing one Roadside Assistance and eleven Consultations.

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 six 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;
- The Data Mover Exhibition and associated work with our simplified portal to check transfer times against known “good” end points;

- 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 six activities in Year 3 Quarter 1. Note that at the time of this report, COVID-19 and its associated travel restrictions were in a state of high fluctuation.

2. Staffing and Internal Coordination

At the beginning of Year 3, 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

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.

Ken Miller from ESnet joined EPOC in April, 2020, and will focus on supporting the Data Mobility Exhibition, Roadside Assistance, and Managed Services aspects for the near term. He will also assist longer term with the execution of Training and Deep Dive activities when these resume.

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.

Our next formal Team All Hands meeting will take place later in 2020 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. Travel and Virtual Meeting Participation

EPOC staff participated in various meetings to support ongoing deployment, collaboration, and training. Starting in February 2020, activities that involved travel were severely impacted by COVID-19. The EPOC activities shifted from in-person to remote/virtual interactions. Remote participation in Quarter 1 meetings included:

- Doyle and Schopf attended the virtual GlobalNOC User Meeting on April 13-14, 2020.
- Addleman presented at the virtual Large Scale Networking (LSN) Workshop on Huge Data: A Computing, Networking and Distributed Systems Perspective on April 13-14, 2020, <https://protocols.netlab.uky.edu/~hugedata2020/>.
- Addleman attended the virtual FABRIC Community Workshop on April 15-16, 2020, <https://whatisfabric.net/events/fabric-community-workshop-2020>.
- Zurawski attended the virtual GlobusWorld on April 29th 2020, <https://www.globusworld.org/conf/>.
- Addleman, Zurawski, Chevalier, Southworth, Miller, and Eli Dart attended and presented at the virtual Training Workshop for Educators and Network Engineers on High Speed Network Protocols and Security on May 4, 2020, http://ce.sc.edu/cyberinfra/workshop_2020.html. Zurawski presented on ScienceDMZ architectures, Addleman and Dart presented on BGP best practices, and Southworth and Chevalier presented on perfSONAR.
- Zurawski attended the virtual LEARN Member Meeting on June 1-3, 2020.
- Southworth presented at the virtual WestNet Meeting, on June 24-26, 2020, <https://www.westnet.net/new-events>.

Canceled or rescheduled meetings in Year 3 Quarter 1 included:

- Internet2 Global Summit, March 29-April 1, 2020, Indianapolis, IN, <https://meetings.internet2.edu/2020-global-summit/update-coronavirus/>. This event was cancelled.
- 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.
- NSF Large Facilities workshop, April 14-16, 2020, Alexandria, VA, <https://www.largefacilitiesworkshop.com/>. The meeting was postponed until Spring, 2021.
- 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 February, 2021.
- 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.
- 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:

- 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 Spring 2021.
- University South Dakota / GPN Deep Dive, June 2020. This event has been postponed until Summer 2021.
- Arizona State University / Sun Corridor Network Deep Dive, Sept 2020. This event has been postponed until 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 3 Quarter 1, the EPOC presentations, invited posters, and publications are listed here and referred to throughout the report with the reference number listed:

1. Addleman, H. "EPOC: Roadside Assistance to the Rescue!", Invited Talk, Large Scale Networking (LSN) Workshop on Huge Data: A Computing, Networking and Distributed Systems Perspective, Virtual Meeting, on April 13-14, 2020. Available online at: https://drive.google.com/file/d/1s_kbTQNEbwIYSSbcmX6tIKFEu_NNiQFs/view?usp=sharing
2. Addleman, H., Dart, E., "Network Strategy to Enable Data Intensive Science", Invited Talk, CI Engineering Brown Bag, on May 1, 2020. Available online at: https://drive.google.com/file/d/16vE-kmktR3YGFJYoYfZSTqU_rxv04Did/view?usp=sharing.
3. Zurawski, J., "Science DMZ and TCP", Invited Talk, Training Workshop for Educators and Network Engineers on High Speed Network Protocols and Security, Virtual Meeting, on May 4, 2020, Available online at: http://ce.sc.edu/cyberinfra/docs/workshop/workshop_2020_online/TCP_DMZ-Zurawski.pdf.
4. Chevalier, S., Southworth, D., "perfSONAR Overview", Invited Talk, Training Workshop for Educators and Network Engineers on High Speed Network Protocols and Security, Virtual Meeting, on May 4, 2020. Available online at: <https://drive.google.com/file/d/1AOxRnIVWi-4kIqUff14Mo42sZS9ep5SV/view?usp=sharing>.
5. Addleman, H., Dart, E., "BGP Architectures and Best Practices", Invited Talk, Training Workshop for Educators and Network Engineers on High Speed Network Protocols and Security, Virtual Meeting, on May 5, 2020. Available online at:

<https://drive.google.com/file/d/1SomS5T6xB4Smko7Y-IB9BtbtYeNaCNN/view?usp=sharing>.

6. Miller, K. "Security best practices in high-speed networks", Invited Panel, Training Workshop for Educators and Network Engineers on High Speed Network Protocols and Security, Virtual Meeting, on May 6, 2020. Available online at: <https://drive.google.com/file/d/1VZ-RUOAtKIk4GwM2zu7cw3ZoYKboo9Pq/view?usp=sharing>.
7. Zurawski, J., Schopf, J., & Addleman, H. University of Wisconsin-Madison Campus-Wide Deep Dive. Lawrence Berkeley National Laboratory. Report #: LBNL-2001325, on May 2020. Available online at: <https://escholarship.org/uc/item/99c4v5xh>
8. Southworth, D. "EPOC Overview, Cases, and Tools", Invited Talk, WestNet User Meeting, on June 26, 2020, Available online at: https://drive.google.com/file/d/1eDdHg6jwXfa-EIk4EEW5Lsze1WoDVQx_/view?usp=sharing.

