

THE QUILT CIRCLE

2018 EDITION



A LETTER FROM THE PRESIDENT

Welcome to our 2018 edition of The Quilt Circle. The theme of this year's Quilt Circle is interconnection. Our cover and collection of stories present wonderful examples of how our national community of research and education (R&E) networks are interconnected at both the physical layers of network infrastructure as well as the collaboration layer. Scientific discovery and academic advancement truly know no bounds and R&E networks are the linchpin to ensure those interconnections are strong, expansive and support the exciting frontiers of research and education.

The Quilt is a national collaboration of 40 R&E networks throughout the United States. Our collective mission focuses on investing and operating network infrastructure that is purpose-built to further scientific discovery and advance our country's academic enterprise. The Quilt Circle annually showcases the important impacts that R&E networks have on the institutions they serve and offers insight into the depth and breadth as to how these networks continually interconnect community anchor institutions all over the country.

These interconnections are not based just on hardware or applications but also on an expanded community of technology practitioners who support the endless possibilities of a future facilitated by the right digital tools. For those of you already familiar with the work of the R&E network in your area and for those who are just learning about them for the first time through this edition of The Quilt Circle, you will quickly learn how Quilt members are exceptional in their ability to collaborate in so many innovative ways in order to fulfill the goals of the communities they serve. These organizations work with partners at the highest level to advance individuals, local economies, scientific discovery, educational outcomes, and so much more.

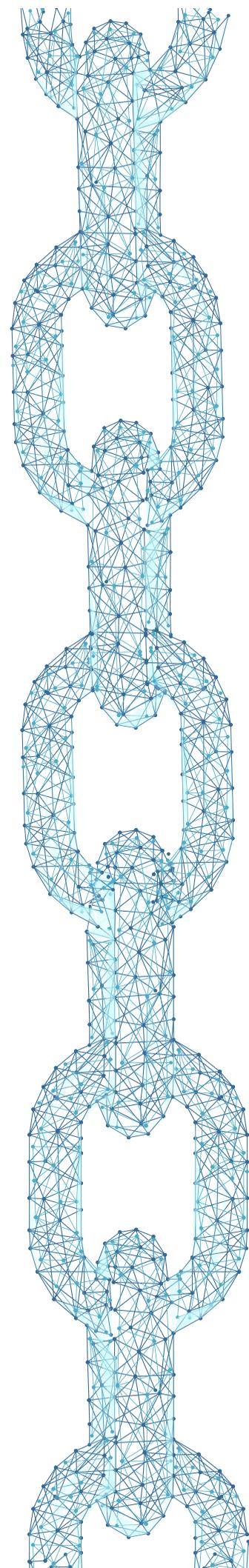
The Quilt continues to be a vibrant community where our members collectively move the national networking needle forward in support of research and education at the highest level. Because of the interconnections forged and supported by the membership, our work together this year is a valuable reminder of the key role each member plays in the success of one another's organizations as well as building the national networking fabric in our country that we call "The Quilt."

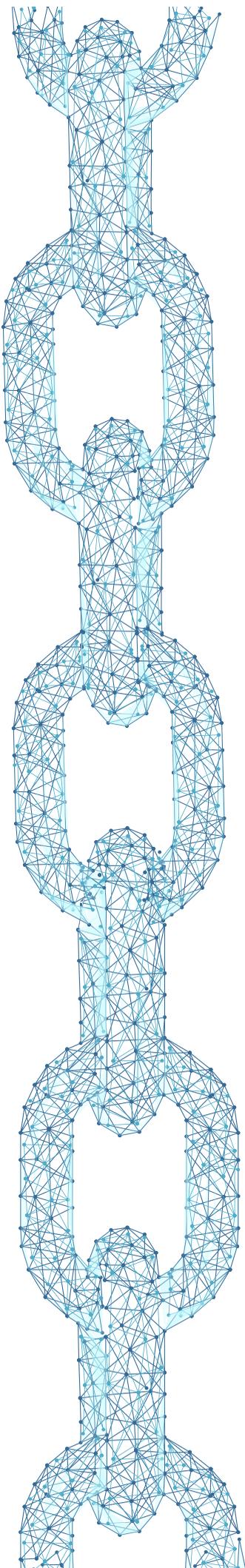


Jen Leasure
President and CEO

ACKNOWLEDGEMENTS

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THE QUILT

About Us

The Quilt is the national coalition of non-profit U.S. regional research and education networks representing 40 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. With the goal of promoting 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

Through The Quilt, non-profit regional research and education networks collaborate to develop, deploy and operate advanced cyberinfrastructure that enables innovation in research and education.

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.

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MEMBERS AND BOARD OF DIRECTORS

Albuquerque GigaPoP (NM)

Steve Perry
abqg.unm.edu

Arkansas Research and Education Optical Network (AR)

Steven Fulkerson
www.aron.net

CENIC (CA)

Dave Reese
www.cenic.org

Connecticut Education Network (CT)

Ryan Kocsondy
cen.ct.gov

Florida LambdaRail (FL)

Joseph Lazor
www.flrnet.org

Front Range GigaPoP (CO, WY)

Marla Meehl
www.frgp.net

Great Plains Network

(OK, SD, KS, MO, NE, AR, IA, MN)
Roberta Ambur
www.greatplains.net

Illinois Century Network (IL)

Lori Sorenson
www.illinois.gov/icn

Indiana GigaPoP (IN)

Dave Jent
indiana.gigapop.net

KanREN (KS)

Cort Buffington
www.kanren.net

KINBER (PA)

