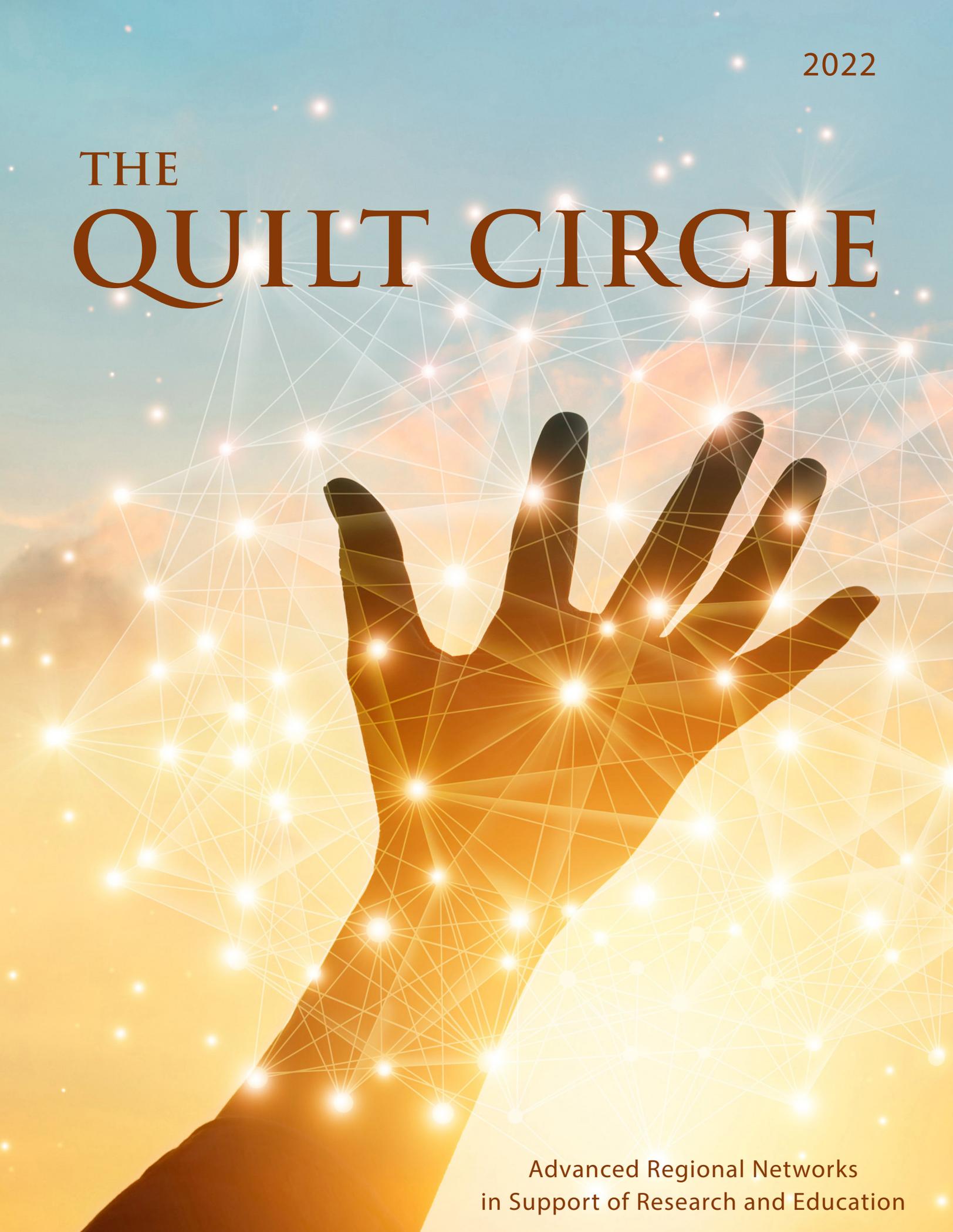


2022

THE QUILT CIRCLE



Advanced Regional Networks
in Support of Research and Education

A Letter From the President

Welcome to the 2022 edition of *The Quilt Circle*. Each annual edition highlights the impact the national research and education (R&E) networking community has on broadband infrastructure and shares the many ways that we each collaborate with one another to support the 100,000 community anchor institutions that connect to these networks.

The pandemic has stretched us in so many ways; as individuals, families, and communities. Being true to our public service missions, the R&E networking community has answered and even amplified the call over the past two years to rethink connectivity, resiliency, and security to meet the needs of our researchers and students. Our non-profit member networks continue to lead the way as we all embark on a journey towards new frontiers across America that will come from a once-in-a generation investment by the federal government in broadband infrastructure.

I encourage you to dive right into this edition to learn how R&E networks have risen to the challenge during the pandemic. You will discover wonderful examples of how R&E networks are uniquely positioned to solve difficult Internet access challenges for community anchor institutions that have vital public service roles. Read about how several Quilt members forged unique partnerships for the purpose of improving connectivity to public libraries as critical points of internet access for their communities. This edition also has a treasure trove of examples of how R&E networks play a significant role within a global research IT ecosystem providing network infrastructure, software, tools, and training to further scientific discovery and collaboration among higher education institutions of all sizes. Members of The Quilt are key partners in supporting strategic investments by the National Science Foundation in higher education cyberinfrastructure that enables academic research and leading-edge science curriculum through its Campus Cyberinfrastructure program.

Our R&E networks have long understood the importance of middle-mile networks for delivering high-performance network connectivity and technology services for research and education. As experts in owning and operating these types of networks for decades, we are uniquely positioned to create solutions that bridge the digital divide for unserved and underserved areas. You also won't want to miss the article at the center of this year's edition that highlights the collaboration across our Quilt member organizations, university partners, and other national stakeholders to address the talent gap of underrepresented populations in technical fields such as networking.

This remarkable compilation of stories from our members is a reminder of the roles each one of us plays in our collective success and in strengthening the national fabric of the R&E networking community that we call "The Quilt".

A handwritten signature in black ink that reads "Jen Leasure". The signature is written in a cursive, flowing style. The background behind the signature is a decorative pattern of glowing orange and yellow nodes connected by thin white lines, resembling a network or constellation.

Jen Leasure
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OARnet's rapid growth continues with major network upgrades

The Ohio Academic Resources Network (OARnet), which provides technology solutions to education, government, and health care communities in Ohio, was one of five R&E Networks in the nation to initiate a 400G connection to Internet2 by the end of 2021.

During 2022, OARnet will upgrade its current 100G Internet2 connections in Cleveland and Cincinnati, which support peering, cloud computing, research, and education activities. The network has seen more than a 50 percent utilization rate. Planning for the future, OARnet will create a unique architecture to support growth of those dedicated services.

“During the last two years OARnet has experienced significant demand for its network,” said Pankaj Shah, executive director of OARnet. “Educational institutions face a growing need for cloud services and connectivity. In addition, the state has seen an increase in the number of researchers actively pursuing new projects and collaborations, especially in the very topical areas of health care and cybersecurity.”

The Internet2 connection offers colleges and universities the ability to easily collaborate with hundreds of other higher education institutions across the country. These collaborations have helped advance the endeavors of Ohio's research-intensive institutions, which include five R1 and eight R2 universities, as well as entities such as the Wright-Patterson Air Force Base.

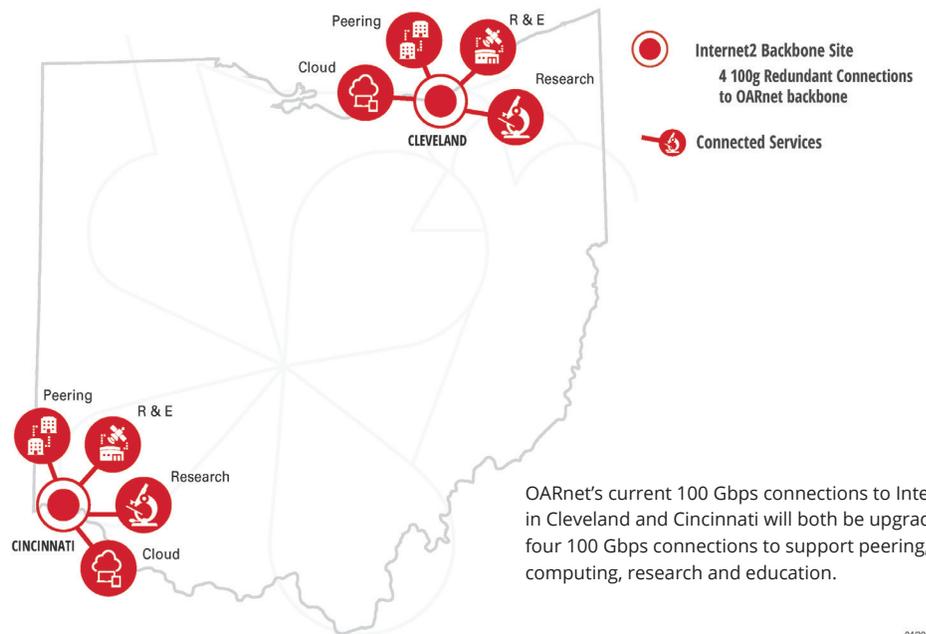
Researchers at The Ohio State University, for example, are able to participate in the ATLAS collaboration that is conducting

groundbreaking particle physics research at the Large Hadron Collider at CERN in Switzerland. Ohio State scientists also attracted \$15 million in NSF funding for a new Imageomics Institute to advance research in the biomedical, biological, and agricultural sciences. The Ohio Supercomputer Center, Ohio State, and Case Western Reserve University are collaborating on the new \$20 million NSF-funded AI Institute for Intelligent Cyberinfrastructure with Computational Learning in the Environment (ICICLE), which will render AI more accessible to everyone.

In the lead-up to the 400G project, OARnet has been playing an active role in supporting the rising networking needs of K-12 and higher education institutions in Ohio. In late 2020, the Ohio Department of Higher Education awarded OARnet \$12.1 million from the Governor's Emergency Education Relief (GEER) Fund to establish the Last-Mile Enhancement Program, through which

OARnet is increasing broadband at 41 Ohio colleges and universities and doubling the Internet subscriptions at connected institutions for two years. By the end of 2022, all OARnet member schools will have a minimum 10G last-mile connection to their campuses.

In July 2021, OARnet received an NSF Campus Cyberinfrastructure (CC*) planning grant for the Virtual Research-Education Ohio (VROhio) program, which will build on these upgraded capabilities. OARnet and its partners are developing a network of STEM training and research resources for smaller higher education institutions across Ohio. The Ohio Supercomputer Center and the Case Western Reserve University Electron Microscopy Facility are initial content and resource providers on the project, which is also supported by national entities EPOC, The Quilt, InCommon/Internet2, and Trusted CI.



04/20/2021

The Ohio Academic Resources Network (OARnet), a division of the Ohio Department of Higher Education's Ohio Technology Consortium (OH-TECH), serves the state's government, education, healthcare and public broadcasting communities. Through innovative public-private partnerships and a state-of-the-art fiber optic network, OARnet expands access to affordable broadband and delivers critical networking and technology services for academic and commercial R&D. www.oar.net

OneNet extends supercomputing resources to small universities

Thanks to new connections to OneNet's research network, smaller universities such as the University of Science & Arts in Chickasha, Okla., now have access to supercomputing resources across the state, allowing for quicker computation of data and new opportunities for research initiatives.

Last fall, Science & Arts connected to the OneOklahoma Friction Free Network (OFFN) through a NSF Campus Cyberinfrastructure (CC*) grant awarded to the Oklahoma State Regents for Higher Education and OneNet. OFFN is a 10 and 100 Gbps research network that provides higher education institutions with a dedicated Internet route that is much faster than traditional Internet highways.

The new connection opened doors for faculty and students to access supercomputing resources at Oral Roberts University in Tulsa, which was connected to OFFN in 2019 through a previous NSF grant award.

"The OFFN connection provides opportunities for smaller institutions to access high-performance computing resources that previously were not possible, allowing for greater collaborations and scientific discovery,"

said Brian Burkhart, OneNet's senior director of network services. "The OFFN network runs parallel to OneNet's network, and the extension of the OFFN network to the smaller institutions furthers OneNet's mission of advancing research and education initiatives across the state."

With the new OFFN connection, Science & Arts' associate professor of chemistry Dr. Dany Doughan requested use of Oral Roberts' Titan supercomputer to conduct potential energy surface calculations of a multifunctional organic molecule and transfer the data at high-speed between the data transfer nodes (DTNs) on their OFFN connection. When Science & Arts reached out to university, it allowed them to pursue other advanced research projects with Titan's high-performance computing capabilities. With the supercomputer, scientific calculations can be processed at much higher speeds, allowing researchers to accelerate their projects and find results quicker.

"OneNet's OFFN network allows for a quick transfer of the large set of molecular configurations to Titan. The supercomputer speeds up the calculations and the OFFN connection sends them to Science & Arts," said Doughan. "Without the OFFN connection, the data transfer

between the two institutions would take a lot longer, which would impede the progress of the data analysis process."

Doughan is leveraging his research in chemistry with the supercomputer to change certain aspects of the pharmaceutical industry processes. Prior to utilizing the supercomputer, researching the potential energy surface of a multifunctional organic molecule would be a very slow and computationally taxing process to run on a single machine. Due to the advanced computation required to successfully complete this project, Doughan put the research on hiatus for an extended time. Science & Arts' new connection to OFFN changed that timeline.

"The ability to generate potential energy surfaces in a short period of time can change how we develop a timeline for active ingredient identification in the pharmaceutical industry, or how we decide on viable chemical reagents without having to purchase a number of candidate molecules and test them in a wet laboratory setting," Doughan said.



As a division of the Oklahoma State Regents for Higher Education, OneNet's mission is to advance technology across Oklahoma. OneNet serves colleges and universities, research centers and laboratories, public and private schools, libraries, tribal organizations, hospitals and clinics, non-profit organizations, and local, state, and federal governments. www.onenet.net

OSHEAN closes broadband gap for Providence's most vulnerable



The pandemic exposed just how broadband access really is in today's world. When lockdowns forced school districts to go remote and the term "distance learning" leapt from education jargon to commonplace and the enormity of the broadband access gap was laid bare for many in our state and across the country.

While the broadband gap exists in all communities, it's wider in Rhode Island's most urban areas, including the capital city. When the pandemic forced temporary closures of otherwise reliable, well-known free Wi-Fi access locations like libraries, coffee shops and community centers, ONE Neighborhood Builders stepped up to fill the need in the Olneyville neighborhood. ONE|NB, as they are known, is a Providence-based community development organization now providing free Internet to a portion of the Olneyville neighborhood situated in West-central Providence. Working

with IT partners Ocean State Higher Education Economic Development and Administrative Network (OSHEAN), Brave River and Harbor Networks, ONE|NB built a mesh Wi-Fi network covering 5 million square feet in the community, serving roughly two-thirds of all local residents.

"The Internet is a public utility," said Jennifer Hawkins, executive director of ONE|NB. "No one questions whether you should have access to clean water and heat and so forth, right? For so long, we just considered the Internet to be a luxury, a convenience. But, it really has absolutely transcended that at this point in time."

It wasn't long ONE|NB got off and running in late 2020, on a mission to provide broadband for the Olneyville neighborhood, that the team at OSHEAN stepped up to help make free community Wi-Fi a reality.

"Partnering with ONE|NB has been a natural fit for OSHEAN as we're able to lend not only our expertise interacting with service providers like Cox, regulatory compliance and engineering know-how, but also just executing on delivering reliable broadband access within Rhode Island," said David Marble, CEO at OSHEAN.