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 Additional Network Partners

Over the last eighteen months, several institutions have approached EPOC about the possibility of becoming formal partners. While some EPOC activities are available to the broader community, such as Roadside Assistance and Consulting and Training, others are limited to partners or partners receive scheduling preference, including NetSage deployments and work with Managed Services. Complementary to this, the EPOC project has experienced cost savings due to the reduction in staff travel, so it was determined that we could consider expanding our formal partner set at this time.

Our first three additional Regional Networking Partners are Southern Crossroads (SoX), the regional network for the state of Arizona, Sun Corridor, the regional network for much of the southeastern part of the US including parts of Alabama, Georgia, South Carolina, and Tennessee, and the Texas Advanced Computing Center (TACC) at the University of Texas at Austin, United States, an advanced computing research center that supports Texas institutions as well as having a national mission. We are currently investigating if more formal documentation would be helpful.

5.B Regional Networking Partners

EPOC is partnered with the six regional network operators.

- **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: Presentation at the WestNet Members Meeting [8]
- Roadside Assistance: #76
- NetSage: <http://frgp.netsage.global>, deployment February 2020, 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.
- **iLight** is the regional network for Indiana.
 - NetSage: <http://ilight.netsage.global>, deployment May 2019, working on ASN splitting with SWIP
- **The Great Plains Network (GPN)** is the regional network that serves North Dakota, South Dakota, Nebraska, Iowa, Minnesota, Kansas, Missouri, and Arkansas.
 - Roadside Assistance: #59
 - Consultations: #50, 72, 86
 - Deep Dives: In planning with University of South Dakota, possible Summer 2021 timeframe
 - NetSage: <http://gpn.netsage.global>, SNMP deployment completed 2019, Flow data deployment using containers deployed this quarter
- **The Keystone Initiative for Network Based Education and Research (KINBER)** is the regional network for Pennsylvania.
 - Consultations: #73, 87
 - NetSage: <http://kinber.netsage.global> Deployment November 2020, working on ASN extensions with SWIP
 - Managed Services: We continue to work with Arcadia University and KINBER on deploying a perfSONAR managed service at Arcadia. A training event that was postponed is still in the process of being rescheduled
- **The Lonestar Education and Research Network (LEARN)** is the regional network for Texas.
 - Meetings: Attended LEARN Member Meeting in June.
 - Roadside Assistance: #71 (Note: we include these for both LEARN and TACC)
 - Consultations: #62, 69 (Note: we include these for both LEARN and TACC)
 - Deep Dives: January 2020 with LEARN partner Baylor, report expected Year 3 Quarter 2
 - NetSage: In discussions, waiting for time after COVID issues.
 - DME/Portal: LEARN-member Baylor University investigating use of Portal service
 - Managed Services: Interest in joint work for managed services at several LEARN member schools, associated with LEARN NSF CC* funding;
- **The Ohio Academic Resources Network (OARnet)** is the regional network for Ohio.
 - Consultations: #35, 51, 93
 - NetSage: Continued discussion for deployment
- **Southern Crossroads (SoX)** is the regional network for much of the southeastern part of the US, including parts of Alabama, Georgia, South Carolina, and Tennessee
 - Meetings: Discussions for membership took place this quarter
 - Roadside Assistance: #88
 - NetSage: Deployment in discussion

- **Sun Corridor** is the regional network for the state of Arizona
 - Meetings: Discussions for membership took place this quarter
 - Roadside Assistance: #81, 83
 - NetSage: Deployment in discussion
 - Deep Dive: Discussions for a Deep Dive to take place in Summer 2021 are ongoing
- **Texas Advanced Computing Center (TACC)** at the University of Texas at Austin, United States, is an advanced computing research center
 - Meetings: Discussions for membership took place this quarter
 - Roadside Assistance: #71 (Note: we include these for both LEARN and TACC)
 - Consultations: #62, 69 (Note: we include these for both LEARN and TACC)
 - NetSage: Deployment for TACC network in discussion, Archive deployment in production since 2019

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

5.C Infrastructure Partners

EPOC's Infrastructure Partners are used to leverage the 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 and participating in several of them actively and is planning a talk on Deep Dives for Quarter 2.
- **Trusted CI: The NSF Cybersecurity Center of Excellence** supports cybersecurity for NSF funded projects. Addleman is the main contact for Trusted CI. EPOC has been invited to give a talk during the ongoing Trusted CI Webinar series in Quarter 2. Southworth is preparing the presentation this quarter.
- **Internet2** supports solving common technology challenges for their over 200 educational, research, and community members. Schopf is the main contact for this organization. The Internet2 Global Summit, which was planned for April, was canceled. We are currently seeking additional ways to work with Internet2 in the absence of face-to-face meetings.
- **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 has submitted a story for the 2020 Quilt Circle Magazine, but has not received word of publication. EPOC staff are involved in the ongoing Quilt-run seminars related to the CC* program, and will give several presentations as part of this work in Quarter 2.
- **The Science Gateway Community Institute (SGCI)** provides best practice recommendations and support for scientists building and using data portals. In Quarter 1, Moynihan attended an internal SGCI partners video conference to learn more about their plans for 2020 and how they are adjusting to COVID-19 travel restrictions.