Wendy Huntoon
www.kinber.org

KyRON (KY)

Doyle Friskney
kyron.ky.gov

LEARN (TX)

Pankaj Shah
www.tx-learn.org

LONI (LA)

Lonnie Leger
www.loni.org

MARIA (VA)

Richard Hach
www.marialliance.net

MDREN (MD)

Guy Jones
www.mdren.net

Merit Network (MI)

Joe Sawasky
www.merit.edu

Mid-Atlantic Crossroads (DC, VA, MD)

Tripti Sinha
www.maxgigapop.net

MOREnet (MO)

Chip Byers
www.more.net

MREN (IL)

Joe Mambretti
www.mren.org

NCREN (NC)

Mark Johnson
www.mcnc.org

Networkmaine (MA)

Jeff Letourneau
www.networkmaine.net

New Jersey Research and Education Network (NJ)

Sam Conn
www.njedge.net

Northern Crossroads (MA, CT, RI, ME)

Michael Krugman
www.nox.org

Northern Lights (MN)

Louis Hammond
it.umn.edu/northern-lights-gigapop-introduction

NYSERNet (NY)

Tim Lance
www.nysernet.org

OARnet (OH)

Paul Schopis
www.oar.net

OneNet (OK)

Von Royal
www.onenet.net

Oregon GigaPoP (OR)

José Domínguez
www.ogig.net

OSHEAN (RI)

David Marble
www.oshean.org

Pacific Northwest GigaPoP (AK, HI, WA, ID, MT)

Amy Philipson
www.pnwgp.net

Southern Crossroads/ Southern Lambda Rail (GA, AL, FL, TN, SC, MS)

Cas D'Angelo
www.sox.net

Three Rivers Optical Exchange (PA, WV)

Ken Goodwin
www.3rox.net

Utah Education Network (UT)

Jim Stewart
www.uetn.org

WiscNet (WI)

Brian Remer
www.wiscnet.net

WVNET (WV)

Dan O'Hanlon
www.wvnet.edu

QUILT STAFF

Jen Leasure
President and CEO

Jennifer Griffin
Program Coordinator

Tracey Norris
Administrative Assistant

OSHEAN: BUILDING COMMUNITY VIA CAMPUS CONNECTIVITY

Known for its Culinary Arts program and top-ranking business, technology, and hospitality programs, Johnson & Wales University (JWU) prides itself on providing “exceptional education that inspires professional success” for its student community.

JWU has established itself not only as a leader in experiential education but also IT innovation. With its flagship campus in Providence, RI, and regional campuses in Charlotte, Denver, and North Miami, JWU tackles the challenges of delivering network and information services through continuous evaluation and innovation. JWU had previously been using an MPLS backbone from a commercial telecommunications company to provide wide area network (WAN) services between campuses. While this service satisfied the initial needs of JWU and served the campuses well over the past decade, bandwidth constraints and premium costs were causing increasing concern. JWU connects all of its major facilities in Rhode Island via OSHEAN fiber and was an early adopter of OSHEAN’s

business continuity/disaster recovery cloud services. JWU agreed to look at a R&E alternative to their current commercial WAN connectivity to the remote campuses to overcome present technical limitations and potentially reduce cost.

Working with OSHEAN and alongside other Quilt REN members Florida LambdaRail, Front Range GigaPop (CO) and MCNC (NC), JWU was able to design a solution that significantly increased bandwidth to and between regional campuses while drastically reducing operational costs. The connectivity and expense savings were achievable through the partnerships between local RENs coupled with the power of Internet2’s national fiber backbone.

Additionally, JWU was able to introduce more redundancies at the network layer that will provide higher availability and increased flexibility to perform maintenance without disrupting service. These improvements also better positioned JWU to continue business operations in the event of a disaster

at the Providence, RI, campus. “As we increased technology services across our campus backbone to deliver core services to the whole University, traditional telecommunication providers found it difficult to provide the level of required service within a reasonable budget.” remarked David Nardolillo, associate director of Network Services. He continued, “The cooperative nature of The Quilt community and Internet2, through OSHEAN, enabled us to do a lot more with a lot less.”

“Anytime we can assist members in extracting value from our network, we’ve fulfilled our mission,” commented Tim Rue, chief technology officer at OSHEAN. A cornerstone of this initiative is Internet2’s Advanced Layer2 Services (AL2S) offering. With AL2S, participating RENs are able to easily interconnect their members to Internet2’s global backbone via layer 2 virtual circuits. This project exemplifies the collaborative nature of The Quilt community, who embraced this initiative with professional, technical competence.



OSHEAN Inc. is a 501c3 non-profit consortium of member organizations that was formed to foster the development of a communications infrastructure for Rhode Island’s research, educational, health care, and public service community. OSHEAN is committed to developing network expertise among its member organizations and to creating an environment that encourages collaboration through shared resources, information and expertise.

CALREN FACILITATES COMMUNICATIONS DURING NAPA FIRES VIA LOCAL LIBRARIES

A public library equipped with robust broadband, can play a critical role in the community during an emergency.

“During the fire emergency in Napa County in October, 2017, the Napa County Library became a center for public access for many in our community who lost power, phone, and internet access,” said Edward Bell, library computer systems technician at the Napa County Library. “We served as an information resource as well as communication hub for our constituency, and our network never faltered. At the height of the emergency, on Tuesday, October 10, over 2,000 people visited our main library and 491 people accessed our network—four times more than usual—with no latency or service outages. We are very grateful for the dependability built into CENIC’s CalREN network.”