OSHEAN was in the thick of the project the whole way, working with Brave River and Harbor Networks to find Wi-Fi design solutions that blanketed as much of the community as possible. Together, the teams collaborated on mapping, engineering and network design, with ADT installing the hardware. They also developed a heat map to determine the optimal locations for Wi-Fi access point placement that would cover the greatest number of people with the fewest number of devices. Olneyville's high population density was an advantage, with about 6,900 people within just four-tenths of a mile. Ultimately, the team chose two underground fiber-optic cable routes connecting 12 access points, a solution that covered a little more than 66% of Olneyville's residents with a strong Wi-Fi signal.

OSHEAN looks forward to repeating this success in other neighborhoods - working either with municipalities or housing authorities to create more public Wi-Fi networks. "The Internet is not a luxury anymore, but a necessity to opportunity," added Marble. "We've got a long way to go in bridging access gaps, but we're prepared to work with state and local leaders to help make that goal a reality."

For two decades, OSHEAN, Inc., has played a significant role in connecting people, institutions, technologies, and solutions across the research and education community in southeast New England. By delivering a next-generation technology infrastructure and solutions to member institutions and the communities they serve, OSHEAN empowers healthcare organizations, colleges and universities, K-12 schools, libraries, government agencies, and other community organizations to build relationships, leverage shared expertise, foster innovation, and advance their missions.

www.OSHEAN.org

QuaNeCQT project aims to connect quantum computers to a quantum Internet

The National Science Foundation recently awarded \$5 million through a two-year cooperative agreement to a multi-institutional team for the Quantum Networks to Connect Quantum Technology (QuaNeCQT) Project (NSF Award #2134891). The research team includes Edo Waks (PI, UMD), Norbert Linke (co-PI, UMD), Tripti Sinha (co-PI, UMD/MAX), Dirk Englund (co-PI, MIT), and Saikat Guha (co-PI, U. Arizona).

The goal of QuaNeCQT is to develop technologies and hardware that enable quantum computers to communicate over the Internet. This project is a continuation of the work completed by the same multi-institutional team in 2020 (NSF Award #2040695).

QuaNeCQT is a logical next step as more and more quantum computers emerge. Just like the classical Internet revolutionized lives by enabling computers to communicate with each other, the quantum Internet could potentially do the same by enabling quantum computers to connect over long distances. However, before this can happen, core technologies which connect quantum computers to quantum networks will need to be developed, including quantum hardware equivalents of modems and routers that have the capability of routing quantum information (qubits).

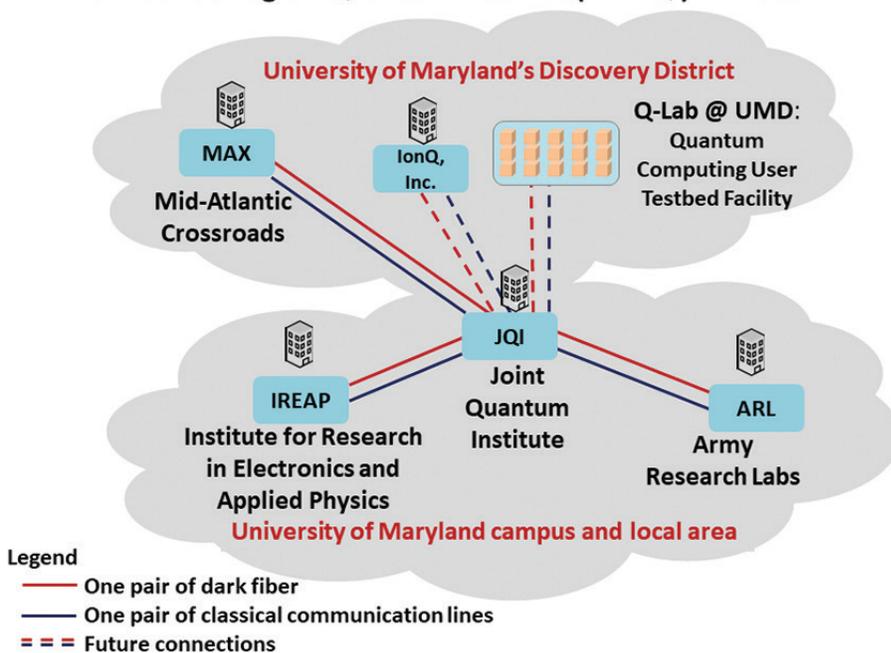
Two deliverables will be produced by the QuaNeCQT team during this two-year project.

The first deliverable is the *qFC module* which acts as a quantum modem and provides an interface between a quantum computer and a fiber network by converting quantum information from quantum computers to telecom-wavelength photons using a process called Quantum Frequency Conversion (qFC). The first generation qFC module focuses on the photon conversion from ion-trap quantum computers and the team is also considering photon conversion for other flavors of quantum computers. The second deliverable is the *qROADM module* which is a quantum router that routes signals while preserving their quantum coherence using Quantum Teleportation. Once developed, these devices will be deployed in the Mid-Atlantic Region Quantum Internet network (MARQI), a network of fiber connections between several research labs containing ion-trap quantum

computers and single-photon detectors. MARQI will be expanded to include IonQ, a leading developer of quantum computing devices, and University of Maryland's new quantum computing user testbed facility, Q-Lab.

This project will bring the quantum community a step closer towards a fully functional quantum Internet – a valuable resource for research and education communities. MAX built the nascent quantum network footprint in phase I and continues to build the network testbed to add additional nodes and trial these emerging technologies. The MAX network footprint will be leveraged to provide significant opportunities for future expansion of the MARQI network footprint in Washington, D.C., Northern Virginia, and Baltimore region.

Mid-Atlantic Region Quantum Internet (MARQI) – Phase II



Mid-Atlantic Crossroads (MAX) is a center at the University of Maryland that operates a multi-state advanced cyberinfrastructure platform. MAX's all-optical, Layer 1 core network is the foundation for a high-performance infrastructure providing state-of-the-art 100-Gbps network technology and services. MAX participants include universities, federal research labs, and other research-focused organizations in the Washington and Baltimore metropolitan areas. MAX serves as a connector and traffic aggregator to the Internet2 national backbone and peers with other major networks. Its mission is to provide cutting-edge network connectivity for its participants, tailored and generic data-transport solutions, and advanced services to accommodate and optimize large data flows and to facilitate network and application research. www.maxgigapop.net

Broadband for All: GoldenStateNet building a new California middle-mile network



In July 2021, California Gov. Gavin Newsom signed the historic “Broadband for All” Act establishing a \$6 billion effort to deploy fast, affordable Internet services for residents, businesses, and community anchor institutions. This is the largest-ever investment by the state for broadband equity and notably prioritizes unserved or underserved regions. Approximately \$3.25 billion was allocated to build a much-needed, middle-mile network - the critical infrastructure that bridges last-mile providers to the global Internet.

In recognition of its unique networking expertise and breadth of partnerships, the Corporation for Education Network Initiatives in California (CENIC) was chosen as the project’s third-party administrator (TPA). Under the auspices of CENIC’s California Middle-Mile Initiative, the organization created GoldenStateNet as a 501(c)(3) in August 2021 to operate as the TPA and manage

all aspects of the state’s middle-mile project.

“We’re honored to be part of the most ambitious state digital equity effort in the history of the public Internet,” said Louis Fox, founder and chair of GoldenStateNet. “Our team – together with community and industry leaders – will work expeditiously to deliver on the promise of this historic legislation.”

While it was known that substandard broadband exists in communities across California, the COVID-19 pandemic amplified the state’s digital divide. Slow links to remote education in rural and mountainous areas, many Tribal Nations, and many left-behind urban neighborhoods crippled students’ ability to learn. Telework and telehealth applications similarly suffered. Due to market economies and other factors in underprivileged urban areas, last-mile provider plans proved too expensive

or providers couldn’t serve these communities.

“The pandemic underscored how access to broadband is now a social determinant of health, education, work and economic security,” added Fox. “Our goal, in partnership with the state, is to ensure that every community – rural, urban, tribal – has access to broadband technologies and to do this work with alacrity.”

The Governor’s Office and the California Department of Technology (CDT) presented GoldenStateNet with 18 initial priority projects in November 2021. GoldenStateNet will oversee technical recommendations, construction, and management of the middle-mile network through construction of new fiber routes or purchase of long-term IRUs, where available. These approaches may be combined for certain projects. Wherever possible, ring topologies will be designed to improve resiliency and reliability for statewide networks and to better enable performance for home applications.

The project will continue to add routes for a cohesive, statewide network with work expected to extend through December, 2026. GoldenStateNet will collaborate with CDT, the California Department of Transportation (Caltrans), and the California Public Utilities Commission to design, acquire, and construct the state’s middle-mile network. GoldenStateNet also will work with critical regional community stakeholder groups, last-mile providers, and industry partners to fulfill the promise of this ambitious initiative.

Funded through California State Legislature and Governor Gavin Newsom’s “Broadband For All” legislation, GoldenStateNet was selected by the California Department of Technology (CDT) as its Third Party Administrator (TPA) for the state’s 3.25 billion dollar project. GoldenStateNet is managing the development, acquisition, construction, maintenance, and operation of a statewide open-access, middle-mile, broadband network. GoldenStateNet is a Limited Liability Corporation managed by CENIC. GoldenStateNet leverages CENIC’s key partnerships including broadband consortia, metropolitan and rural planning organizations, community-based organizations, state, tribal, and private sector organizations. www.goldenstatenet.org

UETN expansion benefits Utah during ongoing pandemic

The Utah Education and Telehealth Network (UETN), based at the University of Utah in Salt Lake City, provides state-of-the-art broadband infrastructure and other services to schools, colleges, libraries, and health care communities throughout the state. “Despite the challenges of a second pandemic year,” according to Ray Timothy, UETN executive director and CEO, “UETN excelled with expanded services, connections, and video productions.”

In 2021, UETN continued a multiyear project to improve network capacity and speed throughout the state. UETN installed 42 miles of fiber-optic cable in the southeastern corner of the state. When completed, the fiber-optic cable replaced the existing microwave connections to schools in rural San Juan County.

UETN also continues to make great progress in closing the digital divide. UETN and the Murray City School District tested the use of a private LTE radio network to connect hundreds of students learning at home to their school network for remote classes and homework. They also collaborated with partners to conduct the fourth statewide inventory of network equipment and devices; working with Connected Nation, the Utah State Board of Education and other stakeholders, UETN collected data from all K-12 districts and charter schools. UETN also supports the education community by providing professional development courses. In 2021, UETN helped 8,909 educators earn 85,368 hours of professional development.

UETN and its partners promoted the FCC’s Emergency Broadband Benefit on-air and online. The federal program makes Internet access more affordable to low income families. To date, almost 30,000 households have enrolled in the program. UETN also provided training to schools and filed applications for libraries through the FCC’s Emergency Connectivity Fund. In Utah, the fund provides an estimated \$30 million for more than 118,000 devices and 15,000 home Internet connections for families.

The Network saw unprecedented growth for telehealth services. Patients and health care providers can now connect via a UETN platform that delivers high-quality video conferencing with the security needed to protect privacy. Eight organizations and 24 clinics are using the service, averaging 1,500 telehealth visits per month. In addition, the telehealth division provides support for school nurses. In 2021, UETN created a pilot program to distribute 170 telehealth kits to rural schools that school nurses cannot staff full-time. The kits help school staff and students connect to the school nurses

remotely and provide medical screening information. These virtual visits often help keep students in school instead of sending them home.

In 2021 UETN began a program to celebrate its people. “Humans of UETN” is a video series that explores the career paths of those who help make Utah’s public media network for education and health care possible. See the first two profiles here: <http://go.uen.org/bUI>. UETN’s leadership is also important to the high performance computing community. “UETN helps us move, process, and analyze large-scale data faster than ever before. Together, we help researchers advance toward potentially transformative or life-saving breakthroughs,” said Thomas Cheatham, professor and the Director of the University of Utah Center for High-Performance Computing and a member of one of UETN’s advisory councils.



Whether it’s a teacher in Tooele or a physician in Fillmore, a patient in Parowan or a student in St. George, the Utah Education and Telehealth Network (UETN) provides robust infrastructure, applications and support for education and healthcare. UETN connects all Utah school districts, schools and higher education institutions and serves hospitals, clinics, and health departments in urban, suburban and rural areas of the state. www.uen.org

LONI helps researchers find solutions to feed, power the planet

Since its conception, the Louisiana Optical Network Infrastructure (LONI) has been the provider of high-performance computing (HPC) resources to researchers to tackle challenging problems in science and engineering with the help of state-of-the-art computing technologies.

Over the last few years, LONI has delivered at least 50 million CPU-hours to its HPC users every year. In 2021, thanks to the newly-added QB-3 cluster with Intel Cascade Lake processors and NVIDIA V100 GPUs (Graphics Processing Units), that number increased to more than 80 million, a nearly 50 percent jump compared to the year before.

Among the researchers enabled by LONI HPC is Dr. Maheshi Dassanayake, associate professor in the Department of Biological Sciences at Louisiana State University, whose research mainly focuses on plants that could feed and power the planet in the not-so-distant future. According to the report issued by the United Nations, food supply will be under serious threat in the next 30 years due to the adverse effects of climate change, including the continued rise of global temperatures, changes in precipitation patterns, an increased frequency of droughts and heatwaves, sea-level rise, melting of sea ice, and a higher risk of more intense natural disasters. In the meantime, the global population is predicted to grow to 9.6 billion by 2050, which requires food production to increase at least 60 percent to meet the projected demand. With yields declining and demand increasing, intervention is a must.

Funded by the Department of Energy and the National Science Foundation,

LONI is the premier high-performance computing and high-capacity middle-mile fiber optic network provider for Louisiana higher education and research entities. The technology assets include a 1,674-mile system of fiber optics cables that provides subscribers with private and public cloud access at an improved level of service over a typical service provider and enhanced support for digital activities for teaching, learning, and administrative functions. The high-performance computing (HPC) service allows researchers to conduct and store highly complex experiments using compute powers specialized for highly intensive computational processing. It also enables greater collaboration on research that produces results faster and with greater accuracy. LONI is owned and operated under the authority of the Louisiana Board of Regents.

Dr. Dassanayake's team rose to the challenge. "As plant biologists, we try to understand the genes that make plants grow in extreme environments; what genes make this possible?" Dassanayake asks. "Why can one crop species survive while a related crop species cannot? The nature of the genes contributing to this fascinating diversity in physiology and development is currently hidden."

In addition to plants suitable for human consumption, those that could be used as biofuel crops are also of great interest. "We need to be able to grow bioenergy crops on lands that are not used for agriculture," she says. "These are marginal lands where we have lots of problems, such as drought, or lands that are inundated with brackish water or seawater; planned cultivation of bioenergy crops on soils of poor quality is necessary so as not to compete with other agricultural sectors."

Dr. Dassanayake's team is using recent advances in machine learning and genome sequencing technologies to study the "hidden" genes associated with plant

resilience in extreme environments to be introduced into other stress-sensitive species. Projects like hers are usually very compute-intensive, as huge amounts of data in the form of hundreds of millions to billions of sequencing reads need to be processed and analyzed, a need LONI is well-placed to meet with its HPC clusters.

Using the QB-3 cluster, Dr. Dassanayake's team recently produced and published the first high-quality reference genome for the common reed, an invasive plant species in North America, which will help the development of genomics-based bio-control measures and provide researchers "novel genetic material for selection to harness biomass and stress resilience potentials from an invasive species. In the long term, she hopes to establish a practical blueprint for data analytics on LONI that will be broadly applicable to the study of gene functions and result in a roadmap for improving plant traits for food, bioenergy, and beyond.