- **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 is updating XSEDE liaisons during the quarter. We are jointly consulting on Case #75.

5.D 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, 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.

The Year 3 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. In Quarter 1, the ESIP Executive Board made the decision to move all in-person meetings to virtual conferences until July 2021. This will impact their upcoming Summer meeting originally scheduled to be held in Burlington, VT, and their annual Winter meeting scheduled for January 2021 in Washington, DC. Discussions continue with ESIP leadership on the possibility of doing an EPOC Deep Dive at an upcoming meeting and what that might look like given the move to all virtual meetings.
- **The University of Hawai'i System Astronomy Community** supports 15 facilities with hundreds of researchers and experiments every year. Data was added to the NetSage science registry with this project, and staff members are trailing the Data Portal. We are also coordinating on Consultations #57.
- **The Midwest Big Data Hub (MBDH)** supports the use of data for a variety of applications and end users across twelve states. Southworth was planning to attend the All Hubs Meeting, a conference which includes all of the regional hubs, in June 2020. This meeting was cancelled due to COVID related travel restrictions. No updated meeting date has been set at this time.

5.E Advisory Committee

The EPOC External Advisory Board (EAB) members met virtually on April 17 2020 and were asked to offer feedback on key project goals, including:

- 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 could be adapted to address

The EAB provided valuable feedback that indicated that EPOC should not attempt to dilute core approaches, such as Deep Dives, just to adapt to an opportunistic virtual environment. Other items, such as targeted training, were worth pursuing if the outcome would lead to advancement of EPOC mission space. Most, if not all, members agreed that there will be a fundamental shift in a post-COVID-19 environment where R&E sites may have to make hard choices regarding supporting research activities.

5.F External Partners

In addition to the previously mentioned partners, 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.

We are working closely with members of the University of South Carolina Cyber Training team (MNSF#1829698), as detailed in Section 11.A.

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 Lunch and Learn series held from 2017 to present. To date, 87 webinars have been uploaded to the EPOC YouTube channel as of June 30, 2020, and available online at:

<https://www.youtube.com/channel/UChIaulc1bccif1Dz4cfZl0w>.

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, which helps collaborators when data sharing failures occur. EPOC coordinates with the multiple domains and organizations involved to achieve a resolution. 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 Roadside Assistance Cases

In Year 3 Quarter 1, we had one completed Roadside Assistance case:

- **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 each polled every 2.5 minutes by two separate servers on the TTU campus and each station sends back a few kilobyte data payload to both servers. On Thursday Dec 12, 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 13, 2020. The intermittent and complex nature of the problem made it very difficult to troubleshoot. The only change made shortly before February 13 was that the original collection server was retired and replaced by new hardware running the same collection program, which should not have affected this issue. Due to the intermittent nature of this problem, we held this engagement open for 10 weeks past the February problem resolution. TTU engineers reported that the problem has not recurred.

In Year 3 Quarter 1, we had four ongoing Roadside Assistance cases:

- **59 - Saint Louis University transfers to Amazon S3 Cloud:** 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. EPOC reached out to SLU IT staff to start, but the university 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 transfer path for the biology data. 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 set up several perfSONAR nodes for continued testing, but then left SLU. EPOC continues to engage with the SLU IT group, Missouri Research and Education Network (MOREnet), and the Great Plains Network (GPN) to debug this issue. During Quarter 1 EPOC staff met with SLU's Director of Infrastructure who confirmed that the network was planned to be upgraded during Summer 2020 and asked EPOC to engage again in September to retest the transfer rates. He also expressed interest in a Deep Dive on his campus in the future.
- **76 - NCAR 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 testing a new version of the file transfer protocol, based on UDP multicast, on a 5-site testbed that includes UCAR, University of Virginia (UVA), University of Wisconsin Madison (UW-M), University of Washington (UW) in Seattle, and University of California San Diego (UCSD). In the current setup, UCSD and UCAR are having issues with packet loss when sending and receiving from the other three sites. UW-M, UVA, and UW are able to transmit and receive data as expected from each other. EPOC staff worked with engineers for each institution as well as a suite of regional network engineers associated with the end points and narrowed the issue down to a single switch in the FRGP network. This device is scheduled to be replaced in July 2020, at which point we will resume testing.
- **90 - University of California Santa Cruz to A*STAR:** Researchers at the Agency for Science, Technology and Research (A*STAR) in Singapore have recently begun transferring large amounts of data from the University of California Santa Cruz (UCSC) Genome Browser. Slow transfer speeds of less than 60Kbps were noted by IN@IU staff using NetSage during an investigation into possible COVID-19 research data transfer performance issues. EPOC staff reached out to engineers at both UCSC and A*STAR in order to gather additional information regarding network configuration and endpoints. UCSC engineers shared the configuration of the Genome Browser end point and the path within the UCSC campus. UCSC has also updated their perfSONAR nodes to allow testing to A*STAR. Investigation into the cause of the performance issues is ongoing.
- **94 - National Library of Medicine to Academia Sinica Grid-computing Center (ASGC):** Researchers at ASGC in Taiwan have been consistently transferring roughly 3TB of biology-research data per month from the National Library of Medicine (NLM). While adequate performance was noted on some flows, the vast majority showed poor performance with transfer speeds of less than 5Mbps. EPOC staff engaged with engineers from NLM and ASGC. The first challenge was to determine the route for the data flows, as the Academia Sinica network is subdivided into segments that reach the United States

via different paths depending on their source location in the network. Investigation into the endpoint of these transfers on the Academia Sinica side is ongoing, and NLM engineers are prepared to allow perfSONAR testing to and from ASGC networks once the endpoint is identified.