Library Director Danis Kreimeier noted, “Internet connectivity in our communities was severely compromised during the fires. Because much of internet service in Napa County is delivered via landlines or microwave connections, many public institutions, including Napa Valley College, lost their connection and all public schools were closed for two weeks. AT&T, a major provider in the region, lost over 80 towers. Because our connection to CalREN is delivered via fiber underground, it was not impacted.”

Serving as an information hub, librarians worked with the many visitors to the Napa County libraries to assist them in signing up for the emergency alert system and for the “Safe and Well” Red Cross



check-in system. Reporters filed stories from the library and workers came in to log on to their company websites to see if they needed to go to work. The town of Yountville lost all internet access and town officials came to the library to post updates.

Assistant Library Director Anthony Halstead commented on the difference high-speed broadband makes during a public emergency. “During our last public emergency, the earthquake that occurred in 2015, we were not yet connected to CalREN and had only 100 Mbps of connectivity. Many municipal buildings in our county were damaged, and government offices were relocated to our main library. We had to put tight restrictions on the number of users and the length of their sessions. Now our main library and three branches are all connected to CalREN at 1 Gbps or 10 times faster than our previous service. In addition to dramatically improved speed,

our reliability has improved.

In the more than two years since connecting to CalREN, we have had fewer than 20 minutes of service outage, and these outages were in our carrier circuit and equipment, not the CalREN backbone.”

In response to a 2013 assessment that found 52% the California public libraries had slower broadband connections than many Californians had in their homes, the Governor and the State Legislature provided funds to support libraries as Charter Associate members of CENIC and for their CalREN backbone use. This was the beginning of an historic initiative to help all of California’s public libraries receive high-speed broadband service via CENIC. Through the efforts of CENIC and Califa (califa.org) over 80% of eligible public library jurisdictions in California are now either connected or in the process of connecting to CalREN.

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 other vital public-serving institutions.

LEARN TO THE RESCUE DURING HURRICANE HARVEY

When Hurricane Harvey hit the Houston area in August 2017, it flooded homes, businesses, and roads. Americans sat glued to their TVs as news stations carried stories of heroic rescues and tragic losses.

But it turns out that some of those same news stations faced flooding of their own. Harvey forced CBS affiliate and TEGNA-owned KHOU-TV in Houston to evacuate its studio as water rushed into their building while they were broadcasting. Though forced to leave their studio, KHOU still had to provide information to residents on evolving conditions in the city — information that proved critical during the dangerous storm and its aftermath.

PBS member station KUHT on the University of Houston campus, which had access to power and broadcasting capabilities, offered studio space to KHOU. However, in order to broadcast critical news and information, in addition to other equipment, KHOU needed on-screen text, graphics and mixing capabilities and the equipment to process those graphics. TEGNA identified WFAA, their Dallas, TX station, as a location that could perform the video processing, but they needed a way to get the video to Dallas. Gary Gunnerson, senior IT architect for TEGNA, was introduced to Akbar Kara, chief technology officer of LEARN, and the two began discussing solutions to connect the Dallas station to the University of Houston campus.

According to Kara, LEARN's network had survived the storm and had plenty of capacity, they just needed a way to connect WFAA to LEARN. One of LEARN's partners



provided fiber to connect WFAA to LEARN and with that last piece in place, KHOU started passing data between the two sites immediately.

“While it is theoretically possible to transmit such data over the internet, the internet is not a point-to-point, Layer 2 circuit like LEARN, which means you get dropouts, artifacts and other glitches,” said Gunnerson. “So, it wasn’t until we had the LEARN connection that we could work at production quality.”

Between the first call to LEARN shortly after the storm struck and the initial transmission from Houston to Dallas, only two weeks had elapsed.

“LEARN has an absolutely fantastic fiber network. It’s a great resource for the entire state of Texas,” Gunnerson said. “We were very happy that we received permission to use the network. It was a lifesaver for that time.” Gunnerson continued, “It just floored me that LEARN could go out of their way to help us as much as they did.

It’s a testament of their desire to help in an emergency situation.”

During a moment of crisis, people and systems working together ensured that the citizens of greater Houston received critical and life-saving information.

“Our mission is always people first,” said Pankaj Shah, LEARN CEO and director. “In the case of KHOU and the city of Houston after Hurricane Harvey, we were happy that we had a ‘LEARN Champion’ on the ground in the form of the University of Houston.”

This, Shah says, is what LEARN is all about - supporting institutions and communities through their state-wide research and education network.

Shah stated, “We truly believe that LEARN is an extension of our members’ enterprise network. Whether in crises or growth, our subject matter experts carry this torch and repeatedly leverage partnerships to support people while providing seamless and friction-free connectivity.”

LEARN is a 501(c)(3) consortium of 41 organizations throughout Texas that includes public and private institutions of higher education, community colleges, the National Weather Service, and K-12 public schools. The consortium connects these organizations, and over 500 affiliated organizations, together with high performance optical network services to support their research, education, healthcare, and public service missions.

MORENET CONNECTS WITH MOZAMBIQUE RESEARCH AND EDUCATION NETWORK

Although the organizations are based more than 9,000 miles apart, the information technology challenges and community opportunities when providing connectivity, technical services and consulting to public sector organizations are quite similar. Those shared experiences recently connected the Mozambique Research and Education Network (MoRENet) in Southeast Africa and the Missouri Research and Education Network (MOREnet) in the United States.