LONI is a state-of-the-art, fiber optics network that runs throughout Louisiana and connects Louisiana research universities to each other as well as Internet2. The resources provided by LONI enable greater collaboration on research that produces results faster and with greater accuracy. www.loni.org

KINBER building more community connections through libraries



The Keystone Initiative for Network Based Education and Research (KINBER) continues to grow its work in serving unserved and underserved communities across Pennsylvania. The nonprofit is particularly excited to work with the Office of Commonwealth Libraries to serve as the managing agency for the Libraries Connect Communities and Broadband Resources Project.

KINBER is positioned to successfully support and execute this activity maximizing the impact of the Governor's Emergency Education Relief (GEER) funds and serving community anchor institutions and populations in identified counties of greatest need.

“Libraries are community anchor institutions that play a critical role in providing free access to technology

to those who may not have access otherwise,” said Glenn R. Miller, deputy secretary for the Office of Commonwealth Libraries. “Throughout the pandemic, we have heard countless stories of individuals and families who have used library devices or Wi-Fi from parking lots to complete homework, attend classes or job interviews, connect with loved ones, and more. Libraries are community partners that provide critical resources and tools that support families, schools, municipalities, businesses and organizations. This project will help libraries and their communities build technology capacity for Pennsylvanians in need.”

The first cohort has concluded, and KINBER was able to assist libraries in nine different counties to improve their network and broadband connectivity. KINBER helped 14 libraries increase

their understanding of broadband technologies and capabilities as well as provide them with the equipment and resources to ensure their IT infrastructure is as future ready as possible.

“KINBER is pleased to collaborate with the Pennsylvania Department of Education's Office of Commonwealth Libraries,” said Nathan Flood, president and CEO of KINBER. “We understand the needs and services that are essential to support the targeted communities across the state that have been significantly impacted by the COVID-19 pandemic due to the lack of available connectivity and broadband resources.”

KINBER continues to meet with multiple libraries and service providers on ways to implement network connectivity solutions and help more people within their community, including facilitating and collaborating on small fiber builds with commercial providers in the area. With the success of the first cohort, KINBER is eager to move into a second cohort and assist libraries in another 28 counties to improve their network and broadband connectivity.

Providing this support to Pennsylvania's public libraries is the first step in improving overall broadband needs in these communities. KINBER remains grateful for the opportunity to help provide high-quality broadband in the Commonwealth's most unserved and underserved areas.

The Keystone Initiative for Network Based Education and Research (KINBER) is Pennsylvania's statewide research, education, and community network. The non-profit organization is a trusted technology partner that provides a strategic and competitive advantage to 100+ Pennsylvania-based organizations through high-speed broadband connectivity, collaboration, and innovative use of digital technologies. KINBER is committed to delivering equitable, reliable, and affordable digital infrastructure and tools to inspire tomorrow's scientific discoveries, enable the exchange of ideas and culture among diverse populations, educate the next generation of citizens, and revitalize Pennsylvania's economy. www.kinber.org

Arkansas Research Platform to boost data-science collaboration

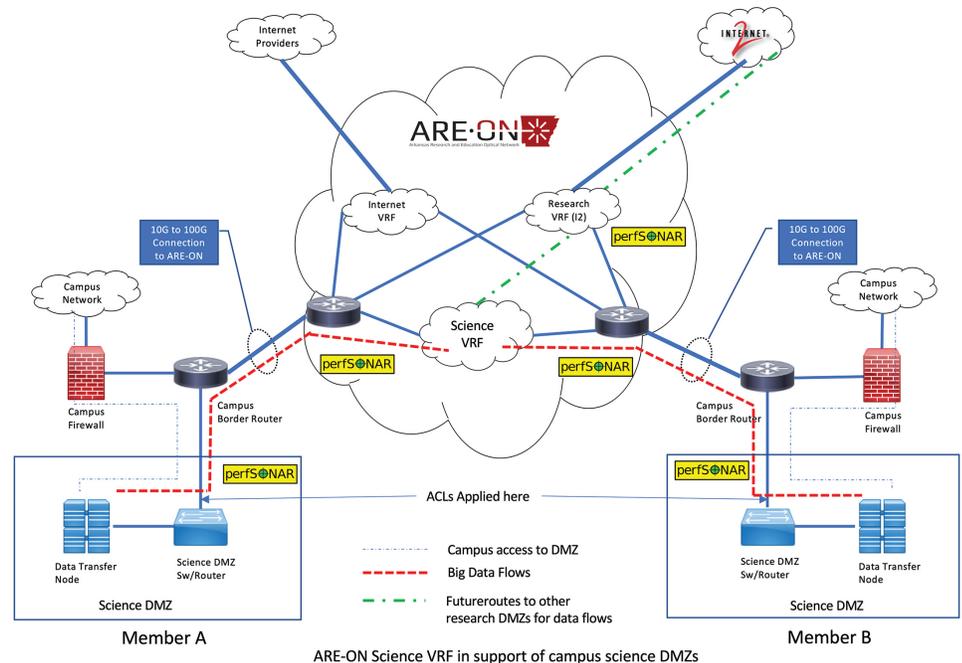
Arkansas universities are building greater research collaboration through the Arkansas Research Platform (ARP) implementation. ARP is a private research cloud that allows researchers in Arkansas to access a set of shared cyberinfrastructure resources to improve data science collaboration and output. ARE-ON, the research and education network serving the State of Arkansas, is key to this frictionless collaboration between connected institutions.

This concept was launched out of the Data Analytics That Are Robust and Trusted (DART) award from the National Science Foundation (NSF) in 2020, which sought to build a hub of data transfer infrastructure between eight in-state schools. The Arkansas Research Platform concept was developed to address that vision.

“Each higher-ed school in Arkansas has a growing demand for federated access to high-speed resources, managed services and technical training,” said Don DuRousseau, director of research technology at the University of Arkansas. “Most schools in Arkansas lack the connectivity, budget, and staffing to fully utilize advanced HPC and HTC capabilities, and each school is unique in its technical capacity and networking expertise. The Arkansas Research Platform serves this demand by coordinating the operation of the state’s research cyberinfrastructure as a shared resource and providing easy access for researchers to reach advanced computing centers, scientific instruments, cyber ranges, and other research environments spread across the state.”

The ARP extends the concept of the typical Science DMZ beyond the borders of a single institution, expanding into a research cloud of connected peers along the ARE-ON backbone network. ARE-ON has created a Science Virtual Routing Facility (VRF) network to provide a private, secure routing domain to connect members’ Science DMZs. The campus border router advertises only the routes to their Science DMZ with the ARE-ON Science VRF to isolate the network of Science DMZs at each institution. Once a connection is established across the ARE-ON Science VRF, data will flow from a data transfer node (DTN) on each campus to the destination member’s DMZ and allow remote access to a high-performance computing system to a participating researcher. Security is provided through configuring trusted routes and access lists across nodes participating in the Science VRF.

The ARP will provide a scaled ecosystem of resources, previously unavailable to many institutions, to improve the research output of the state. To begin, the University of Arkansas at Fayetteville and the University of Arkansas for Medical Sciences will utilize the ARP to build integrated high-performance computing resources, allowing users to use the resources at either institution to further their research. More schools will be added with this initial framework through an ongoing planning effort funded by NSF, assessing barriers at an expanded cohort of schools in Arkansas. A later step in developing the ARP will be the acceptance of regional and national network peers by allowing routes from the Internet2 research and education route table to be included in the Science VRF, facilitating data transfer to institutions outside of Arkansas.



ARE-ON is a not-for-profit organization in Arkansas passionate about providing members with technical expertise, cost-effective network services, and personal connections with a high level of customer service. We create a collaborative community for local anchor institutions to leverage technology resources and knowledge to achieve their goals.
www.areon.net

Merit Network's commitment to schools stayed strong in 2021



Michigan's Merit Network saw a return to its research and education roots in 2021. Implications of the digital divide, increased bandwidth needs, evolving security concerns, and a challenging cybersecurity talent pipeline were exacerbated by the ongoing pandemic. Merit's relationship with local communities, strong public-private partnerships, and a dedication to innovation helped support multiple connectivity and security initiatives for its K-12 educational partners.

Connectivity upgrades at the state and local levels helped schools provide fast, affordable, and secure broadband Internet. Last year, an upgrade to the Michigan State Education Network began with expected completion this year. To increase resiliency, the network saw the addition of two new headend sites, the creation of 40G metro ethernet delivery, and the addition of several 100G links to the network core.

At the local level, thanks to a collaboration between Detroit Public Schools Community District, Crown Castle and Merit Network, all 109 schools in the district were connected at 10G and 100G speeds, respectively. This new fiber ring was completed last October, providing each school with state-of-the-art broadband and creating opportunities for greater access, speed, and reliability.

The cities of Detroit, Inkster and Flint, along with Washtenaw County, benefitted from expanded free Wi-Fi access at more than 50 community locations across Southeast Michigan through the Community Access Network Project. Detroit and Flint have the highest number of households in the state without Internet access. In addition, 57 percent of K-12 students in Washtenaw County do not have high speed Wi-Fi access at home. The expansion improved Internet access for these communities and their students, allowing them to live, learn, and work better.

Merit's Information Security Team worked over the past year to grow cybersecurity skills and awareness in K-12 environments. "The Seven-Layer Cybersecurity Burrito" workshop was developed to increase knowledge of the threat and impact that malware and ransomware can have at educational organizations. In addition, a transition to a fully-remote 2021 Annual Governor's High School Cyber Challenge, a multi-round competition hosted by Merit and the State of Michigan, garnered a record number of participants. The goal of this competition was to expose students to cybersecurity career paths in order to bolster the talent pipeline.

Through a focus on K-12 connectivity and security, Merit has been able to leverage its middle-mile network, federal E-Rate programs, and a strong contingency of community anchor institutions to work to ensure Michigan schools remain connected and secure, regardless of geographic location or socioeconomic conditions. Continued support and relationship building will continue to be prioritized in the coming year, with much of that effort devoted to K-12 institutions. Given their critical importance to Michigan's educational industry as a whole, stronger K-12 organizations will in turn bolster the resiliency and connectivity of the entire ecosystem.

Merit Network, Inc. is an independent non-profit corporation governed by Michigan's public universities. Merit owns and operates America's longest-running regional research and education network. In 1966, Michigan's public universities created Merit as a shared resource to help meet their common need for networking assistance. Since its formation, Merit Network has remained at the forefront of research and education networking expertise and services. Merit provides high-performance networking and IT solutions to Michigan's public universities, colleges, K-12 organizations, libraries, state government, health care, and other non-profit organizations. www.merit.edu

Link Oregon finding partners during Broadband Investment Era

Entering the third year of the pandemic, Link Oregon continues to address the digital divide in practical ways by expanding access to education, health care, remote work, and innovation across the state. Over the past year, the organization has increasingly focused on building an intentional, inclusive, statewide strategy around broadband investment and expansion.

Laying the groundwork for long-term infrastructure investments to serve the greater good requires sharing expertise and partnering with the state's Economic Development Districts (EDDs), Education Service Districts, League of Oregon Cities, Association of Oregon Counties, regional Broadband Action Teams (BATs), and Tribes. It also means collaborating with state legislators, the Oregon Broadband Office, private telecoms, municipal providers, co-ops, and local Internet exchanges to envision a cohesive, future-ready, statewide network ecosystem.

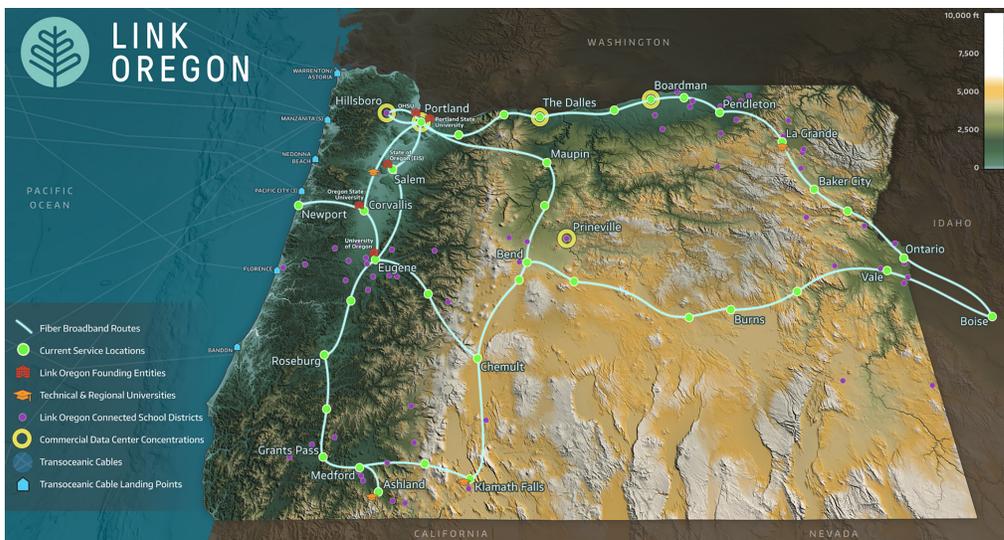
This past spring, at the request of Rep. Pam Marsh and two legislative

colleagues, Link Oregon's Steve Corbató and Zayo's Stuart Taubman convened a group of broadband experts to develop ideas for addressing the remaining gaps in middle-mile infrastructure and service delivery in Oregon. The resulting Middle Mile Infrastructure Planning Group's Futures Report presents recommendations to inform statewide broadband strategy and policy.

In December 2021, in conjunction with a number of Tribal and academic sponsors, Link Oregon hosted the first Oregon Tribal Broadband Summit, which engaged members of Oregon's federally-recognized Tribes; representatives from federal, state, and regional government agencies; and broadband equity advocates and experts, including Dr. Vint Cerf, Matt Rantanen, and Danae Wilson. Participants came together virtually to understand common and divergent needs and persistent challenges around Tribal connectivity. In addition, they shared activities that Tribes are undertaking to leverage funding and to build collaborations. A second Summit is scheduled in 2022.

Together with fellow Quilt Member CENIC, Link Oregon also co-hosts the Western States Broadband Alliance, a coalition of representatives from state broadband offices, state libraries, and state networks across seven western states: California, Colorado, Idaho, Nevada, Oregon, Utah, and Washington. The Alliance shares best practices, lessons learned, and resources for strategic broadband development within each state and across the region. Link Oregon also is partnering with Oregon EDDs and Onward Eugene to launch Faster Internet Oregon, a crowdsourced broadband mapping initiative. The initiative will use the M-Lab performance measurement platform for data collection and a commercial product as the initial tool for design and cost estimation. The result will empower EDDs and BATs with the tools and information needed to build comprehensive infrastructure funding proposals.

No one organization can conquer Oregon's connectivity challenges alone. Working in concert with a diverse ecosystem of contributors, Link Oregon is committed to developing a cohesive vision for statewide broadband that ensures a resilient and sustainable future for all Oregonians.



Link Oregon is a federally tax-exempt 501(c)(3) Oregon non-profit organization, a consortium of the State of Oregon through its Enterprise Information Services and the state's four research universities: Oregon State University, OHSU, Portland State University, and the University of Oregon. We provide high-speed, resilient, middle-mile fiber broadband connectivity to our state's public and non-profit sectors. www.linkoregon.org

How a new approach changed KanREN's vision for the future

Change. From the long-lasting effects of the pandemic on remote accessibility to the enactment of the Infrastructure Investment and Jobs Act (IIJA), change will continue to impact research and education (R&E) networks for many years. Differentiating programs and finding services with the most value for R&E network members will become critical as the broadband space becomes even more convoluted.