6.B Consultation Cases

In Year 3 Quarter 1, we had eleven completed and sixteen ongoing consultations. The primary topics were assistance with planning for grant submissions or review responses, Science DMZ architectures, and data transfer strategies.

Completed consultations included:

- **50 - Mississippi State University (MSU):** MSU staff expressed interest in doing a Deep Dive or an EPOC-lead Deep Dive Training Event. When additional information was requested, MSU reported that they needed to focus on other priorities related to COVID restrictions, and that this case should be closed. They will reach out again when they have time to fully engage.
- **57 - University of Hawaii (UH):** UH Astronomy staff were seeing poor file transfer performance to and from the Ohio State University (OSU). UH network engineers were working jointly with EPOC staff to troubleshoot the UH DTNs for configuration errors. After installation of a perfSONAR node at OSU that showed consistently good transfer rates, UH engineers found that the application used for the file transfers used an unpatched version of rsync. Having identified the issue, the case with EPOC was closed and UH staff are working directly with the end users to upgrade or adapt the workflow for better performance.
- **67 - Veterans Administration (VA):** Engineers from the VA reached out to EPOC and ESnet staff for additional information related to the basics of SDN. EPOC staff responded, and also engaged staff from the FAUCET SDN and Network to Code teams.
- **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. We expect additional collaborations with this team in the future.
- **77 - Compute Canada:** EPOC and ESnet staff consulted with Compute Canada about the Zeek Intrusion Detection System architecture, switch characteristics, server decisions, and storage requirements.
- **80 - University of Central Florida:** EPOC met with a researcher at UCF working on COVID-19 testing who wanted to share data more effectively with collaborators. We discussed strategies for data movement, storing, sharing, and visualization.
- **84 - SANReN:** A SANReN engineer requested help contacting Globus administrators at German Climate Computing Centre (DKRZ), a national climate computing center in Germany. EPOC staff made sure that the user received a response to the questions from our contacts at DKRZ.
- **85 - Maryland Research and Education Network (MDREN):** The CTO of MDREN reached out to discuss a CC* proposal under review. A review requested additional information about the switches included in the proposal, and their suitability for large science data flows. MDREN sent a copy of their bill of materials (BOM) and network

diagrams to EPOC staff for review. EPOC and MDREN staff discussed the concerns, the proposed hardware, and the proposed architecture.

- **88 - Oakridge National Laboratory (ORNL):** Engineers from ORNL requested assistance configuring a new perfSONAR MaDDash installation. EPOC staff were able to correct configuration and permission errors that resulted in a functional MaDDash. ORNL engineers have expressed interest in further perfSONAR training when it becomes available.
- **89 - Ocean State Higher Education Economic Development and Administrative Network (OSHEAN):** An OSHEAN engineer requested information regarding perfSONAR installation and configuration, along with current best practices for DTN design and implementation. EPOC engineers were able to answer these questions over the course of two separate Zoom meetings.
- **93 - Kent State University (KSU):** Continuing efforts which began in 2019 (Cases 35 and 51), a KSU engineer reached out for advice and troubleshooting assistance for their 100G-focused perfSONAR MaDDash deployment. EPOC staff offered suggestions to correct several service-impacting errors in the configuration files, suggested updating the software, and provided additional support via targeted documentation. The KSU pS MaDDash deployment was fully operational on June 3, 2020.

Ongoing Consultations in Quarter 1 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 the need to clarify their data transfer use cases in order to deploy the correct infrastructure. This consultation is ongoing and will be picked up later when KSU configures equipment and works with their Internet Service Provider to bring up new links.
- **51 - Kent State University (KSU):** KSU engineers inquired about borrowing the EPOC Viavi network tester in early 2020. They will follow up when their deployment is ready for testing.
- **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 has provided.
- **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 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 network tester 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 and had a Zoom call with systems engineers and researchers at the Allen Institute about the basics of ScienceDMZ architecture, network hardware, and file transfer nodes. The Institute engineer is

interested in further engagement, however, they are currently addressing other pandemic-related critical tasks, and this work is ongoing as they can focus on this issue.