The Mozambique MoRENet is a research and education network established in 2005 and is in a very similar situation that the Missouri MOREnet experienced in its early years. MoRENet is subscription-based and serves more than 100 higher education and research institutions. The network's primary purpose is to operate a fiber network designed to meet the unique requirements of higher education researchers, enabling them to share data through transport, eliminating the need to physically move files or hardware from point A to point B. To put their needs

in our perspective, they reported the average broadband capacity for their higher education institutions is 100Mbps.

As one of the founding members of the UbuntuNet Alliance for Research and Education Networking, MoRENet's leadership team reached out to the Missouri MOREnet's leadership team to begin a conversation about growth, expanding services, evolving business models and adapting to change. What started out as an email exchange and a video conference call, turned into the international sister organizations spending two days together in Missouri in early November 2017.

The visit included formal presentations as well as round-table collaboration and problem solving. Topics covered included product and service development, professional development, conferences and events as well as technical best practices for cyber security, wireless services, strategic planning and network management. The entire MOREnet staff

enjoyed an overview of the Mozambique MoRENet from Chief Executive Officer, Dr. Lourino Chemane.

Currently, the MOREnet consortium consists of more than 700 members across Missouri. Members value its subject matter expertise in the areas of wireless connectivity, systems administration and network management, the variety of video services and support, as well as professional development opportunities, and consortium discounts due to the buying power of the group.

Moving forward, MOREnet will continue to offer tips, guidance and best practices to MoRENet, including but not limited to virtual meetings and training sessions as well as hands-on assistance and technical training regarding their member events and product offerings.

According to Natasha Angell, executive director of the Missouri Research and Education Network, "This was and will continue to be a great opportunity for both organizations to think of connectivity on a global scale." She went on to add, "We are honored that they value our experiences and have invited our experts to the table to provide insights and exchange information. We are excited to continue the discussion and dive deeper into connectivity successes and challenges that will strengthen each of our networks as we serve our members."

Dr. Lourino Chemane, CEO of MoRENet and Dr. Maria Clementina, administrative manager for MoRENet meet with the executive team from MOREnet during a two-day visit to Missouri, November 2017.



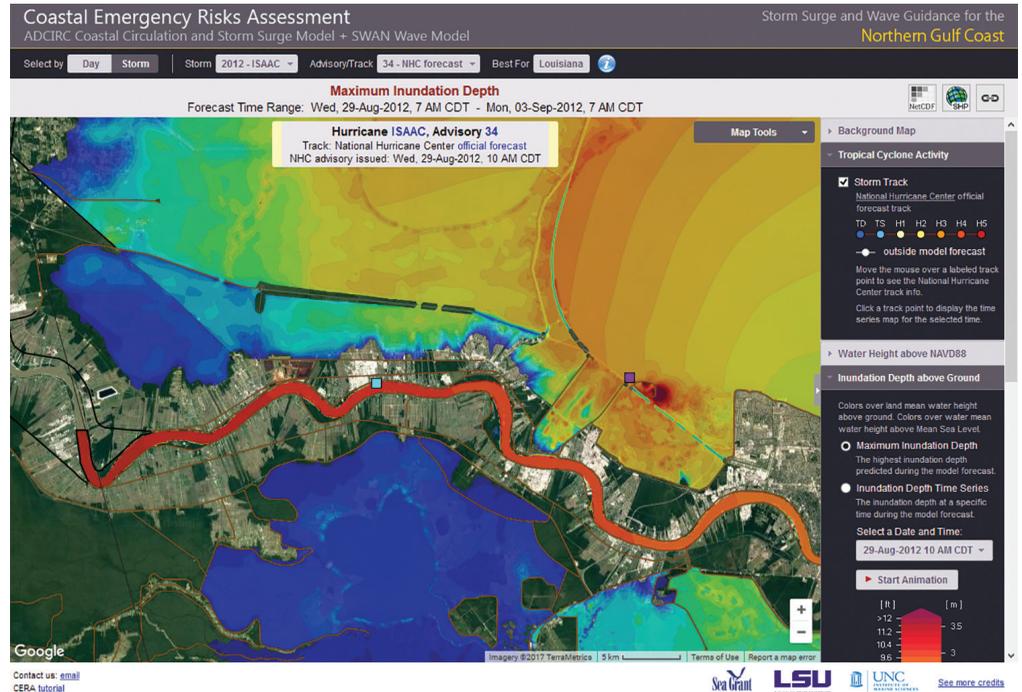
The Missouri Research and Education Network (MOREnet) is a member-driven consortium providing Internet connectivity, access to Internet2, technical services, resources and support, as well as technical training to Missouri's public sector entities, including K-12 schools, colleges and universities, public libraries, health care, government and other affiliated organizations. MOREnet serves more than 700 members across Missouri.

LONI MAKES CRITICAL CONTRIBUTION TO COASTAL PROTECTION AND RESTORATION IN LOUISIANA

For researchers, with access to 397 miles of coastline and the Mississippi delta, Louisiana is the ideal place to study coastal-related issues, among which land loss, sea level rise, hurricanes and climate change are among the most pressing ones. For the two million Louisiana residents living in the coastal area, understanding these issues and mitigating the related risks are far more than just academic exercises: they are a matter of jobs, homes, and, with over 20% of the most intense U.S. mainland hurricanes on record making landfall in Louisiana, life and death.

The State of Louisiana is fully committed to long-term coastal protection and restoration, which involves numerous government agencies, communities, and scientific and academic institutions. Given the increasingly important role that data and computation assume in research and decision-making processes, robust cyberinfrastructure resources are essential for the success of such an undertaking, which is where Louisiana Optical Network Infrastructure (LONI) comes into play.