Over the past year, the Kansas Research and Education Network (KanREN) decided to take a different approach to creating a roadmap for their future.

On the cusp of their 30th year, leaders at KanREN realized that in order to know the best path to take they needed to spend some time understanding what their members needed and valued. They leveraged a fractional CMO (chief marketing officer) to work with their Executive Committee as well as create a custom stakeholder survey to get direct input from stakeholders, staff, vendors, and more.

KanREN CMO consultant Keri Lauderdale Olson explained that most organizations think they know what their customers want, but those needs change over time (especially in this environment). "What you thought you knew may no longer be true," he added. "Finding out where you think you are positioned in fulfilling customers' needs, compared to what they believe, can be a game changer."

As an example, KanREN had stopped offering training opportunities because they believed that their members no

longer wanted or needed that service. Feedback from the survey showed that training and education were areas of great value. Additional feedback included areas of specific interest for training and education, which has helped KanREN create programs tailored to exactly what their members want and need. This remains an opportunity for KanREN to provide something at low-cost that provides high-value to their members and differentiates them from their competitors.

The results of the Executive Committee session and stakeholder survey report were analyzed and presented to KanREN's Board of Directors. The insights from this work were eye-opening on all levels. KanREN executive director Cort Buffington said that the input received probably would not have been the same if these questions were asked

pre-pandemic. "There are ways that education is going to be permanently changed by the pandemic," he explained. "We have to figure out what changes will continue to affect how people communicate and how we can fulfill our members' needs differently than anyone else."

This process started new discussions about the vision for KanREN's future based upon data instead of assumptions about what their members valued. A new strategic plan is being built with strategies that align with members' needs now and in the future.

"If you haven't evaluated the needs of your members since pre-pandemic, you probably aren't aligned with where they are now," closed Buffington.



KanREN brought "The Internet to Kansas" and continues to provide critical, world-class broadband services and support to the Kansas research and education community. As a 501(c)(3) organization established in 1992 by the public universities of Kansas, the Kansas Research and Education Network has a reputation as a forward-thinking advocate for its members through networking, connectivity, and innovation. KanREN has focused, and continues to focus, on advanced network services for all its members. www.kanren.net

Edge and IEEE accelerate research collaboration through shared data platform



Edge, a non-profit research and education network and technology partner based in New Jersey, has joined forces with IEEE to address the data needs of the growing technical community. IEEE, the world's largest technical professional association advancing technology for humanity, is a global community of more than 400,000 technology and engineering professionals. Together, the two organizations will collaborate to increase awareness about IEEE DataPort™ – a web-based, cloud services platform that academic, government, and not-for-profit institutions can now leverage to efficiently store, share, access, and manage data to accelerate institutional research efforts and innovation.

Initially released in 2016, IEEE DataPort is a universally accessible data research platform that expands the opportunities for analysis, replication, and verification of research findings. IEEE DataPort chairman, Dr. David Belanger, said IEEE is pleased to have the opportunity to work with Edge in bringing IEEE DataPort to researchers and institutions. "IEEE and Edge both understand the critical need of the research community for replication and extension of data intensive studies, to meet funding agency requirements, and for a secure platform on which to store, manage, and provide accessibility to research data," added Belanger.

The Edge/IEEE collaboration facilitates global exposure for institutions' research and provides new avenues for scientific collaboration. This unique platform allows researchers and engineers in many disciplines to store, share, and manage datasets with colleagues within their own networks or across the globe.

"As research in nearly all technical domains becomes more data intensive," explained Dr. Forough Ghahramani, Edge's associate vice president for Research Innovation and Sponsored Programs, "Edge looks for new ways to provide its customers with improved access to more high-quality data as well as greater networking and computing opportunities."

IEEE DataPort offers institutional users unlimited access to the platform and a custom dashboard that allows for real-time organization and tracking. Users can upload datasets (up to 10TB each) as well as supporting materials like video, audio, and images, consolidating their research into a single location and making it instantly available for review and feedback from the global technical community. They can also apply logos or other unique markings to increase the organization's brand recognition. Colleagues can then download the

data directly or access it securely from the cloud, citing it in their own research when applicable.

To date, IEEE DataPort has more than 1.7 million unique users (averaging about 80,000 website visits a month) and over 2,900 datasets available. With the overlap in technical domains and research organizations across the country, the Edge/IEEE partnership anticipates a steady increase of users and datasets to harness the power of data sharing to help other pioneers accelerate scientific discovery and innovation. To arrange for an IEEE DataPort demonstration or for additional information on IEEE DataPort and consortium pricing agreements, please contact ieeedataport@njedge.net.

What is IEEE DataPort

Digital Object Identifier	S1 & Xplore Integration	Data Assessment Tools	Metadata Cataloger
Store Data Analyses	10 TB Capability	Easy to Use Web Interface	Data Challenge Manager

Datasets:
Span all areas of research (not just engineering)

- Machine Learning Data
- Computational Intelligence Data
- Power and Energy Data
- Bio-data
- Sensor data
- and more

Accepted Formats:

- Video files
- Images/photos
- CSV
- Audio files
- Many others

Now with over 1.7 million global users and 2,900 datasets!

Data Analytics Community

Universities and Research Institutions

Government Agencies

Industry

IEEE Societies, Authors, and Conference Attendees

Edge is a non-profit research and education network and technical partner to educational institutions, hospital networks, government entities, and other nonprofit organizations. Their mission is to empower members' digital transformation by providing affordable, reliable, and thought-leading technology, connectivity, and services. www.njedge.net

MCNC Vital Cyber defends North Carolina's greatest assets



Making world-class cybersecurity protections affordable and accessible to the MCNC community

- ✓ Managed Security Services
- ✓ Tools and Services
- ✓ Cybersecurity Consulting
- ✓ Advocacy

Cyber threats are all around us and becoming more sophisticated every day, which means our defenses have to be quicker, smarter, and more coordinated. There have been far too many headlines involving phishing or ransomware attacks affecting big companies and industries. But what you don't hear much about is how cyber criminals hit schools, hospitals, libraries, and other community anchor institutions. These important pillars in local communities urgently need better protection from today's growing cyber threats.

In response, MCNC has launched Vital Cyber (mcnc.org/vitalcyber) to ensure all of North Carolina's important community anchor institutions can access affordable cybersecurity solutions.

MCNC has served the technology needs in North Carolina for more than 40 years and is a trusted partner in the state as well as throughout the national R&E Networking Community. Educational

institutions, specifically public K-12 schools, provide the "soft targets" sought by hackers and cyber criminals. MCNC Vital Cyber offers a proactive approach to shoring up technology defenses by prioritizing cybersecurity on school networks as well as other sectors such as health care, research organizations, and other R&E networks.

Cybersecurity is not about IF an attack will happen, it's about WHEN and WHAT you can do when it does. MCNC Vital Cyber manages it all with the best tools and talent available today. These are built-in solutions that take care of security issues before they turn into a costly catastrophe by focusing on improving basic cyber hygiene, network security, cybersecurity education and training, and endpoint protection and monitoring.

MCNC Vital Cyber has partnered with CrowdStrike to provide its new Managed Endpoint Protection Service to help

MCNC clients better guard endpoints – such as desktops, laptops, and mobile devices – from malicious activity. Vital Cyber preemptively looks for risky activity around those endpoints to stop ransomware and malware attacks from entering a network before they can do any real damage. Working in concert with MCNC's elite security team, targeted actions can be taken in real-time to neutralize these threats.

"As cyber threats continue to evolve, it will be the organizations that address security from both a technology and behavior level that will be the strongest and most successful," explained MCNC chief information security officer Chris Beal. "MCNC Vital Cyber is ready to assist and protect against today's sophisticated cyber threats and prepare your organization for what's next."

For many years, MCNC has provided a growing portfolio of cybersecurity protections to automatically detect and mitigate malicious activity including Web Filtering, DNS Filtering, Distributed Denial-of-Service (DDoS) Attack Prevention, Vulnerability Detection, and Secure Access. Additionally, MCNC offers Consulting Services such as a virtual CISO to those who might not be able to afford one, as well as other discreet services.

Vital Cyber reinforces MCNC's goal to support digital equity and inclusion throughout North Carolina by continuing to collaborate with partners to build-out a robust suite of cybersecurity tools and services. MCNC does the heavy lifting to bring more stability and operational health to North Carolina's greatest community assets. Follow MCNC Vital Cyber on Twitter @MCNCSecurity.

MCNC is a non-profit, client-focused technology organization. Founded in 1980, MCNC owns and operates NCREN, one of America's longest-running regional research and education networks. With over 40 years of innovation, MCNC continues to provide high-performance services for education, research, libraries, health care, public safety, and other community anchor institutions throughout North Carolina. www.mcnc.org

WINS steps up to challenges of COVID and outreach in underserved and underrepresented groups



“I feel lucky to have participated in this complex and interesting group project. The fellow engineers I met will hopefully become lifelong colleagues.” - Mary Bull

During the week of November 14th, 2021, six women participated in the Women in IT Networking at SC (WINS) program at SC21, the International Conference for High Performance Computing (HPC), Networking, Storage and Analysis, which took place in St. Louis, Missouri.

Each year, a volunteer workforce designs and creates SCinet, the fastest and most powerful volunteer-built network in the world, to support the SC Conference. Since SC91, SCinet has provided SC attendees and the HPC community with the innovative network platform necessary to connect, transport, and display HPC research at SC from around the world. In addition to high-performance demos, SCinet supports wired and wireless connections for attendees to maintain connectivity to the rest of the world. SCinet takes a year to plan, a month to build, a week to operate, and a day to tear down.

The volunteers building the SCinet infrastructure come from academia,

government, and industry. As such, SCinet provides an ideal “apprenticeship” opportunity for engineers and technologists looking for direct access to the most cutting-edge network hardware and software, while working side-by-side with the world’s leading network and software engineers and top network technology vendors. The WINS program seeks qualified female U.S. candidates in their early to mid-career to join the SCinet volunteer workforce.

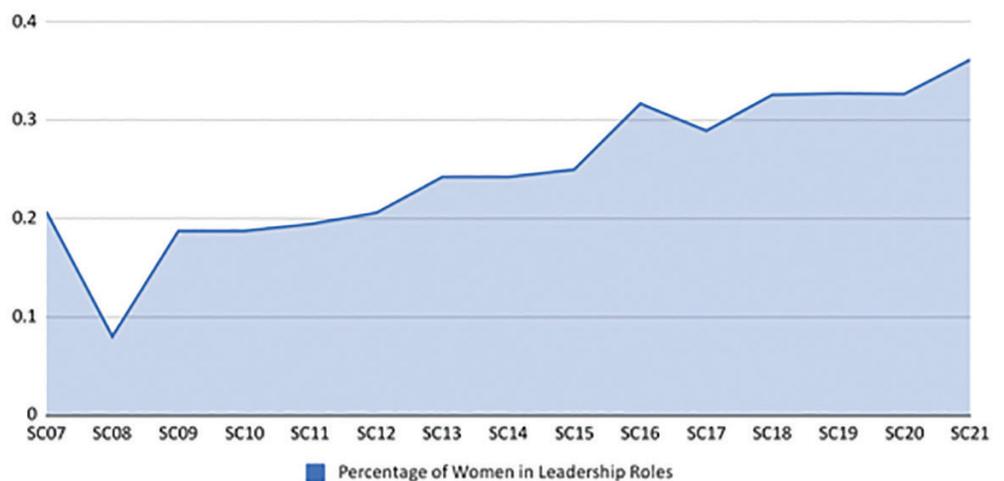
WINS was developed in 2015 to help address the gender gap that exists in information technology, particularly in the fields of network engineering and HPC. The program seeks women of all

ages, races, backgrounds, IT-related professions, and geographic areas.

“In the technology industry specifically, women faced challenges in what was ultimately deemed a ‘she-cession.’ The total representation of technical women decreased by 2.1 percentage points from 2020 to 2021. The representation of technical women decreased at all levels except intern.” - TCI Insights Report.

Data continues to show there are significant ongoing discrepancies in the number of women — particularly underrepresented minorities — in IT fields, and COVID appears to have exacerbated this trend.

Women in SCinet Leadership Roles



The percentage of women in SCinet leadership has grown from a low of 8% for SC08 to 36% for SC21.

This year, WINS management focused on outreach to underrepresented and underserved groups and organizations. In order to further broaden the diversity within the WINS program itself, preference this year was given to applicants who are historically underrepresented in the Information Technology field, including Black or African American, American Indian or Alaska Native, and Hispanic or Latinx. To date, nine percent of the WINS applicants and fifteen percent of the finalists work at Minority Serving Institutions.

For SC21, the WINS team and participants faced unusual challenges with the uncertainties of COVID. WINS management worked with the SCinet team to monitor the meeting status, implement safety measures, and commit to covering unexpected costs. WINS participants were offered the option to defer if they had travel restrictions. Three participants did choose to defer.

In 2021, nineteen women applied, with five selected, the most diverse WINS cohort to date. The following women participated in SC21:

- Mary Bull, College of William & Mary, SCinet Wireless Team
- Melinda DeHerrera, Los Alamos National Laboratory (LANL), SCinet Fiber Team
- Jennifer Kim, Montgomery County Community College, SCinet Edge Team
- Deshon Miguel, Tohono O’odham Community College, SCinet WAN Team
- Stacie Nixon, North Carolina Central University, SCinet Wireless Team

- Shashwitha Puttaswamy, The George Washington University, SCinet Routing Team

Those who deferred to SC22 include:

- Kristen Beneduce, Sandia National Laboratories, SCinet Network Security Team
- Karen Lopez, National Renewable Energy Lab (NREL), SCinet DevOps Team
- Kimberly Schjang, University of Nevada - Las Vegas, SCinet Edge Team

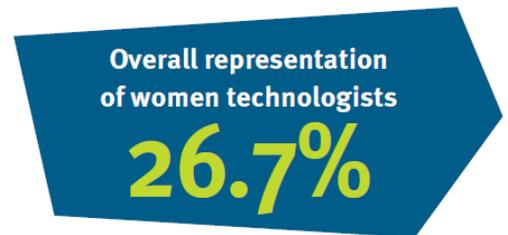
“SC21 was an amazing experience. I learned so many skill sets, in and out of my realm, which I was able to apply to my current job. I would definitely love to do it all over again, ask more questions, and gain more insight into the whole process. I had a great time!”
- Melinda DeHerrera

Over the past year, due to the restrictions on in-person gatherings, WINS implemented monthly WINS alumni virtual meetings, encouraging interaction between WINS participants to discuss general topics of interest, including the impacts of COVID on them and women in general. These meetings proved to be effective, well-attended, and successful.

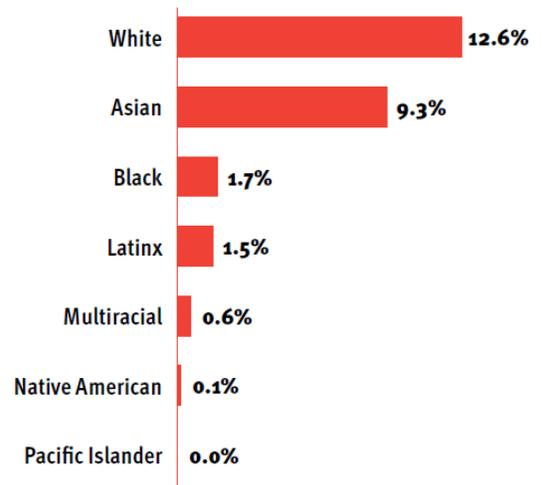
“SC is a unique event built on teamwork and miles of networking that has to be experienced to be understood. I am grateful to have been part of SCinet for SC21, which proved to be a challenging yet uplifting opportunity rooted in support and professional growth.”
- Jennifer Kim

Since 2007, when only 15 of the 105 volunteers (14%) were women, the number of women participants has grown. In 2021, 35 of the 123 volunteers (29%) were women. Nineteen of those women were either previous or current participants in the WINS program. Nine of the SCinet team leads in SC21 were previous WINS participants.