- **75 - Reed College (RC):** A researcher at RC was writing a grant to support data transfers for a high-end microscope that produced 4TB datasets. EPOC answered questions on file transfer nodes, Globus, and ScienceDMZ. The proposal was submitted in early March, but our conversation is ongoing.
- **81 - Sun Corridor:** Staff from Sun Corridor, the regional R&E network for Arizona, and EPOC met via Zoom to review their ScienceDMZ CC* proposal. Topics discussed included architecture, DTN, perfSONAR, intrusion detection systems including Zeek, and firewalls. EPOC will follow up on the status of their proposal in Quarter 2.
- **83 - Arizona State University Sustainable Cities Network (ASU SCN):** EPOC reviewed the SCN CC* proposal with ASU staff and discussed ScienceDMZ architecture for small campuses. This engagement remains open for possible future action items.
- **86 - OneNet:** EPOC staff spent time with OneNet staff reviewing questions they received from an NSF review panel about switch buffering, network hardware, and their proposed ScienceDMZ. The proposal is still pending and we will engage again in Quarter 2 if needed.
- **87 - Penn State to the Advanced Light Source at Berkeley (ALS):** Penn State reached out to an EPOC team member directly as part of their set up to support computed tomography (CT) imaging at the ALS since Argonne will be closed for an upgrade next year. Penn State staff requested estimates for expected file transfer rates between Penn State and ALS Berkeley. EPOC staff provided baseline iperf tests between the borders and requested additional information on both endpoints. Penn State has an enterprise firewall as well as a firewall in front of the Medical college.
- **91 - Rede Nacional de Ensino e Pesquisa (RNP):** EPOC engineers are consulting with the Brazilian NREN, RNP, to assist them with specifications for 100G capable data transfer nodes and sharing known performance results for various configurations.
- **92 - University of Central Florida (UCF):** UCF requested information about sustainability models for both staffing and hardware. A custom spreadsheet of the service and financial models was completed and shared with UCF. A follow-up call is pending.
- **95 - City College of New York (CCNY) to Japanese Gigabit Network (JGN):** Engineers at the JGN reported packet loss across a tunnel between a JGN device in Seattle and a workstation endpoint at CCNY. EPOC staff have engaged engineers at CCNY to set up perfSONAR tests between the sites. At this time, testing has not replicated the packet loss. Several configuration changes are taking place, and this will continue to be followed.
- **96 - Yale:** EPOC and Yale staff met virtually to discuss their proposed ScienceDMZ architecture, DMZ best practices, and known pros and cons of using Cisco SDA network technology. Further discussion centered around Yale use cases and where to best position data transfer nodes. EPOC will check on their progress in Quarter 2.
- **97 - University of Central Florida (UCF):** UCF requested assistance to redesign their research and production networks, including the restoration of their perfSONAR testing infrastructure. Initial contact with EPOC resulted in the development of a basic plan of attack and subsequent email exchanges have helped keep the process moving forward. EPOC will continue to answer questions and offer design assistance regarding their testing infrastructure and methodology as the project progresses.

6.C Metrics

Table 2: A summary of Year 3 Quarter 1 Roadside Assistance and Consultation Cases. Green rows are completed cases.

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
35	Kent State	OARnet	Cons	9/24/19		DTN	Eng	Infra	R	S
50	MSU	GPN	Cons	11/1/19	6/1/20	DD, Training	Eng	Infra	E	L
51	Kent State	OARnet	Cons	11/1/19		Tester, PS	Eng	Infra	R	S
57	U Hawaii	HI Astro, OARnet	Cons	12/6/19	5/26/20	Trans Perf	Sci	Infra	E	L
59	SLU/AWS	GPN	RA	12/11/19		Trans Perf	Sci	Bio	E	S
62	LEARN	LEARN/TACC	Cons	12/13/19		DTN	Eng	Infra	O	-
67	VA	-	Cons	1/9/20	5/11/20	SDN	Eng	Infra	O	-
69	UT San Antonio	LEARN/TACC	Cons	1/21/20		DMZ, Security	Eng	Infra	R	L
71	Texas Tech	LEARN/TACC	RA	2/6/20		Trans Perf	Eng	Climate	E	L
72	GPN	GPN	Cons	2/13/20	6/22/20	Intro, DD	Eng	Infra	E	L
73	Duquesne University	KINBER	Cons	2/20/20		Tester	Eng	Infra	E	S
74	Allen Institute	-	Cons	2/28/20		DMZ, DTN	Eng	Bio	R	S/M
75	Reed College	XSEDE	Cons	3/5/20		DMZ, DTN, Globus	Eng	Bio	E	S
76	NCAR	FRGP	RA	3/6/20		Trans Perf	Eng	Climate	R	L
77	Compute Canada	-	Cons	3/13/20	5/13/20	IDS	Eng	Infra	R	L
80	UCF	-	Cons	3/31/20	5/11/20	Arch	Eng	Bio	R	L
81	Sun Corridor	SC	Cons	4/3/20		DMZ	Eng	Infra	E	L
83	ASU	SC	Cons	4/6/20		DMZ, Security	Eng	Infra	E	S
84	SANReN	NEAAR	Cons	4/3/20	4/8/20	Trans Perf	Eng	Infra	R	M
85	MDREN	-	Cons	4/23/20	6/30/20	DMZ, Trans Perf, Grant	Eng	Infra	E	-
86	OneNet	GPN	Cons	4/29/20		DMZ	Eng	Infra	E	-

87	Penn State	KINBER	Cons	4/30/20		Trans Perf	Scientist	Bio	E	L
88	ORNL	SoX	RA	5/5/20	5/29/20	PS	Eng	Infra	R	L
89	OSHEAN	-	RA	5/11/20	6/10/20	PS	Eng	Infra	R	S
90	UCSC-A Star	TP	RA	5/20/20		Trans Perf	Eng	Infra	R	L
91	RNP (Brazil)	-	Cons	5/27/20		Trans Perf	Eng	Infra	R	L
92	UCF	-	Cons	5/29/20		DMZ	Eng	Infra	E	L
93	Kent State	OARnet	Cons	6/1/20	6/03/20	PS	Eng	Infra	E	S
94	NLM/ASGC	TP	RA	6/5/20		Trans Perf	Eng	Bio	R	S
95	CCNY/JGN	TP	Cons	6/8/20		Trans Perf	Eng	Security	E	L
96	Yale	-	Cons	6/16/20		Arch, DMZ	Eng	Infra	E	L
97	UCF	-	Cons	6/26/20		PS	Eng	Infra	E	S

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.