The availability of computing resources like the LONI QB2 cluster, a supercomputer equipped with more than 10,000 CPU cores and capable of processing more than 1,000 trillion numbers per second, is critical in order to continue development and testing of storm surge models, according to Dr. Scott Hagen, the Laborde endowed chair for the Louisiana Sea Grant Program and director of the LSU Center for Coastal Resiliency. Dr. Hagen and his team have been using QB2 to develop and apply numerical



models to simulate coastal flooding due to astronomic tides, wind-waves, and hurricane storm surge, as well as the impacts that climate change may have on flood frequency and risk.

The state-of-the-art, high-resolution models developed by Dr. Hagen's team are an integral part of the Coastal Emergency Risks Assessment (CERA) coastal modeling research and development effort, which also relies heavily on the computing power of QB2. Led by Dr. Robert Twilley, executive director of the Louisiana Sea Grant Program, CERA is an advisory service to provide advice in regards to environmental issues associated with operations during a hurricane event and other coastal hazards, to various local, state and federal emergency response teams including the Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP), and

the NOAA weather forecasting centers in Louisiana and Mississippi.

Together with coastal scientists, computer scientists, and engineers, biologists join the battle as well. Dr. Scott M. Duke-Sylvester, associate professor of biology at the University of Louisiana at Lafayette, is using the LONI QB2 cluster to simulate landscape-scale plant community dynamics for the Louisiana coastal ecosystems and to evaluate the impact of many restoration and conservation projects set forward by the state of Louisiana, both individually and in combination, on the coastal ecosystems. By comparing observed spatial and temporal patterns of infectious diseases to numerical results from mathematical models to evaluate the potential role of different biological mechanisms, Dr. Duke-Sylvester aims to help with future planning and implementation of the long-term restoration and conservation efforts.

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

WVNET: BUILDING A BETTER PATH FOR THE FUTURE

WVNET was instrumental in the development of West Virginia's P-20W Statewide Longitudinal Educational Data System, a comprehensive cross-sector database that incorporates educational and employment data from West Virginia partner agencies which includes the West Virginia Higher Education Policy Commission (HEPC), the Community and Technical College System of West Virginia (CTCS), the West Virginia Department of Education (WVDE), Workforce West Virginia (WFWV), and West Virginia Network (WVNET).

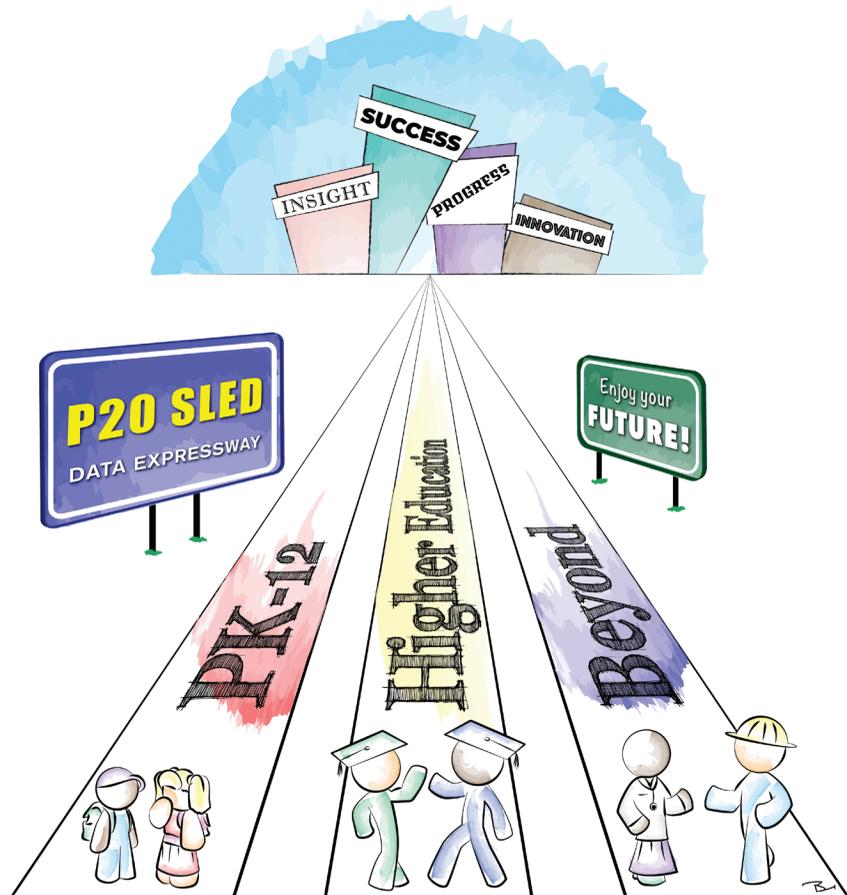
WVNET is at the heart of this initiative, not only because they have the collective expertise to participate in the project from inception to completion, but also because they are legally mandated to house the data. WVNET leveraged their expertise in database design, system configuration, and graphic user interface, to work with HEPC's P-20W Data Project management team to bring together diverse data from orthogonal data systems. Together, they developed a comprehensive framework for the data system along with protocols to securely transfer data from each agency. The data from partner agencies is matched by utilizing a robust matching algorithm that cross-references information about students across agencies. The personally identifiable information (PII) is removed to de-identify individuals, and a unique P20 ID is assigned each record. The data is stored in the secure data warehouse using methods and protocols that adhere to state and partner agency privacy guidelines. The P-20W database is updated annually to include new data

generated by participating agencies. The data can be accessed, on demand, to generate context specific answers while remaining within the dictates of strict privacy protocols. WVNET maintains the database, uploads the data from partner institutions, trouble shoots and resolves errors during the batch process, and houses the warehouse data archive. In addition, they write and apply customizations at the request of the WVHEPC's P-20W Project management team.