Members of the SC21 WINS coordinating team include PI Marla Meehl, Belinda Green, Susan Guastella, and Carlos Rojas Torres (SCinet Inclusivity Liaison), of UCAR; co-PI Wendy Huntoon of Keystone Initiative for Network Based Education and Research (KINBER); Jason Zurawski, Lauren Rotman, and Kate Robinson of ESnet; and Kimball Sekaquaptewa with Santa Fe Indian School (SCinet Co-Chairs of WINS).



Representation of tech women by race/ethnicity



WINS is a joint effort between the University Corporation for Atmospheric Research (UCAR), the Department of Energy’s Energy Sciences Network (ESnet), and the Keystone Initiative for Network Based Education and Research (KINBER). The multi-year program is funded primarily by grants from the National Science Foundation (NSF), direct funding from ESnet with support from the Department of Energy, and donations to the program. Due to COVID travel restrictions, ESnet did not provide programmatic support for SC21. www.women-in-networking.net

Networkmaine helps boost Wi-Fi in rural communities through projectConnect

Networkmaine and the Maine State Library partnered with the Information Technology Disaster Resource Center (ITDRC) over the last year to boost connectivity at 71 Maine locations, expanding and upgrading Wi-Fi technology at libraries, parks, schools, community centers, town halls, and other locations across the state.

Forty-nine of these locations participate in the Maine School and Library Network (MSLN), operated by Networkmaine, with the majority of them being public libraries in rural communities, with schools also included.

Networkmaine is providing Internet access, network management systems, and ongoing technical support for the schools and libraries participating in this project. ITDRC volunteers have made their way across Maine installing new equipment, funded in part by the Maine State Library to boost Wi-Fi signals and extend service into parking lots and surrounding areas.

ITDRC (<https://www.itdrc.org>) is a volunteer-driven non-profit that has deployed more than 850 Wi-Fi hotspots for its COVID-19 operation alone, providing free Internet access points, installation, and other IT support for COVID-19 testing sites, emergency operations centers, schools, libraries, community centers, non-profits, and other facilities for the benefit of the communities they serve. This support is critical to address standard IT disaster response needs as well as the significant

impact of COVID-19 on communities across the country.

“While the global pandemic has shown us all the importance of broadband, it has also exposed the growing inequities in our communities,” said Networkmaine executive director Jeff Letourneau. “Access to reliable, affordable Internet is essential for students to learn and thrive – both in school and at home – but far too many have been unable to participate in distance learning the past couple years.”

With ITDRC’s projectConnect initiative (<https://go.itdrc.org/projectconnect>) deployed in Maine, more than 270 Wi-Fi hotspots, hosted by Networkmaine

members, have enabled children to participate in online curricula and complete classroom assignments, allowed community members to obtain unemployment and reemployment resources, provided access to digital banking, connected citizens to telemedicine resources, enabled voter registration and census taking, and much more. This Internet connectivity additionally helps to bridge the digital divide, especially in rural areas and underserved neighborhoods which often lack broadband options.

For more information, visit <https://networkmaine.net/wifi>.



ITDRC volunteers at Ivan O. Davis Library in Liberty

Networkmaine is a unit of the University of Maine System providing Maine’s Research & Education (R&E) community with access to high-bandwidth, low-latency connectivity and complimentary services that enhance their ability to successfully deliver on their missions. Created in 2009 by a memorandum of understanding, Networkmaine operates through a coordinating council which comprises the University of Maine System, the Maine State Department of Education, the Maine State Library, and the Maine State Government Office of Information Technology. The Networkmaine Council provides the public entities served with greater involvement in shaping the future of Maine’s research and education network, MaineREN. www.networkmaine.net

Pacific Research Platform continues to exceed expectations



PACIFIC RESEARCH PLATFORM

When COVID shut down the country, many homes experienced inadequate Internet for work, school, and entertainment needs. For researchers linked to the Pacific Research Platform (PRP), supported by the Corporation for Education Network Initiatives in California (CENIC) and its own Nautilus infrastructure, scientific research continued forward so important discoveries wouldn't be interrupted.

“We may not have had toilet paper,” said networking pioneer Tom DeFanti, “But computational science continued with no problem.”

The PRP was conceived in 2014 by member institutions of CENIC as a way to support data-intensive research projects. The challenge was to connect multiple researchers in various locations with rapid access to dispersed datasets. Led by principal investigator UC San Diego physicist and networking savant

Larry Smarr and managed by UCSD co-principal investigator Tom DeFanti, the impact of this NSF-funded project exceeded expectations.

“We began thinking we would develop a way to connect the 150 or so Science DMZs at major universities to achieve large disk-to-disk transfers of information,” said DeFanti. “Along the way, we learned that rather than move giant files around, we could provide access to large datasets through creative networking and virtual co-location of data.”

Their innovative networking engineer colleagues led by John Graham of UCSD's Calit2/Qualcomm Institute, along with Dima Mishin and Tom Hutton of the San Diego Supercomputer Center, learned that when scientists exploring complex topics involving layers of data and information the potential for scientific discovery and innovation fuels

change that can improve our world.

Take the challenge of predicting, rather than reacting to, the persistent spread of wildfires in California. With PRP capacity and engineering ingenuity, scientists have developed WiFIRE, a critical decision support tool for first responders seeking to predict the behavior of fires. With an array of sensors throughout the state detecting wildfires, scientists at UCSD have layered information from multiple real-time data sources to enable scientists to model and predict fire behavior. That breakthrough can provide critical information to those on the frontlines working to minimize fire impact.

“We can bring together all the data sources to enable fast decision support using models, data science and fire science,” said Ilkay Altintas, director of the UCSD WiFIRE Lab. “That's what we have achieved.”

A future goal is to extend the innovative power of the network beyond traditional research and education institutions.

“As a nation, we can't afford to lose the innovative insights of our diverse communities by having any community lost simply by a lack of access to our cyber infrastructure,” said Louis Fox, president and chief executive officer of CENIC. “Now is when the historically disengaged – our indigenous communities, our historically black colleges and universities – must be connected, engaged, and empowered by access to our national high-performance network that leverages science towards solutions of important problems.”

CENIC connects California to the world — advancing education and research statewide by providing the world-class network essential for innovation, collaboration, and economic growth. This nonprofit organization operates the California Research & Education Network (CalREN), a high-capacity network designed to meet the unique requirements of over 20 million users, including the vast majority of K-20 students together with educators, researchers, and others at vital public-serving institutions. www.cenic.org

I-Light stays attuned to its community's needs

As Indiana's high-speed research and education network, the I-Light network connects its 40+ member institutions seamlessly to each other as well as to the Indiana GigaPOP, which also gives them access to national and international R&E networks. It's a big job that requires the I-Light team to be in regular contact with its members to best meet their various needs; and in our new reality the I-Light team has had to rethink how to stay connected with their community.

That's where their new monthly virtual town halls come in.

"Regularly meeting in this informal way has been a game changer in the way we're able to identify and support our members' needs," said Marianne Chitwood, director of I-Light and the Indiana GigaPOP. "Of course, there's really no substitute for personally sitting down with someone and getting to know them and their users, but in these times, we've found virtual meetings to be a very effective alternative."

The town halls hosted on Zoom have uncovered many issues I-Light members are grappling with, such as, security. With ransomware and other cyberattacks on the rise, especially in higher education, I-Light partnered with OmniSOC to provide cybersecurity services to its members — at no extra cost. Also based at Indiana University, OmniSOC is a shared cybersecurity operations center and a leader in higher education cybersecurity. The service is set to be fully operational in 2022.

The town halls also have been instrumental in expanding service offerings in other ways. For example,

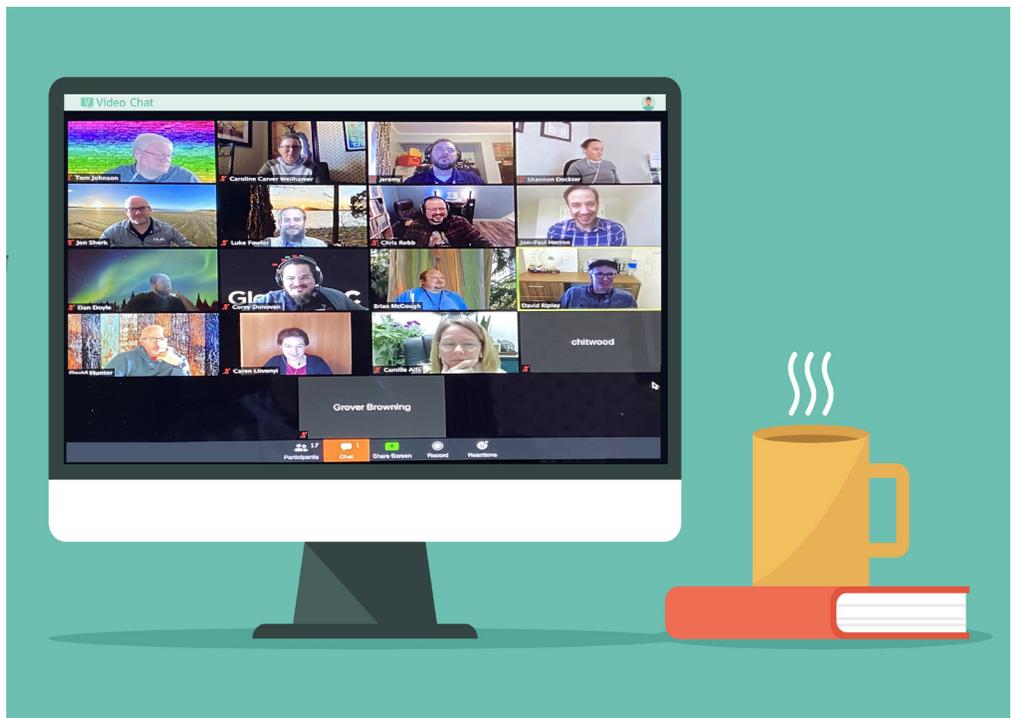
I-Light now offers interested members a managed router service, allowing I-Light engineers to maintain the border routers and ensure the network connectivity is stable and secure. I-Light also has been working with members on the deployment, support, and troubleshooting of eduroam. This service has been especially useful for members who need to work remotely — and being able to log in simply using their home institution's credentials has been very impactful.

The I-Light team's expertise with the Educational Broadband Service (EBS) radio spectrum has proved valuable as well. They have worked with members to locate use-case scenarios of the EBS licenses, and wireless hotspots have been deployed in areas of the state to members who need additional network connectivity. I-Light sourced more than 400 hotspots prior to the March/April 2020 shutdowns. And, now with

on-campus learning back, those Wi-Fi hotspots remain available to I-Light members.

Finally, I-Light is stepping into the eSports arena, and recently formed an eSports Working Group for its members. This development comes in direct response to the large uptick in the number of institutions participating in this form of gaming and the value it brings to their schools. Notably, these institutions have also seen student recruitment and retention jump in response to their new eSports programs.

No one could have predicted that the pandemic would still loom in our lives for this long. At I-Light, however, the team is using the experience to explore ways to remain connected as well as provide value to its members.



I-Light, a unique collaboration among Indiana colleges and universities, state government, and private sector broadband providers, is a high-speed fiber optic network that connects Indiana member sites to state, national, and international research and education communities. www.ilight.net

ICN's middle-mile infrastructure helps facilitate broadband to unserved communities

Since 2013, the Illinois Century Network (ICN) has provided open-access, middle-mile infrastructure facilitating broadband to unserved and underserved homes, businesses, and community anchor institutions in Illinois.

Broadband delivered to a home, business, or community anchor institution is typically provided by a retail service provider. In remote, rural locations, the retail provider may be many miles from broadband infrastructure. It is often cost-prohibitive for the retail provider to build networks to reach the nearest Internet point-of-presence (POP). This is where a middle-mile network comes in. If the retail provider connects to a nearby middle-mile network, there is now access to the public Internet and connectivity to other areas in Illinois. A local middle-mile network interconnect point allows the retail provider to focus their resources on serving the community, providing the “last mile” connection to the unserved location and serving more locations than would be the case if they had to

Locations Defined

Unserved: Does not have access to 25 Mbps downstream and 3 Mbps upstream broadband (with downstream being towards the location).

Underserved: Does not have access to 100 Mbps downstream and 20 Mbps upstream broadband.

expend resources on lengthy middle-mile segments.

ICN, operated by the Illinois Department of Innovation & Technology (DoIT), helps facilitate broadband to unserved and underserved communities throughout the state by providing an open-access, middle-mile network.

As a result of a state and federal grant of \$96 million in 2010 from the American Recovery and Reinvestment Act (ARRA), the ICN built 1,000 miles of 144-strand count fiber and leased (under long-term contracts) an additional 1,100 miles of fiber. Core equipment (electronic and optical) also was upgraded resulting in dark fiber and lit capacity that could be made available to retail service providers.

As a result of the upgrade, completed in 2013, retail providers in Illinois have been able to purchase middle-mile connectivity from ICN to help facilitate broadband to unserved and underserved homes, businesses, and community anchor institutions.

Middle-mile service provided by ICN includes lit service, dark fiber, and colocation. Lit service means a point-to-point broadband connection between two endpoints. Dark fiber IRUs also are available for one or more strands of fiber to be lit by a commercial provider. Colocation is used by providers for regeneration of signal over the dark fiber network and/or to locate equipment in an ICN POP. Interconnecting to ICN means interconnecting via dark fiber, meaning splicing the provider’s dark fiber to the ICN dark fiber at an ICN hand hole, or interconnecting via a lit cross connect at an ICN POP site, where the provider has built into the POP site.

ICN’s open-access, middle-mile network has been successful, with ICN interconnected to more than 40 providers. Services facilitated include not just broadband to homes, businesses, and community anchor institutions but also broadband to 4G and 5G cell sites and broadband for electric cooperative signaling operations.



The Illinois Century Network (ICN) began in 1997 with the recommendation from the Higher Education Technology Task Force to create a single, statewide educational network. The ICN became reality in May 1999 with the signing of the legislation called the Illinois Century Network Act. The ICN has evolved into a 2,100-mile, high-speed broadband network serving K-12 and higher education, public libraries and museums, state and local government, and commercial service providers. www.illinois.net

NYSERNet develops affordable security solution for vulnerability scanning



Any security professional will tell you the importance of performing vulnerability scans against your network. These scans assess computers, systems, and networks to help identify known weaknesses that could be exploited. This seems easy enough; however, to really mimic how hackers attempt to gain access to your network, the scan must be performed externally – something most institutions often can't do on its own.

For already resource-constrained higher education and non-profit institutions, this posed a significant challenge, meaning external scans simply weren't being performed or schools were paying astronomical fees to third-party vendors to conduct them. To this end, NYSERNet security professionals developed NYSERNet's Scan+.

NYSERNet services are built for members and by members. In 2018, Mike Evans, NYSERNet's director of information technology and information security officer, started working with five

pilot institutions – from small private colleges to large educational systems – to build a scanning management tool and portal to perform external scans for members. This provided critical input in the development of the early Scan+ vulnerability scanning solution.