7.A Completed Application Deep Dives

The following Deep Dive activities are complete and published:

- 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 final report was published in May, 2020 [7].

7.B In Progress Application Deep Dives

There is one ongoing Deep Dive report:

- 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 seven completed Deep Dives to date, we now have a set of data regarding CI preparedness 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 Upcoming Deep Dives

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.

Prior to COVID-related travel restrictions, there were three Deep Dives in planning:

- **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. This is tentatively scheduled for January 2021. The previously separate Northern Arizona University event has been combined with this event.
- **University of Central Florida (UCF):** Staff from UCF approached EPOC to stage a Deep Dive for the campus, now tentatively scheduled for Spring 2021.
- **University of South Dakota (USD):** Staff from USD approached EPOC to stage a Deep Dive for the campus, now tentatively scheduled for Summer 2021.

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. 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 would be, and the Advisory Board also emphasized their belief that

this activity would lose much of its effectiveness without the in person component. 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
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. Y3Q2
1/21	Arizona State Univ, Sun Corridor	Priv	ASU, UofAZ, NAU, and Sun Corridor Network staff	Req			
Spring 2021	Univ Central Florida	Priv	University Researchers & Staff, Florida Lambda Rail	Req			
Spring 2021	Univ South Dakota	Priv	Staff from GPN, USD, SDSU, Black Hills State, and other guests	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 Deployments

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 and flow dashboard for the GPN associated circuits (<http://gpn.netsage.global>) was initially deployed in October 2018 for just SNMP data. At the end of April 2020, we finished work with GPN to successfully deploy a containerized version of the NetSage Ingest Pipeline, allowing us to start collecting and visualizing flows that had been deidentified within the GPN boundary. The flow dashboards were rolled out for GPN shortly after this time. Members from the EPOC team met with GPN at the end of May to review these new features as well as to gather feedback about future work. This resulted in several new items tracked in NetSage development.
- **iLight/Indiana GigaPop:** Flow data collection for the five Indiana GigaPop routers began in mid-April 2019, and continues to be publicly available at <http://ilight.netsage.global>. We have begun to work with iLight to identify members on their network without ASNs so that we can properly tag them using Shared Whois Project (SWIP) data. Initial tests and code have been written that show this works, though we are waiting on the documentation of these addresses to be cleaned up. This task will hopefully be completed in Quarter 2.
- **KINBER:** Collection of flow data for the PennREN network began at the end of October 2019 and remains publicly accessible at <https://pennren.netsage.global/>. Similar to iLight above, we have begun working with engineers to identify and properly tag members without ASNs on their network using Shared Whois Project (SWIP). This work will continue into Quarter 2.
- **LEARN:** At their 2019 All Hands Meeting, LEARN staff expressed an interest in moving forward to deploy NetSage for the state of Texas network. We made contact with the new LEARN CEO, who has asked to delay additional conversations until August 2020.
- **FRGP:** The FRGP Technical Advisory Board approved the sending of de-identified flow data to the NetSage Archive in December 2019 and remains 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.
- **TACC:** Conversations with TACC about an EPOC deployment for flow data from network devices kicked off in April 2020. We already have been collecting Tstat data from their archive sites as a separate effort. Work on the flow collection began shortly afterwards on deploying the new containerized flow pipeline and is nearly complete. We anticipate that a public NetSage instance for TACC will be available in Quarter 2.
- **Southern Crossroads:** Initial talks geared towards getting a SoX NetSage deployment kicked off in April 2020. After some initial discussions and a few pauses, we ultimately started receiving data at the very end of June. Barring any unforeseen issues, this should be complete and publicly accessible in Quarter 2.

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:** The TACC archive 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. This work is running in a stable state.
- **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 Network Performance Detection

This quarter, EPOC staff began to use NetSage to investigate performance issues for databases related to COVID research. This is related to the original project milestone of using NetSage to detect or analyze network “disturbance”. The thinking was that in many cases, groups that were publishing COVID data had likely done so without thought to the performance and so it was likely to be poor.

The first end-to-end performance investigations are described as part of the Roadside Assistance cases 90 and 94 in Section 6.B. We expect there to be others in the upcoming quarters.

8.C Metrics

Table 4: Metrics for NetSage activities for Year 2.

Where Regional	Data	Date Live	# Monitored Devices	# Large Flows	# Unique Src Orgs	# Unique Dest Orgs
GPN	SNMP, Flow	10/18	2 routers	3,750,750	523	1585
iLight	Flow	4/19	5 routers	18,957,502	2,752	9,888
KINBER	Flow	11/19	2 routers	6,403,514	2,072	4,407
FRGP	Flow	1/20	1 router	30,843,470	2,679	4,665
TACC (LEARN)	Tstat	1/19	4 head nodes	10,429,565	251	335
UHawaii Astro	Tstat	5/19	1 DTN	135,184	98	265
NCAR (FRGP)	Tstat	7/19	1 DTN	10,772,785	499	1,907
NERSC	Tstat	3/18	11 head nodes	1,058,134	100	87

9. Data Mobility Exhibition and Data Portal

In Quarter 1, we decided to formally add an Activity area to group the work on the Data Mobility Exhibition and the Data Portal. Ken Miller is the lead for this area.