This initiative provides accurate and timely information for agency leaders and policymakers in such a way that they are able to identify strengths and weaknesses in a student's education and employment

path, and in the process, facilitate student success by targeting programs and policies that work to increase student retention, matriculation, successful completion of postsecondary education and/or vocational certifications, and to find employment in their chosen career.

Pamela Woods, the HEPC P-20W project manager stated, "When we connect data from multiple sources and then look at this information over time, we see things from a new point of view. We can explore trends, find patterns, and gain a better understanding of the whole picture." The P-20W project is just one of the many ways in which WVNET serves public education, higher education, and the workforce in West Virginia.



Founded in 1975, WVNET operates one of America's longest-running education & research networks and is a trusted network and educational service provider in West Virginia. WVNET is a state agency that provides a diverse suite of technology services to West Virginia Higher Education, K-12, libraries, government and nonprofits. Through consolidation of equipment, software, licenses and personnel, WVNET is able to offer top-quality technology at a great savings to customers.

ICN: ILLINOIS CLOUD FIRST – HELPING TRANSFORM TO A SMART STATE



Illinois' Cloud FIRST strategy is not only helping transform the business of the state's IT, but is also lowering costs and providing new and easy to use applications and services for Illinois citizens to interact with state government.

Cloud implementation is foundational for Illinois' transformation to a Smart State, which is defined as a state with a vision, plan and an execution road map to enact the digital transformation of government. In 2015, much of the state compute workload was based on in-house servers. This resulted in low to moderate asset utilization, fragmented demand for resources, duplicative systems and differently governed and managed data centers. By moving compute workload to the cloud, the cost of computing is expected to decrease with increased flexibility where resources are matched precisely to demand, with the State only paying for compute resources that are used.

To develop Illinois' cloud strategy for all state agencies, agency CIOs came

together, forming a cloud working group. This collaboration resulted in the Cloud FIRST strategy and a cloud architecture that addresses the particular needs of all state agencies, with respect to data security, privacy, use and transmission.

Illinois' cloud architecture consists of a public, private and hybrid cloud, as well as the Illinois Century Network. The Illinois Century Network (ICN) is the statewide fiber network interconnecting state agencies with cloud interconnect points and State of Illinois data centers. The ICN enables secure, high speed data transfers between and amongst state agencies and cloud resources, whether internal data centers or provided by third parties.

The public cloud supports standard workloads for applications used by a large number of customers. In the private cloud, the computing environment is operated exclusively for a single organization, supporting applications that are business critical where strict governance and security requirements are necessary. The public and private cloud are operated by

top-tier global technology providers that are external to state government. The hybrid cloud involves a composition of two or more clouds, leveraging Illinois data centers to host applications having high security requirements.

Illinois' cloud environment has enabled a statewide implementation of an Enterprise Resource Planning System, based on SAP, that has dramatically improved the efficiency of administrative and citizen services. Illinois software developers are using platform services provided by the cloud to develop new and innovative applications. One example includes chatbots that enable an automated FAQ application using natural language processing.

Developers are also looking to the future of cloud implementations by exploring the use of containers as a means to lower costs and reduce reliance on a particular cloud provider. Container technology enables work units to be agnostic to the cloud provider and thus further optimizes the flexibility and cost attributes.

Illinois staff collaboration has been a key component of the implementation of the Illinois cloud architecture. From the initial cloud working group, formed from state agency CIO's, to implementation and working with the Illinois Century Network, working across the enterprise has been critical. This kind of cooperation is helping to facilitate a smooth roll out of cloud applications and services for Illinois citizens.

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 of 1999 with the signing of legislation called the Illinois Century Network Act. The ICN has evolved significantly since 1999 and is now a 2000 mile state wide high speed broadband network serving K12 and Higher Education, Public Libraries and Museums, State and Local Government, the Healthcare community and Commercial service providers. The ICN is managed and operated by the Illinois Department of Innovation and Technology.

KINBER NETWORK EXPANSION DRIVES ECONOMIC GROWTH AND COMMUNITY INNOVATION IN RURAL PENNSYLVANIA

In the late 19th and 20th centuries, Venango County, PA, dubbed “Oil City,” was a vibrant oil boomtown, but like so many rural areas across Pennsylvania, the county’s most thriving industry moved away long ago. However, the City of Franklin in Venango County did have the new digital oil — high-speed fiber. Nearly a decade ago, fiber came through Franklin as part of the build-out of a high-frequency trading network. Franklin had a 10 Gbps wavelength to Chicago, but there it sat, unused for nearly 10 years. Recently KINBER’s director of operations, Mike Carey, realized the infrastructure asset that Franklin had and proposed a partnership that would benefit both the local community in Franklin and help KINBER better serve its members. Carey suggested a collaboration that used KINBER infrastructure to provide internet connectivity to Franklin and Venango County while also establishing a peering connection to WiscNet, the regional research and education network in Wisconsin, and its WRIPS service using that dormant wavelength in Franklin, PA.

KINBER worked with a consortium of the City of Franklin, PA, the Franklin Industrial and Commercial Development Authority (FICDA), and the County of Venango, PA. While Venango County and City of Franklin provided the bandwidth to Chicago, KINBER then provided internet connectivity to the consortium in exchange for access to Chicago.