“Working with these pilot institutions was monumental to ensuring that what we were building would effectively enhance their security posture,” said Evans, who also previously served as a higher education information security officer in New York and brought this perspective to the development of this new solution.

One member institution provided this testimonial: “NYSERNET's Scan+ service provides us with invaluable information regarding the external vulnerabilities of our organization. It affords us the opportunity to be proactive in closing the security gaps before the bad guys can take advantage of them. It is a valuable tool in our arsenal of

security products that help keep our organization safe.”

Vulnerability scans are a first step in security mitigation and NYSERNet wants to ensure members have an affordable solution. The NYSERNet Scan+ service uses a flat rate pricing model versus many for-profit scanning offerings that are often based on a pay-by-the-IP-address model. This is a key differentiator to competitors that are not as friendly to stretched higher education budgets.

Additionally, the NYSERNet Scan+ solution has a customized portal that allows institutions to prioritize identified risks, track changes in risk posture over time and assign attributes to those risks, such as mitigation status, responsible parties, and planned remediation dates. All these features – from price to flexibility – offer schools a robust tool that allows them to have significant insights and visibility not previously available. Today, Scan+ continues to evolve, and institutions leveraging this service consider it a critical tool to their IT service portfolios.

Now more than ever before, securing your network is a top IT concern for institutions of all sizes. Scan+ is just one more way NYSERNet is an extension of its members' existing staff and a trusted partner in its ongoing commitment to ensuring that members have affordable, adaptive solutions.

NYSERNet is New York State's Research and Education advanced networking organization serving education, research, healthcare, and non-profit members. NYSERNet's core mission is to advance science, research, and education missions of our members by delivering a full range of customized, progressive, and affordable end-to-end data and networking technology solutions. www.nysernet.org

MDREN pilots private wireless network at University of Maryland

Colleges and universities crave and require connection. Students must be able to complete research, Zoom into classes and collaborate with fellow students, even when those students are across campus or working from a remote location.

The University System of Maryland boasts some of the most technologically advanced campuses in the country, and the Maryland Research and Education Network (MDREN) helps to ensure students and faculty at the University of Maryland Baltimore County (UMBC) are at the forefront of networking and connectivity, leveraging Private LTE and 5G technologies.

According to MDREN executive director, Dr. Ray Barghi, the plan to launch the private LTE network over a CBRS 3.5G band began more than two years ago. But when COVID hit, the need became more acute. “With so much emphasis on remote learning,” explained Barghi, “we realized how critical this project was and that UMBC was the perfect location to develop a proof of concept that could scale to other institutions within and outside the Maryland system.”

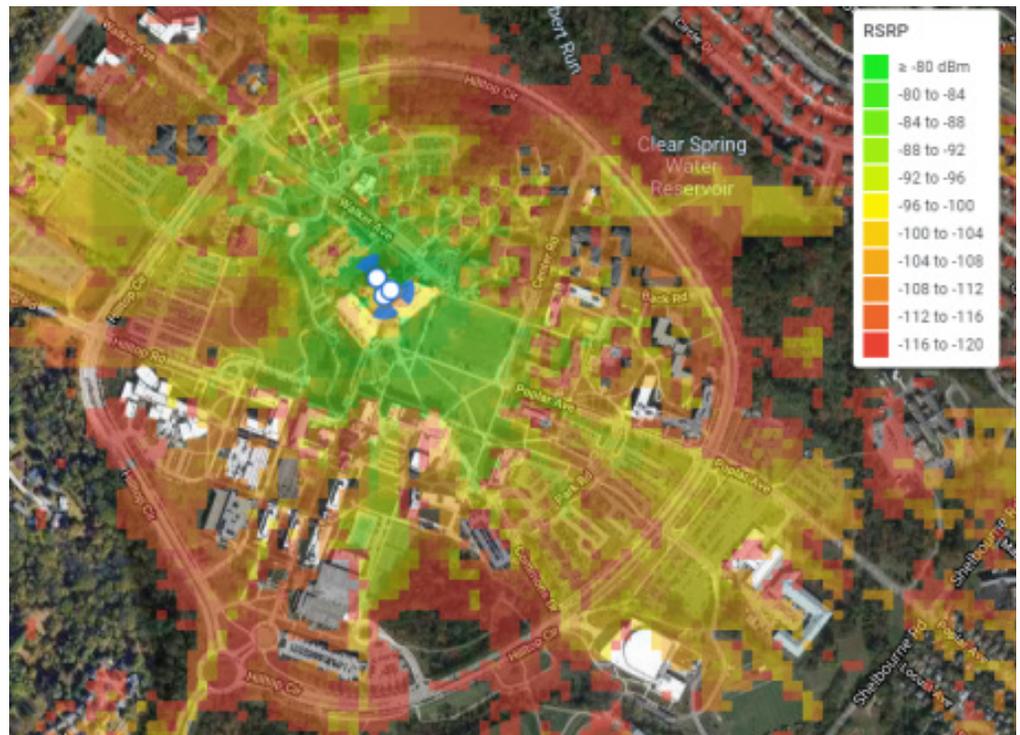
Currently, most institutions rely on Wi-Fi networks that work within limited geographic spaces, which can create access, interference, coverage, and congestion issues for students. The new CBRS network, however, is better suited for larger spaces with the increasing demand for reliability, capacity, coverage, and security. It provides a better overall experience for students with a higher level of security due to data encryption and SIM authentication.

This type of network uses proven technology that has been used by national wireless operators for years to provide reliable, consistent service. Hardware is minimal, consisting of an evolved packet core (either an on-premise or cloud-based server), small cells (radios), and some end user equipment. Beyond seeing the occasional new radio antenna on top of a tall building, students really won’t notice the infrastructure that supports their network. However, they will notice faster speeds (even during peak hours), more reliable connectivity, free hotspots almost everywhere on campus, and fewer opportunities for cyber attacks or hacked accounts. Furthermore, students who don’t have Internet service at home or off-campus will also benefit from the use of Fixed Wireless Access over the CBRS network.

A number of campus-use cases were identified, and it quickly became clear that this network was uniquely suited to deliver services across the university setting. Among the capabilities the new network can support are video conferencing; high-speed downloads; video surveillance (campus security and facilities management); portable point of sale (retail spots and e-ticketing for school events); and outdoor classes and labs.

The pilot installation and testing phase took about three months to complete, but Dr. Barghi anticipates quicker follow-on efforts.

“We faced multiple challenges including COVID and supply chain issues, but we learned a great deal from this deployment and anticipate smoother sailing with future installations,” he said.



The Maryland Research and Education Network (MDREN) provides reliable, high-speed, and advanced networking services to education, research, and community anchor institutions throughout Maryland. We engage our membership to promote education, collaboration, and research to support their missions. MDREN also leverages the diverse, cumulative wisdom of our membership and strategic partnerships to remain relevant and respond to the ever-changing needs of our members. www.mdren.net

Connecting rural libraries in Texas is a duty for LEARN

Ten rural libraries in Texas are now benefiting from LEARN connectivity as part of a project with the Texas State Library and Archives Commission (TSLAC).

LEARN worked with several partners to provide these libraries with up to 1G connectivity to the LEARN network, increasing their Internet reliability and speeds for some 100 times faster.

“Rural libraries tend to be chronically underfunded and struggle to have the resources to serve their communities,” says retired TSLAC state librarian, Mark Smith. “This project has brought Internet access to 10 communities that would not be able to have speed of access in a reliable network that ties them into this larger world of education and community anchor institutions, and does that in a way that is affordable and sustainable for them in the long run.”

One of those libraries is located in Grapeland in East Texas.

“Grapeland is a small rural town, and if you don’t live in the city limits, then your options for Internet are limited to slow satellite Internet,” says Ashley Corns, a librarian at Grapeland Public Library. According to Corns, a typical library visitor in this community is likely to be a retiree or a homeschooler, many looking for a better Internet connection than what they have at home in order to search the web or complete schoolwork. When the library reopened after COVID closures library foot traffic doubled with its new connection to the LEARN network. For communities such as Grapeland, a straightforward upgrade of the library’s Internet unsurprisingly makes an outsized impact.

At Allen Memorial Library in Hawkins, also East Texas, librarian Norma Hallmark says local patrons love having more reliable Internet in a central location in town. “Hawkins has a lot of seniors in the area – some use the library computers,” says Hallmark. “Wi-Fi is great for people bringing their own devices to use. Some patrons need to stream training videos for work, and they

come to the library to do it because it’s an issue for their home Internet.”

LEARN and the libraries it serves through this project share one thing in common: the duty to be a convener of community to the people they serve. With a connection to LEARN, libraries across rural Texas are now better prepared to meet the needs of their patrons.

Library	Location	Population (as of 2019)
Alexander Memorial Library	Cotulla, TX (Southwest Texas)	4,168
Allen Memorial Library	Hawkins, TX (East Texas)	1,337
Cochran County Love Memorial Library	Morton, TX (West Texas)	1,939
Fairfield Public Library	Fairfield, TX (East Texas)	2,916
Friona Public Library	Friona, TX (West Texas)	3,865
Grapeland Public Library	Grapeland, TX (East Texas)	1,671
Jacksonville Public Library	Jacksonville, TX (East Texas)	14,790
Lee Public Library	Gladewater, TX (East Texas)	5,991
Muleshoe Public Library	Muleshoe, TX (West Texas)	5,798
Upshur Public Library	Gilmer, TX (East Texas)	5,105

Table 1 shows each of the ten libraries connected to the LEARN network as part of this project. Each library received from 500 Mb up to 1G bandwidth - in some cases, a 100x increase.



Coding class at Fairfield Public Library in Fairfield, TX. Photo courtesy of Gary Wiggins.

Lonestar Education and Research Network (LEARN) is a consortium of 42 organizations throughout Texas that includes institutions of higher education, community colleges, and K-12 public schools. Organized as a 501(c)(3), LEARN connects its members and over 300 affiliated organizations to statewide resources through high-performance optical and IP network services. www.tx-learn.org

EPOC provides personalized technology support for science communities

Scientific progress is built on top of a complex system of hardware, software, networks, and well-defined processes to translate innovative ideas into research outcomes. When components of this finely-tuned pipeline break down, either due to broken parts or the inability to scale with changing data needs, data transfer speeds can be reduced, impacting research productivity.

The Engagement and Performance Operations Center (EPOC) is a collaborative focal point for operational expertise and analysis jointly led by Indiana University (IU) and the Energy Sciences Network (ESnet). EPOC provides researchers with a holistic set of tools and services needed to debug network 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.

One of the main activities of EPOC is the Roadside Assistance and Consultation Service. Roadside Assistance provides an operations center and process pipeline for immediate help when data sharing failures occur. EPOC coordinates partners and related organizations from multiple network domains to identify the cause of performance degradation and network failures, and then resolve them. The cases submitted cover a wide variety of topics, including, but not limited to, network and data architecture design, network performance assessment, Science DMZ design, and advice on the deployment of measurement and monitoring systems.

In 2021, there were 110 requests for assistance from organizations in eight countries, 32 states, and 11 EPSCoR jurisdictions. The majority of these centered around data transfer performance issues between two institutions, Science DMZ deployment reviews, and data architecture planning advice.

One of the highlights was the engagement with the Arecibo Observatory in Puerto Rico. Following the collapse of the Arecibo telescope in December 2020, the EPOC team played a pivotal role in helping move and store over 3 petabytes of information encompassing the only copy of more than 50 years of astronomical observations. EPOC staff provided the expertise required to ensure all network paths were clean and performing as expected, to be able to efficiently transfer the data from Arecibo to the Texas Advanced Computing Center (TACC). Many community partners were involved and this work received an HPCwire Readers' Choice award for Best HPC Collaboration across Academia, Government, and Industry in 2021.

Anyone in the Quilt community can contact EPOC for advice or consultations. Learn more at <https://epoc.global> or email at epoc@iu.edu.



EPOC

Engagement and Performance Operations Center

Founded in 1820, Indiana University is one of the world's foremost public institutions. With nearly 100,000 students and more than 20,000 employees statewide, IU continues to pursue its core missions of education and research while building a foundation for the university's enduring strengths in teaching and learning, world-class scholarship, innovation, creative activity, community engagement and academic freedom. Bloomington is the flagship campus of the university, and each one of IU's seven campuses is an accredited, four-year degree-granting institution. www.iu.edu

The Energy Sciences Network (ESnet) is a high-performance, unclassified network built to support scientific research. Funded by the U.S. Department of Energy's Office of Science (SC) and managed by Lawrence Berkeley National Laboratory, ESnet provides services to more than 50 DOE research sites, including the entire National Laboratory system, its supercomputing facilities, and its major scientific instruments. ESnet also connects to 140+ research and commercial networks, enabling DOE-funded scientists to productively collaborate with partners around the world. www.es.net

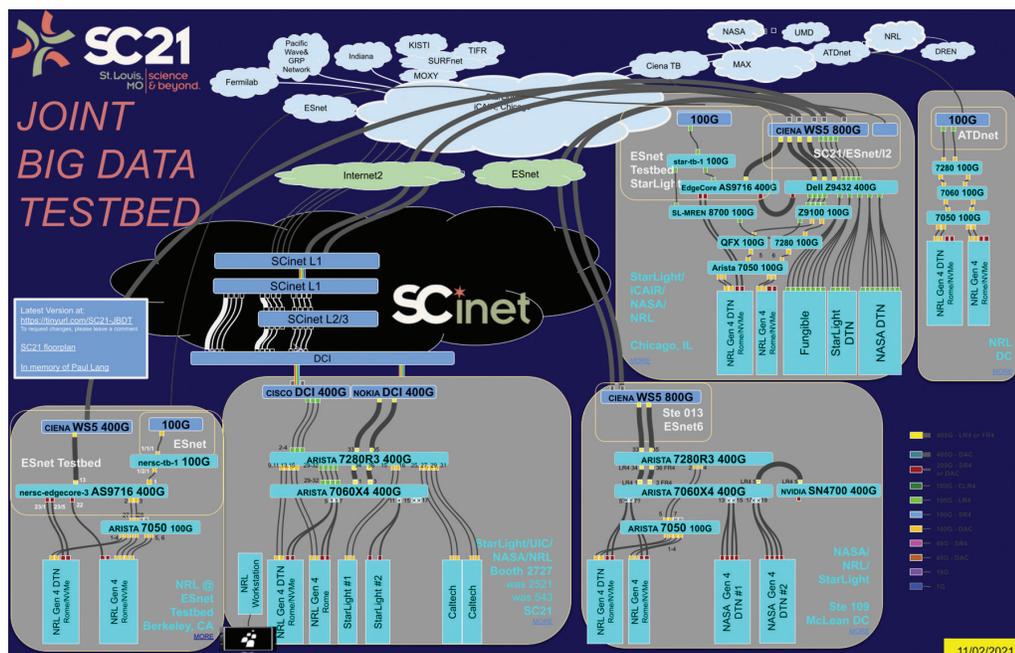
MREN: Building next-gen networks for data intensive science

Each year, with its international, national and regional partners, the Metropolitan Research and Education Network (MREN) collaborates with SCinet to create a national testbed with international extensions for the annual ACM/IEEE International Supercomputing Conference (SC21) for high performance computing, networking, storage, and analysis.

In 2021, SC21 as a hybrid conference, took place in St. Louis, Mo. SCinet, MREN, and its research partners designed, implemented, and operated an international testbed to showcase demonstrations and experiments focused on data-intensive science applications and technologies.