9.A 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/>.

This effort was launched in September 2019 as part of the CC* PI Meeting/Quilt meeting. Since that time, approximately 665 tests had been performed as of June 2020. 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.

9.B 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. 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.

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 Data 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 with a deployment at ESnet. This quarter, we identified two pilot sites, the University of Hawaii Astronomy group and LEARN member Baylor. Early results have focused on technical implementation details (e.g. ease of deployment and integration with existing campus infrastructure). Extensive testing with scientific users will start in Quarter 2.

10. Managed Services (aka “In a Box”)

EPOC is 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.

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.

10.A 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. There is currently a delay with this aspect of EPOC as much of this activity involves hands-on deployments, which are not feasible at all times with current COVID-related restrictions in place. 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.
- **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. Remote assistance has continued intermittently as Arcadia engineers can make time to meet. Currently Arcadia engineers are discussing internal issues surrounding the Science DMZ network security before work can continue in Q2. KINBER member institution Duquesne University is also working with EPOC to use the Viavi network tester (Consultation #73), which will take place when restrictions related to COVID-19 are eased.
- **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.

- **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.

11. 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.

11.A Collaboration with University of South Carolina

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 work 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 participated in the Training Workshop for Educators and Network Engineers on High Speed Network Protocols and Security, (http://ce.sc.edu/cyberinfra/workshop_2020.html) that took place on May 4, 2020. Talks included:

- Zurawski, J., "Science DMZ and TCP",
- Chevalier, S., Southworth, D., "perfSONAR Overview"
- Addleman, H., Dart, E., "BGP Architectures and Best Practices"
- Miller, K. "Security best practices in high-speed networks"

The workshop was attended by over 150 individuals over a 3-day period. The reviews were generally positive, but did note the need to improve:

- Lecture vs. hands on;
- Time allotment per talk, and overall (e.g. need for more breaks)
- Mechanisms to judge understanding of audience;

Year 3 plans with USC include two additional events: a second Virtual Workshop, tentatively planned for Fall 2020, and some activities jointly with LEARN tentatively scheduled for September 2020. In both cases, EPOC staff will be involved in presentations related to Science DMZs, perfSONAR, and BGP.

11.B Border Gateway Protocol (BGP) Training

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 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 will solicit feedback on network engineer BGP experience via a survey sent out to the community in Quarter 2. This survey will help inform upcoming content and training opportunities.

Dart and Adleman also presented “Network Strategies to Enable Data Intensive Science” in May as part of the CI Engineering Brown Bag webinar series. This talk focused on why proper BGP configurations are important for high throughput data transfers.

11.C PerfSONAR Video updates with NSRC

The Network Startup Research Center (NSRC), based at the University of Oregon, had previously worked with members of the perfSONAR community to create a series of instructional videos for perfSONAR in August 2016. EPOC staff are working collaboratively with both NSRC and the perfSONAR Documentation and Training team to update this material. During this quarter, the existing NSRC perfSONAR video library was evaluated and marked for replacement or edits where needed. Video production has not yet begun.

11.D 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. This includes the creation of “evergreen talks”, talks that are still applicable over time, not dated (aka brown and withered) due to changes in technology. These will focus on routing policy, performance monitoring, or system design. 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.

One of the first of the new training videos will be on the topic of “How do I specify a 10G DTN”. This is meant to be a very pragmatic approach to the defining and purchasing of a data transfer node, with walk throughs and pointers to component selection decision points and reasoning.

12. 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 3 Quarter 1.

13. Reporting Against Deliverables

Table 5 lists the current deliverables and their status.

WBS #	Deliverables	Status
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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, Compl Y2Q4
RA 3.2.5	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	C - Baylor (66)	Started Y2Q4, Compl Y2Q4
RA 3.3.7	C- UTSA (69)	Started Y2Q4, Ongoing
RA 3.3.8 (NEW)	RA-Texas Tech (71)	Started Y3Q1, Compl Y3Q1
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, Compl Y3Q1
RA 3.4.6	C- UCinn (68)	Started Y2Q4, Compl Y2Q4
RA 3.4.7 (NEW)	C-Kent State (93)	Started Y3Q1, Compl Y3Q1
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, Compl Y3Q1
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	C- GPN (72)	Started Y2Q4, Compl Y3Q1
RA 3.4.10 (NEW)	C- OneNet (86)	Started Y3Q1, 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	C- Duquesne (70)	Started Y2Q4, Compl Y2Q4
RA 3.6.6	C- Duquesne (73)	Started Y2Q4, Ongoing
RA 3.6.7 (NEW)	C- Penn State (87)	Started Y3Q1, 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	MWBBDH RA	Ongoing
RA 3.12	OSN RA	OBE
RA 3.13 (NEW)	SoX RA	
RA 3.13.1 (NEW)	C- Vanderbilt (20) -prev. RA 4.11	Started Y2Q1, Compl Y2Q1
RA 3.13.2 (NEW)	C- U Southern Carolina (60) - prev. RA 4.32	Started Y2Q3, Compl Y2Q4
RA 3.13.3 (NEW)	C- ORNL (88)	Started Y3Q1, Compl Y3Q1
RA 3.15 (NEW)	Sun Corridor RA	
RA 3.15.1 (NEW)	Sun Corridor (81)	Started Y3Q1, Ongoing
RA 3.15.2 (NEW)	ASU (83)	Started Y3Q1, Ongoing