While KINBER owns and operates the 1800+ fiber optic network in Pennsylvania, integrating the Franklin wavelength into KINBER’s PennREN network allowed for easier access to mid-western peering connections. The additional peering capacity to Chicago augments and diversifies KINBER’s existing peering and caching infrastructure while also providing enhanced access to research centers, labs, and other critical collaboration sites for KINBER’s members. “With the connection to Chicago, we have improved our content connections for our members and also established a tertiary connection for greater network reliability,” said Michael Carey, director of operations at KINBER.

Now, with the connection between KINBER and WiscNet, the City of Franklin and Venango County, PA, are able to tap into what long had been buried underground. The promise of a high-speed fiber network is a big draw for businesses, healthcare providers, and other organizations in the area.

“We are planning a business innovation center through a public/private partnership,” said Timothy Brooks, chairman of the county commissioners, Venango County, PA. “We want to attract young entrepreneurs who want to develop their companies and move to our community. Having high-speed connectivity makes it more attractive for businesses to locate here.” According to commissioner Brooks, the county plans on using the top three floors of the Cornplanter Square building, which was built in 1926 and has housed banks over the years, as a business-type incubator program for high-tech jobs and the bottom two floors for retail space.

Through strategic partnerships such as this one in the City of Franklin, Venango County, KINBER is driving economic growth and spurring community innovation across Pennsylvania.



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.

FLORIDA LAMBDA RAIL ESTABLISHES THE ATLANTIC RESEARCH PLATFORM

The Atlantic Research Platform (ARP) is a science driven, high capacity data exchange and transport facility that links campuses to other regional, national and global science DMZs, Internet2, Energy Sciences Network (ESnet), and the Global Lambda Integrated Facility. The ARP integrates campus Science DMZs (following a model developed by ESnet) and links together many of the NSF backed Campus Cyberinfrastructure initiatives (e.g., CC-NIE, CC-IIE, CC-DNI) funded in recent years. With the ARP, Florida LambdaRail (FLR) foresees extensive benefits for research in Florida and throughout the East Coast by extending and interconnecting campus research, HPC and instructional technology environments beyond campus borders to the global research and education networking fabric with integration of campus Science DMZs as secure enclaves for data intensive science and high speed data transport.

Taking inspiration from Internet2's Innovation Platform, FLR's partner institutions are constructing their own infrastructure to support expansion of the ARP capabilities to include:

- Software Defined Networks - A New Class of Control: Entirely new dimensions of possibility, allowing previously untouchable, inflexible networks to be deeply programmable and optimized for compute, storage, visualization and transport capabilities so all can be driven by applications. FLR is an MPLS network that enables and supports Open Flow/Software Defined Networking – on a FLRNet-wide basis.
- Science DMZ - Fewer Bottlenecks: Pioneering concepts like the Science DMZ provide a blueprint for architecting and optimizing local networks to support the very unique needs of passing high-bandwidth research data. Using this model, campuses experience improved application performance without sacrificing security—and as a result, can fully leverage their investments in 100GE connectivity.

On the network level, FLR deployed the three legs of the innovation platform and added a fourth leg - a Regional Science DMZ - across its network. Table 1 provides a list of FLR partner institutions and their progress on establishing the three legs on their campuses, and in turn, connecting to the FLR Regional Science DMZ.

Moving forward, FLR and Internet2 are working collaboratively to establish a diverse path from Florida westward via Pensacola and Baton Rouge. This 100G path will provide East Coast/West Coast diversity for FLR while providing Internet2 with improved capacity in Florida. This connection will enhance national networking by establishing a southern route across the United States and ultimately supporting the proposed National Research Platform.

INNOVATION CAMPUS	100G	SCIENCE DMZ	FLR MPLS (OF/SDN)	FLR REGIONAL SCIENCE DMZ
Florida Atlantic University		✓	✓	
Florida Gulf Coast University			✓	
Florida Institute of Technology			✓	
Florida International University		✓	✓	
Florida State University	✓	✓	✓	✓
Nova Southeastern University	In Progress		✓	
University of Central Florida		✓	✓	
University of Florida	✓	✓	✓	✓
University of Miami	✓	✓	✓	
University of North Florida			✓	
University of South Florida		✓	✓	✓
University of West Florida			✓	

The Florida LambdaRail, LLC (FLR) is an independent research and education network owned and operated on behalf of the FLR partner institutions and affiliates. Created to facilitate advanced research, education, and 21st century economy initiatives in the State of Florida, utilizing next generation network technologies, protocols, and services, FLR provides opportunities for Florida university faculty members, researchers, and students to collaborate with colleagues in-state, across the country, and around the world.

OARNET LINK TO DRONE RESEARCH CENTER BENEFITS NEW INDUSTRY, HIGHER EDUCATION



Ohio's efforts to advance drone technologies are about to get a major broadband boost. Thanks to an agreement completed in December with OARnet, the Ohio/Indiana Unmanned Aerial System (UAS) Center in Springfield will soon be connected to OARnet's statewide, 100 gigabit-per-second network backbone to support the state's drone testing and data collection efforts. Ohio is currently working to develop a ground-based "sense-and-avoid-system" for unmanned aircraft to empower drone operators, for the first time anywhere in the nation, to fly unmanned aircraft beyond their line of sight. The Ohio-Indiana UAS Center was created in 2013 to "advance the commercialization of technology through research, design, testing, and evaluation and the subsequent certification of systems or system components" and "support the UAS community in research and development, facilitating safe integration into the National Airspace System."