Increasingly, science research requires gathering, analyzing, and transporting extremely large volumes of data, including high capacity single end-to-end multi-100 Gbps data flows that are transported among sensor sites, instruments, analytic sites, HPC centers, and data repositories. Consequently, a key theme was exploring and demonstrating WAN services beyond 100 Gbps – including 400 Gbps, 800 Gbps, and Tbps paths.

The SCinet WAN testbed included: 2*400 Gbps paths (800 Gbps) between the Joint Big Data Testbed Facility in McLean, Va., to the StarLight International/National Communications Exchange in Chicago, Ill.; 2*600 Gbps (1.2 Tbps) between the StarLight Facility and the SC21 venue in St. Louis; 4*100 Gbps from Canada to the StarLight Facility; 2*100 Gbps from CENIC to the



StarLight Facility; and 4*100 Gbps from CENIC to the SC21 venue.

With its research partners, MREN used this testbed to successfully stage 24 large scale demonstrations. Techniques demonstrated included innovative multi-100 Gbps path services based on Software Defined Networking (SDN), Software Defined Exchanges (SDXs), Data Transfer Nodes (DTNs), Network Services Interface (NSI), transport protocols, measurements, P4 data plane programming, and dynamic L2 and L1 provisioning.

Demonstrations included advanced services for Petascale science; the dynamic capabilities of the NSF StarLight International Software Defined Exchange (SDX); programmable dynamic WAN networking; the Global Research Platform; advanced services based on AI/ML/DL optimization techniques for High Energy Physics,

specifically, the Large Hadron Collider Open Network Environment; DTN-as-a-Service; multi-100 Gbps WAN Disk-to-Disk transfers across WANs; and dynamic systems provisioning across WANs.

Also in 2021, MREN supported the design and implementation of an international testbed in 2021 for Data Mover Challenge hosted by the Supercomputing Asia Conference 2022.

The Metropolitan Research and Education Network (MREN) is an advanced, high-performance, regional network supporting organizations in seven states in the upper Midwest. MREN's primary focus is on providing advanced digital communications for leading-edge research and educational applications, primarily communication services for data intensive science. MREN is a founding member of the NSF-supported Pacific Research Platform initiative (PRP), developing a regional Science DMZ that extends from the west coast to the StarLight facility. MREN is also creating a regional MREN Research Platform (MRP) and participating in developing a National Research Platform (NRP).

www.mren.org

CEN provides value one connection at a time

The Connecticut Education Network (CEN) provides more than a network of vital infrastructure and digital connectivity. It is a network of people and organizations extending into every corner of Connecticut, connecting community anchor institutions that serve all citizens. CEN's 21st year has been one of adaptation and continued growth as we pursue our mission to deliver technological value to our members.

In every dimension of CEN's five-year strategic plan, we have raised the bar for providing value, igniting innovation, fostering collaboration, promoting advocacy, and enhancing core resources.

More than an ISP

CEN's membership growth, retention,

and security subscription rates illustrate the value members realize from CEN. In 2021, CEN added 39 new members and retained 99.6 percent of existing members. In addition to membership growth, CEN built new fiber circuits to 59 addresses attached to existing members, enhancing their ability to leverage CEN services across their network of facilities. CEN's security services portfolio including DDoS protection, virtual firewall services, DNS firewall, web filtering and student safety applications, continues to provide education members the safeguards they need to maintain operational integrity and to protect their students and staff.

CEN members realized a cost avoidance savings of \$33.1 million last year, 8

percent more than in 2020. Member costs for CEN provided Internet access, DDoS protection, web filtering, and student safety applications. In addition, the no-cost bandwidth capacity upgrades were significantly less than similar services from competitors or the cost of procuring these services individually.

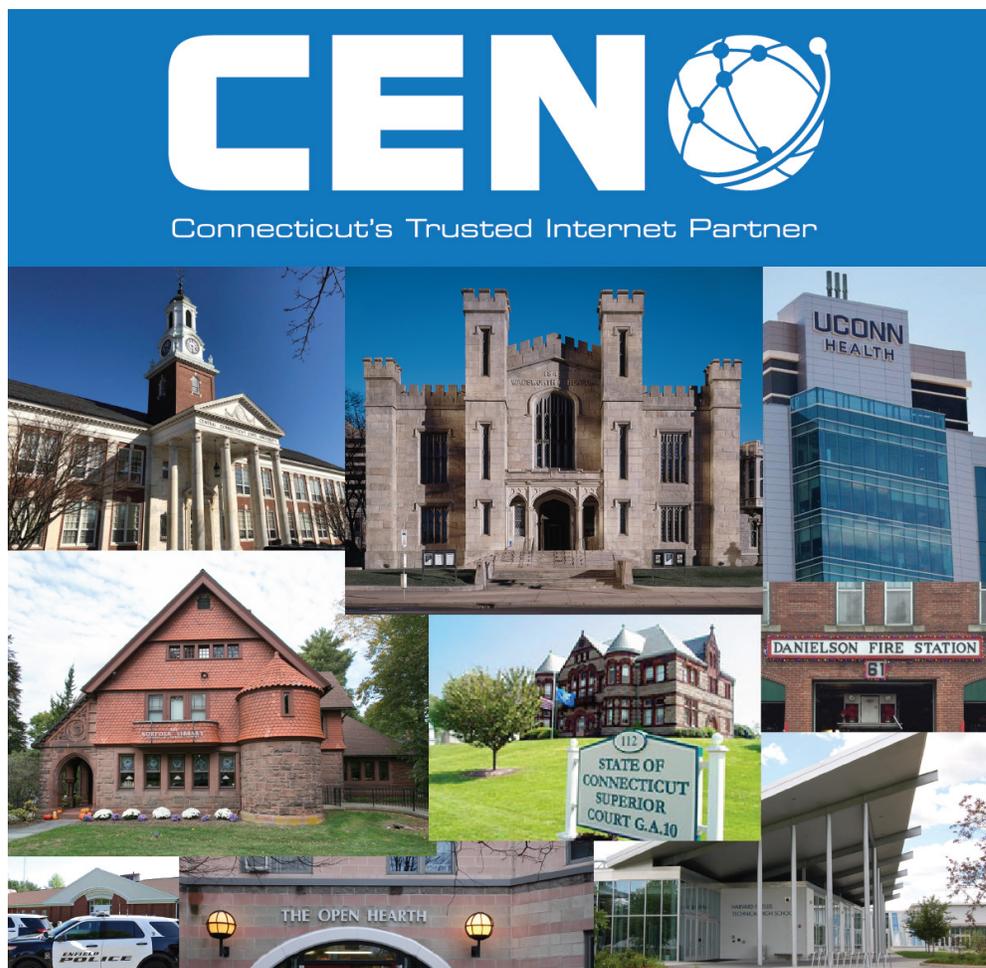
Closing the digital divide

In support of Gov. Lamont's *Everybody Learns Initiative* to close the digital divide in Connecticut, CEN led a project to bring free, outdoor, high-speed Wi-Fi service to public organizations across the state. "Walk-up, Drive-up, Connect!" sites provided students and families 24x7 access to CEN's high-speed Internet. In partnership with its members, CEN built public Wi-Fi access at 154 sites and recorded more than 83,500 unique client logins from community citizens last year.

CEN seized this opportunity to increase access to Eduroam by deploying it at each public Wi-Fi site. With plans to join the Internet2 Support Organization Program for Eduroam in 2022 and high adoption rates in the Connecticut higher education community, CEN already has enlisted multiple public school districts as pilot sites to broaden the member support network.

Building community

CEN and its Engagement and Development Advisory Council led the way in providing the CEN community with more than 40 hours of technical training opportunities throughout the year. This included the Virtual Member Conference with 34 sessions, AI and Proctoring & Alternative Assessments training events, an E-Rate Primer for Schools and Libraries, and three member Town Hall forums.



CEN, the nation's first all-optical research and education network, delivers reliable, high-speed Internet access, data transport, and value-added services to its members drawn from K-12, higher education, libraries, state government, and municipalities throughout Connecticut. CEN's statewide fiber-optic network connects more than 1.8 million citizens in support of Connecticut's workforce and economic development. www.ctedunet.net

One node's journey through Great Plains Network

The spirit of collaboration continues among the Great Plains Network members with the latest National Science Foundation Campus Cyberinfrastructure (CC*) Program award (*Award #2018766, CC* Compute: GP-ARGO: The Great Plains Augmented Regional Gateway to the Open Science Grid*). The name was inspired by the story of Jason and the Argonauts.

GP-ARGO was planned and submitted by the same team that brought a CyberTeam grant to the Great Plains (*Award #1925681, CC* Team: Great Plains Regional CyberTeam*). During the grant writing process, the team joked the ARGO grant was the CyberTeam grant's expansion pack, and the concept stuck.

The goal of GP-ARGO is to place a high performance computational server at several smaller universities around the region, institutions not normally associated with research. These servers augment local high performance computing resources and act as gateways onto the Open Science Grid (OSG). OSG has compute nodes all over the world and is ideal for small, serial calculations. The nodes funded by GP-ARGO boost local and national computing power.

With that background, let's follow one of these nodes on its quest from sealed box to producing research!

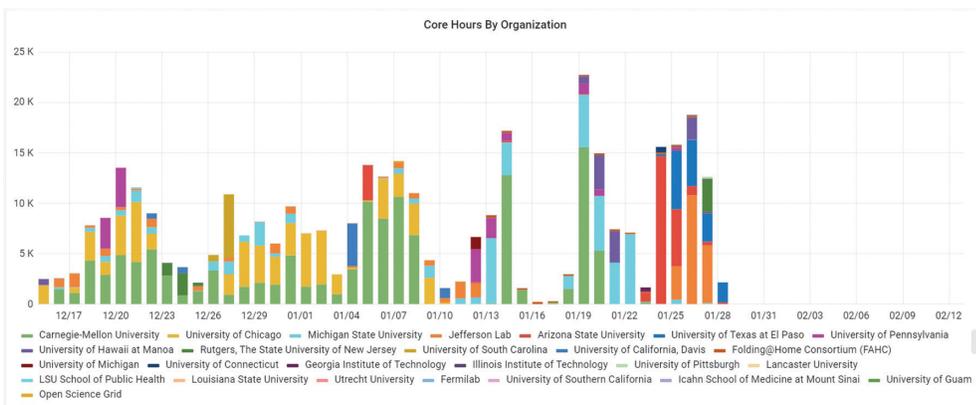
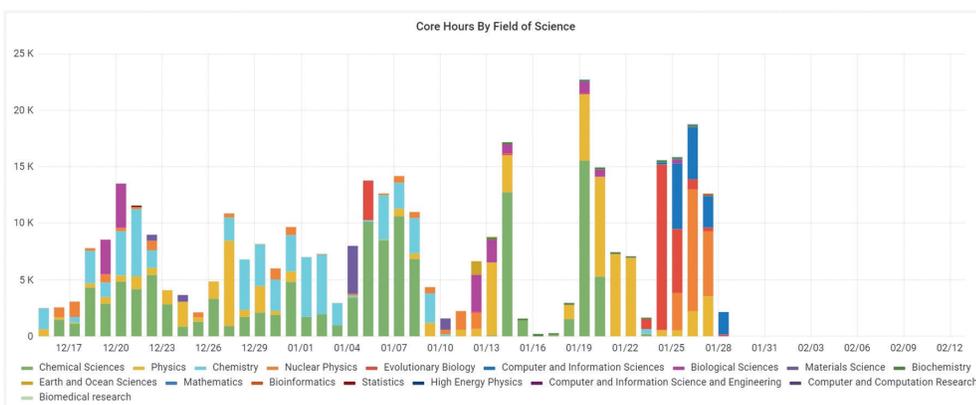
Life is an open map game. Exploration takes the player on some unexpected journeys and side roads. Implementing the GP-ARGO project was no different. The leadership committee knew they wanted to place them at smaller institutions, but based on what criteria?

First, the node had to help researchers at the local university. Rack space must be available. Local expertise was not a requirement since the nodes can be administered remotely. This policy was inherited from the CyberTeam's activities. A core principle of CyberTeam is sharing knowledge and assisting smaller universities around the region. Remote administration of a node is a natural evolution of the CyberTeam philosophy. Three sites that received nodes are Oral Roberts University in Oklahoma, South Dakota School of Mines & Technology, and the University of Arkansas for Medical Sciences.

The next step is assembling a party. Three groups came together to develop the initial install and set up procedures:

Kansas State University, OSG, and SLATE. The nodes were delivered to, and initially installed at Kansas State University. The journey from machine in box to functioning OSG node was a quest in its own right. The nodes were shipped out in ones and twos. Once the nodes arrived, the host site had to rack them. There is no way to perform this step remotely; onsite hands are required. After that, the nodes begin their new lives as OSG compute nodes, transforming more Great Plains institutions into research sites.

Quest complete!



The Great Plains Network (GPN) is a non-profit consortium aggregating networks through GigaPoP connections while advocating research on behalf of universities and community innovators across the Midwest and Great Plains who seek collaboration, cyberinfrastructure, and support for big data and big ideas, at the speed of the modern Internet. www.greatplains.net

ESnet: Sharing research should be as easy as turning on a faucet



ESnet

ENERGY SCIENCES NETWORK

Research and Education (R&E) networks form the underlying “conduit system” for research data movement. Unlike plumbing that directs water, the act of sharing data sets with remote collaborators often involves a deep understanding of the proper hardware, software, and configuration parameters that must be used in order to ensure the operation performs well. This complexity can be frustrating for network users, resulting in lost productivity due to inadequate performance or may cause a mistrust of the available technology to perform routine tasks.

Data mobility is a critical component of the process of science. Being able to predictably and efficiently move data between experimental source, processing facilities, long-term storage and collaborators, is a common use case that transcends the boundaries of research disciplines.

The Energy Sciences Network (ESnet), in collaboration with Indiana University (IU) via the Engagement and Performance Operations Center (EPOC) are working to alleviate this problem.

By considering the full end-to-end data movement pipeline, ESnet and partners are able to uniquely support collaborative science, allowing researchers to make the most effective use of networks to facilitate sharing research data in order to accelerate the scientific discovery process. This program, entitled the “Data Mobility Exhibition,” or DME, is an outcome-oriented approach to measuring and improving the experience of data sharing.

The core question the DME program attempts to answer is: how long does it take a site to transfer 1TB of data? This is answered through performing a set of well-defined tests from each site’s data movement capabilities to a set of supported endpoints at partner R&E sites. The DME goals are flexible, but have set a baseline of having all 10 Gbps capable devices reaching a minimum performance measurement of 1TB/hour performance (e.g., 2.22Gbps, when measured across the wide area network and involving the disk systems of each participating site).

Since the program began in 2019, we have worked with approximately 50 sites to validate upload performance and over 100

sites to evaluate download performance; this testing has determined a community wide average of 3.5 Gbps on uploads and 1.8 Gbps for downloads. Some larger facilities are capable of delivering nearly 70 Gbps routinely and for those that have requested assistance, we have often achieved performance increases of an order of magnitude (e.g., from initial speeds below 1 Gbps to near 10 Gbps).

ESnet and our partners are continuing to work with The Quilt to expand this program to all NSF CC* awardees, campus networks of all sizes, and regional networking exchanges.

For further information, contact engage@es.net or visit us at <http://fasterdata.es.net>.