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	Now RA 3.12.1	
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	Now RA 3.12.2	

RA 4.33	C-U Southern California DMZ (64)	Started Y2Q3, Compl Y2Q4
RA 4.34	C - VA (67)	Started Y2Q4, Compl Y3Q1
RA 4.35	C - Allen Inst (74)	Started Y2Q4, Ongoing
RA 4.36	C - Reed (75)	Started Y2Q4, Ongoing
RA 4.37	C - Compute Canada (77)	Started Y2Q4, Compl Y3Q1
RA 4.38	C - MIT (79)	Started Y2Q4, Compl Y2Q4
RA 4.39	C - UCentral FL (80)	Started Y2Q4, Compl Y3Q1
RA 4.40 (NEW)	SanREN (84)	Started Y3Q1, Compl Y3Q1
RA 4.41 (NEW)	MDREN (85)	Started Y3Q1, Compl Y3Q1
RA 4.42 (NEW)	OSHEAN (89)	Started Y3Q1, Compl Y3Q1
RA 4.43 (NEW)	UCSC-ASTAR (90)	Started Y3Q1, Ongoing
RA 4.44 (NEW)	RNP (91)	Started Y3Q1, Ongoing
RA 4.45 (NEW)	UCF (92)	Started Y3Q1, Ongoing
RA 4.46 (NEW)	NLM/ASGC (94)	Started Y3Q1, Ongoing
RA 4.47 (NEW)	CCNY/JGN (95)	Started Y3Q1, Ongoing
RA 4.48 (NEW)	Yale (96)	Started Y3Q1, Ongoing
RA 4.49 (NEW)	UCF (97)	Started Y3Q1, 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	Ongoing
NS 3.1 (NEW)	Examine COVID-related data transfer performance	Started Y3Q1, Ongoing
D/P (NEW)	Data Mobility Exhibition/Data Portal	Note: Restructured Y3Q1
DP 1 (NEW)	Data Mobility Exhibition Setup	Ongoing
DP 2 (NEW)	Data Mobility Exhibition Support	Ongoing
DP 3 (NEW)	Data Portal	Ongoing
DP 3.1 (NEW)	Portal Prototype Development (Prev MS 1.5)	Development begun Y2
DP 4 (NEW)	Portal Deployments	Ongoing
DP 4.1 (NEW)	Portal with Baylor (LEARN) (Prev MS 2.3.3)	Started Y3Q1
DP 4.2 (NEW)	Portal with GPN member (Prev MS 2.5.2)	OBE
DP 4.3 (NEW)	U Hawaii Astronomy Data Portal MS	Started Y3Q1
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	Tester Managed Service	Definition Compl Y2
MS 1.5	Now DP 3.1	
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	Now DP 4.1	
MS 2.4	OARnet MS	TBD
MS 2.4.1	OARnet DT MS	On hold Year 3
MS 2.4.2	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	Now DP 4.2	
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	Testset Loan to Duquesne	Expected Y3 (COVID)
MS 2.7	Other MS Deployments	Ongoing
MS 2.7.1	Now DP 4.3	
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	Compl Y3Q1 (virtual)

T 2.8	CyberTraining w/USC - BGP, PS, DMZ	Delayed until Jul'20 (COVID)
T 2.9 (NEW)	PS Training w/ USC and LEARN	Planned Y3 Q2 or 3
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	BGP BOF at I2 TechEx	Compl Y2Q3
T 4.4	BGP BOF at I2 Global Summit	Delayed (COVID)
T 4.5	PS NSRC Updates	Ongoing
T 4.6	10G Easy DTN Video	Started Y3Q1, ongoing
T 5	Reworking Training during COVID	Ongoing
T 5.1	New plan development	Started Y2Q4, ongoing

14. Financials

Item	Univ	Apr-20	May-20	Jun-20	TOTAL
STAFF COSTS (INC. BENEFITS, F&A)					
Schopf, Jennifer-PI	IU	3,007	3,007	9,020	15,034
Addleman, Hans	IU	7,110	7,110	12,186	26,406
Chevalier, Scott	IU	594	594	594	1,782
Southworth, Doug	IU	3,248	3,248	4,547	11,043
Moynihan, Ed	IU	0	0	1,890	1,890
Hubbard, Heather	IU	1,635	2,359	1,573	5,567
Doyle, Dan	IU	2,315	2,315	2,315	6,945
IU Dev Team	IU	8,094	8,094	8,094	24,282
IU OmniSOC support	IU	1,188	1,188	1,188	3,564
Zurawski, Jason	LBNL	8,650	12,357	14,154	35,161
Robb, George	LBNL	1,299	680	1,299	3,278
Miller, Ken	LBNL	5,844	8,164	8,442	22,450
TOTAL STAFFING		42,982	49,115	65,302	157,399
Travel - Addleman I2 GS IN Mar'20	IU		-1,181		-1,181
Travel - Schopf CENIC CA Mar'20	IU		-745		-745
Travel - Chevalier SC CO Nov'19	IU	6,390			6,390
Travel - Southworth SC CO Nov'19	IU	8,437			8,437
Travel - Chevalier Arcadia PA Mar'20	IU		691		691
TOTAL TRAVEL		14,827	-1,235	0	13,592
TOTAL EXPENDITURES		57,809	47,880	65,302	170,991

Table 6: Year 2 actual expenses.