The Energy Sciences Network (ESnet) is a high-performance, unclassified network built to support scientific research. Funded by the U.S. Department of Energy’s Office of Science (SC) and managed by Lawrence Berkeley National Laboratory, ESnet provides services to more than 50 DOE research sites, including the entire National Laboratory system, its supercomputing facilities, and its major scientific instruments. ESnet also connects to 140+ research and commercial networks, enabling DOE-funded scientists to productively collaborate with partners around the world. www.es.net

NetSage helps R&E networks see patterns of behavior

Scientific investigation is highly collaborative and requires the ability to seamlessly share data between institutions to enable scientific discovery. However, effective data sharing (especially for large data sets) can be challenging, and it is still not uncommon for researchers to resort to shipping disks instead of using the network for data delivery due to network performance issues.

The ability to measure and interpret network behavior is critical to understanding data transfer performance. Information about the end-to-end data path makes it possible to identify and address potential problems.

The NetSage Measurement and Analysis Framework was developed specifically to understand pragmatic use of research and education networks and to evaluate data transfer performance. NetSage integrates multiple data sources to support objective performance observations as a whole. NetSage deployments can collect data from routers or switches (such as SNMP or Flow), active testing sites (such as perfSONAR), and science data archives

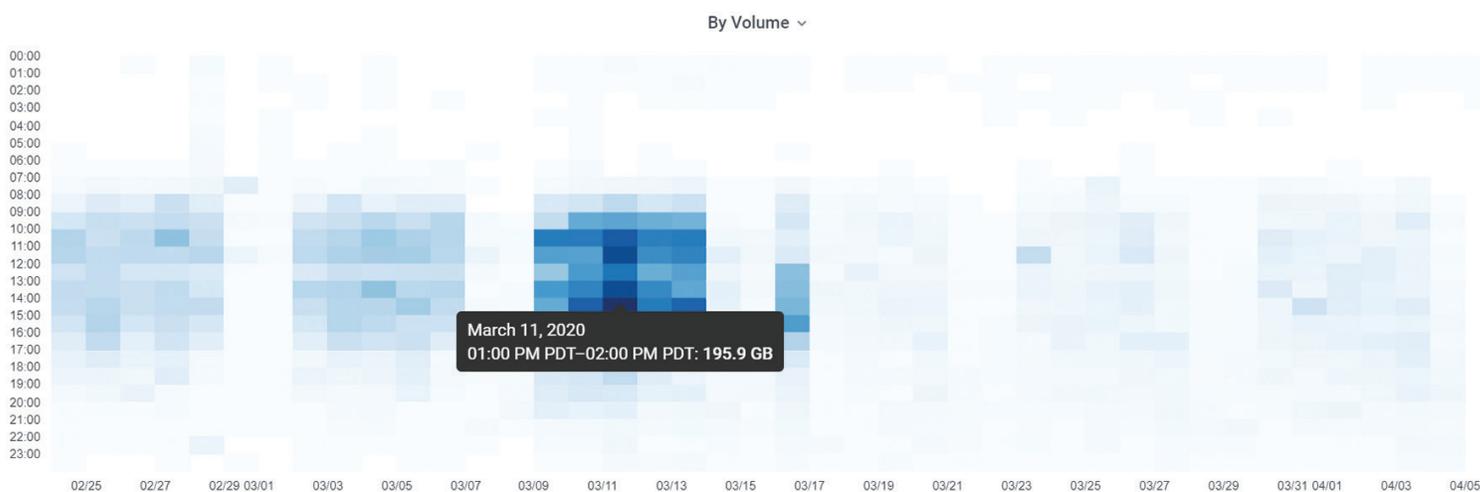
(using Tstat). A NetSage deployment uses a combination of passive and active measurements to provide longitudinal performance visualizations via performance dashboards. These dashboards can be viewed by resource collection, institutions, or projects to identify changes of behaviors for data transfers using visualizations of data over time periods.

NetSage Dashboards can answer several different types of questions about usage. For example, a Heatmap from the Pacific Wave Portal Flow Data Dashboard uses flow data to measure data transfers to and from the Zoom video conferencing hosting site during the time frame where R&E institutional use of Zoom changed radically. In March 2020, when universities started to respond to the COVID-19 pandemic-related restrictions, network resource owners needed to know how their systems were responding to the change of use. The Heatmap shows data volumes starting in February that increased on/around March 12, when many US universities declared that researchers could not travel. This was followed ten days later by a

decrease, likely caused by a combination of institutions shifting to Spring Break, institutions issuing work from home directives (so the traffic shifted to home networks not R&E networks), and Zoom shifting some of its hosting to use cloud services rather than their own IP space.

The main use cases for the NetSage Framework have included: understanding the data movement patterns across a suite of resources; identifying the main sources and destinations for large data transfers, or flows; visualizing information about different research projects and science domains that are moving data; and displaying patterns of behaviors for data movement between organizations.

Currently, a broad set of Quilt members have deployed NetSage as part of their partnership with the Engagement and Performance Operations Center (EPOC). These include: Front Range GigaPop (FRGP); Great Plains Network (GPN); iLight/Indiana GigaPop; KINBER; LEARN; Pacific Northwest GigaPop/PacificWave; SoX; Sun Corridor Network; and TACC. Contact netsage@iu.edu to learn more.



Founded in 1820, Indiana University is one of the world's foremost public institutions. With nearly 100,000 students and more than 20,000 employees statewide, IU continues to pursue its core missions of education and research while building a foundation for the university's enduring strengths in teaching and learning, world-class scholarship, innovation, creative activity, community engagement and academic freedom. Bloomington is the flagship campus of the university, and each one of IU's seven campuses is an accredited, four-year degree-granting institution. www.iu.edu

Southern Crossroads celebrates 25 years of R&E connectivity

Southern Crossroads (SoX) is turning 25!

SoX has been serving the research and education networking needs of the Southeastern region of the United States since 1997. SoX participants over the years have included universities, state networks, and research labs from Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia.

Over those 25 years, SoX has worked hard to establish a community by working collaboratively with individual participants, always seeking ways to provide value to the community-at-large. Their humble beginnings started with an idea on a beverage napkin and has grown into a R&E network that strives to fully support the smallest to the largest members.

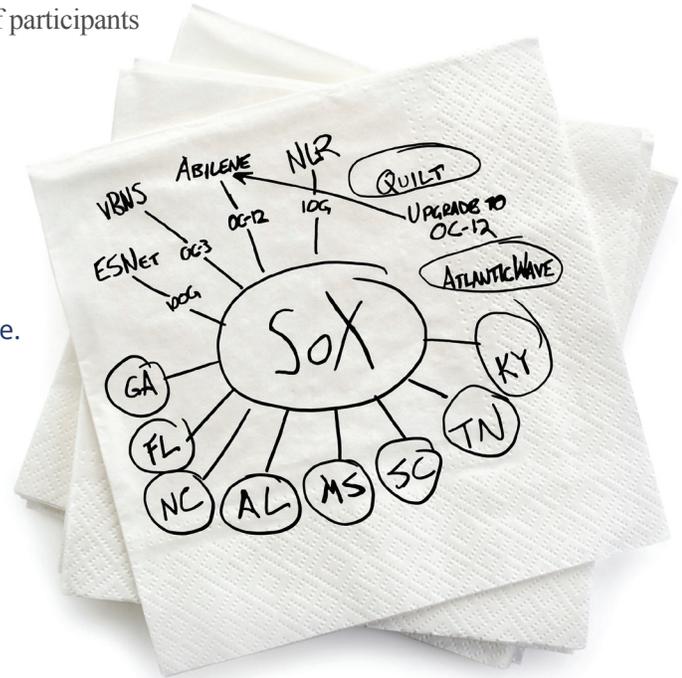
Recent achievements from SoX include the addition of Alabama A&M University, the University of South Alabama, Tennessee Tech, and Middle Tennessee State University as new participants. In addition, the recent NSF Campus Cyberinfrastructure (CC*) grant solicitations focusing on underserved institutions has allowed SoX to support small, minority serving institutions (MSI) with connectivity, technical support, and collaboration opportunities. This growth allows the community to become stronger and more diverse through the variety of participants and their research and education endeavors.

SoX is looking forward to additional growth particularly with smaller universities and MSIs in the coming

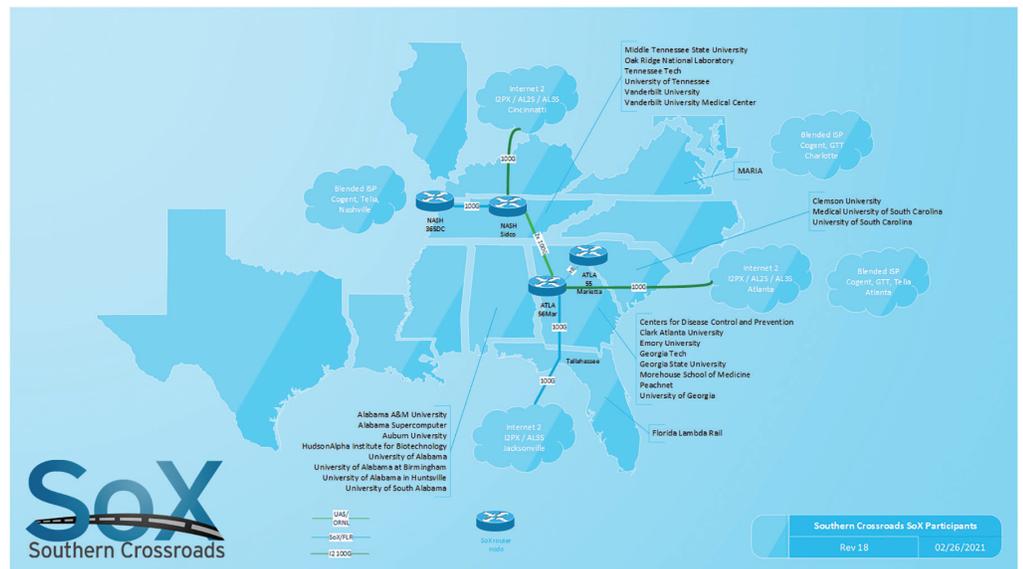
years. SoX recently published its updated mission, vision, and values statement (<https://s5.sox.net/sox-mission-vision-statement/>). The mission, vision and values statements are the guiding principles for the organization, and a reflection of the value placed on meeting the needs of participants and the community they serve.

The future of Southern Crossroads is bright with support of the R&E networking community!.

Our start began here.



In the past 25 years we have grown to here.



Southern Crossroads (SoX) also known as Southern Light Rail (SLR) is a 501(c)3 organization that serves the Southeastern U.S. Research and Education community. SoX provides high-speed, global connectivity and other commodity services. SoX also serves as the Southeast connector to Internet2, ESnet and other major U.S. and international research networks. Through its membership in The Quilt, SoX is able to offer low cost Internet bandwidth throughout the region with Internet Service Providers like CenturyLink, Telia Carrier, GTT, and Cogent. SoX supports universities, K-12 education networks, federal agencies, government laboratories, and non-profit institutions that promote research in the Southeast region of the United States. SoX services are enabled at 55 & 56 Marietta Street in Atlanta, Georgia. This presence provides SoX access to multiple peer groups already present at these carrier hotels. www.sox.net



The Nation's Critical Infrastructure

How Our Country's Research and Education Networks are More Critical than Ever in the Time of a Pandemic

Among the many important lessons that we have learned during the pandemic is our nation's health, education system, workforce, and economic security are dependent on robust, resilient, reliable, and affordable internet access.

Today's Research and Education Networks (RENs) serve as the backbone of access, collaboration, and innovation in the U.S. by providing advanced network services and applications for colleges, universities, K-12 educational systems, public libraries, healthcare institutions, museums, cultural institutions, state and local government, and indigenous communities. Additionally, today's RENs are at the center of successful public-private partnerships to extend their middle-mile networks into unserved and underserved areas nationwide. Working together as one community, RENs empower their member institutions and support their public-service missions which are all truly critical in the time of a pandemic.

Because RENs have been designed to meet the needs of the most demanding Internet users, scientists, academics, and researchers—they are engineered to ensure high capacity, high-performance, secure, and scalable connectivity that remains affordable, regardless of the number of users on the network. These networks simultaneously sustain interactive video that supports healthcare via remote appointments, keep schools and universities prepared and ready for teaching and learning, allow for digital arts to flourish, and enable data-intensive scientific collaboration and critical research to continue. RENs are at the heart of each effort.

Today, during the worst pandemic in a century, there are more demands on the research and education community as the nation adjusts to new ways of living, working, and learning. In more ways than ever before, RENs are stepping up to serve as the critical underpinnings of our country's continued success by:

- **Enabling secure COVID-19 research collaboration among top U.S. research universities, academic medical centers, and the many national and global organizations that collaborate on medical research, vaccines, and therapeutics.** A research institution's connection to a single REN provides researchers with access to vital research resources such as; our country's supercomputing centers, critical biomedical databases, and interconnections with the U.S. National Research and Education Network, Internet2, as well as other federal agency mission-driven science networks.

- **Forging multi-state partnerships within the REN community that align with pacts formed by the governors of those corresponding states and geographic regions to address the issues and challenges of the global pandemic.** These partnerships support collaboration among schools, universities, healthcare institutions, state agencies, and research centers by facilitating the transition to remote education and work, enabling an increase in health sciences network traffic, and reducing barriers to network sharing in support of medical and epidemiological researchers developing treatment protocols and cures for COVID-19.
- **Expediting the turn-up of brand-new network connections, circuits, and backhaul connections for COVID-19 testing centers, overflow hospitals, and research centers.**
- **Using COVID-19 testing data and infrastructure to support vaccine administration and large-scale vaccination sites that will inoculate thousands of citizens.**
- **Facilitating remote learning and access to educational opportunities for students regardless of their location by working with community partners across the country to deliver technical solutions that bridge broadband gaps and allow for low or no-cost Virtual Private Networks (VPNs).**
- **Easing the transition of faculty, staff, educators, and researchers to working from home via services and solutions like cloud-based architectures, remote desktop solutions, and security offerings.**
- **Allowing for the arts to prosper via new methods of digital collaboration, performance, and education facilitated by the networks.**
- **Ensuring constituent access to public services, especially for those in underserved communities by promoting a to-and-through Community Anchor Institution strategy such as schools, libraries, and museums.**

Historically and into the future, our nation’s RENs have truly been the reliable, trusted, agile, and responsive providers of critical technical infrastructure during our nation’s most trying times. Whether it’s expediting solutions for first responders during September 11th, enabling connectivity during natural disasters like fires and weather events, or a global pandemic, RENs across the country work together to ensure network resiliency and continuity.

To learn more about how RENs can transform and enrich your organization’s mission and goals and find one in your state or region, visit our website at www.thequilt.net

Today’s Non-Profit Research and Education Networks: Critical Infrastructure Powering Our Nation’s Most Important Work



About Us

The Quilt is a national coalition of non-profit U.S. regional research and education networks representing 38 networks across the country. Participants in The Quilt provide advanced network services and applications to over 900 universities and thousands of other educational and community anchor institutions. Our goal is to promote consistent, reliable, inter-operable and efficient advanced networking services that extend to the broadest possible community and to represent common interests in the development and delivery of advanced cyberinfrastructure that enables innovation through our education and research mission.

Our Mission

The Quilt: A collaboration of U.S. research and education networks committed to innovation and advancement of these purpose-built networks that empower our public service missions.

Our Name

Just like the various fabric patches of a quilt highlight different colors, patterns and textures, each regional network reflects the diversity and the unique qualities found in different parts of the country and the different institutions that particular network serves. Yet all regional patches must be stitched together seamlessly, coherently and interoperably to serve a larger purpose and community.

www.thequilt.net | [@TweetTheQuilt](https://twitter.com/TweetTheQuilt)

Acknowledgements

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