The new agreement will provide network connections to the city of Springfield, along with giving existing OARnet members, such as Wright State and

Miami Universities, added resiliency, better redundancy and greatly increased bandwidth.

"Gaining connectivity to OARnet's network adds an additional economic-development tool to help attract and support existing businesses and researchers engaged in the development of unmanned aerial systems and their many sub-components," said Tom Franzen, Springfield's assistant city manager and director of economic development.

The project will also provide the opportunity to connect the UAS site at the Springfield-Beckley Municipal Airport to UAS offices in Calamityville, Ohio, as well as to provide important links to Wright-Patterson Air Force Base near Dayton and NASA Glenn Research Center in Cleveland. The OARnet connections will also link the UAS center to Ohio's colleges and universities, K-12 schools, medical centers, public broadcasting stations, and state and local government offices.

The Indiana Fiber Network and Springfield are providing OARnet with access to "dark fiber" within their networks to complete a vital section of this project, with only about

a mile of required new fiber installation. The current connections in those areas are not fiber-based and therefore are only capable of speeds up to 10 gigabits-per-second. The construction and installation work should be completed by early summer in 2018.

"This is a very positive development for the entire region," said Paul Schopis, OARnet's interim executive director. "And, it's a great example of what OARnet does. We leverage a lot of assets to create a whole cloth that benefits all involved, much more so than they could have done on their own."

Further development of the technology could greatly benefit various Ohio industries, in areas such as precision agriculture, project surveying, infrastructure inspection, project monitoring, environmental survey, resource survey, invasive species detection, corrections facility security, and police and firefighting support. The work underway at the UAS center is intended to give Ohio a major advantage as unmanned aircraft and drones become the basis for new industries and economic growth.

The Ohio Academic Resources Network (OARnet) is a division of the Ohio Board of Regents' Ohio Technology Consortium. Since 1987, OARnet has identified and deployed shared services that reduce costs, deliver quality programs, increase productivity, and improve customer service. Ultimately, OARnet promotes community and economic development by expanding access to affordable technology.

NYSERNET, SUNY SAIL RECEIVE ATD BEST AWARD FOR CIO LEADERSHIP ACADEMY

When NYSERNet asked chief information officers from colleges and universities what their priorities were, their responses weren't about technology. Instead, they wanted skills to attract and retain IT talent, develop leaders, and establish solid succession plans. To address this need, NYSERNet joined forces with SUNY Strategic Academy and Innovative Leadership (SAIL) Institute to create the CIO Leadership Academy, a three-month multidisciplinary program to prepare the next generation of IT leaders in higher education. The program was so successful in its first year that NYSERNet and SUNY SAIL received a 2017 ATD Best Award from the Central New York Chapter of The Association for Talent Development (ATD). ATD's BEST awards recognize organizations that show enterprise-wide success by employee talent development used as a results-oriented, strategic business tool.

The CIO Leadership Academy attracted 20 technology leaders from New York state's higher education system, including SUNY campuses, community colleges, private institutions, museums and library systems. Between March and May 2017, the group met with experienced CIOs and other experts at monthly workshops and virtual growth sessions to examine leadership styles, learn more effective ways to communicate and motivate, lead and develop teams in complex organizations, and create a unifying vision as senior institutional leaders. The academy concluded with a capstone retreat at the University of Albany. The CIO Leadership Academy is aligned

with both NYSERNet's mission of strategic education, which brings its member organizations affordable, high-quality, accessible training and workshops, and SUNY SAIL's mission of advancing understanding and development of the next generation of leaders in higher education.

"NYSERNet and SUNY SAIL's collaboration on the CIO Leadership Academy will help shape the future of information technology at colleges and universities across the state," said Christopher M. Sedore, CEO of NYSERNet and a program mentor. "The award is a testament of our commitment to fostering future IT leaders in our industry."

Graduates of the award-winning program have reported better organizational outcomes, improved communication and greater confidence in their leadership abilities, as well as recognition of their new leadership potential from their superiors. Best of all, participants have established mentoring relationships that continued after the program ended to help foster continued professional development.

"The CIO Leadership Academy was a crucial step in helping me develop a 360-degree view of my skills as a leader and gave me the abilities necessary to leverage my strengths," said Michael Benedetto, CISSP, CISM, CRISC, director of information technology

and deputy CIO, American Museum of Natural History. "Moreover, it gave me the opportunity to meet colleagues on similar career trajectories, which allowed us to build a network for guidance and support. Finally, being able to work with established CIOs as mentors gave us access to seasoned professionals that continue to prove invaluable."

Building on its initial success, the 2018 CIO Leadership Academy welcomed twenty more potential leaders this February, and NYSERNet and SUNY SAIL hope the program will continue to grow.



NYSERNet is a Syracuse-based non-profit network and technology company that connects New York's colleges, universities, K-12 schools, museums, libraries and research centers to each other and the broader digital world. It offers high-bandwidth networking, enterprise-grade data centers and a range of services that give its 75 member institutions the tools they need to educate students, support research and solve the world's problems.

INTERNATIONAL PHYSICS RESEARCH LEVERAGES GPN AND SD REED



South Dakota is ideally positioned to advance scientific research in dark matter and high energy physics. It is home to the Sanford Underground Research Facility (SURF), an infrastructure that extends 8,000 feet below the Earth's surface at what was formerly the Homestake Gold Mine in Lead, SD. It is the only research facility like it in the world. Until its closure in 2002, Homestake was the largest and deepest gold mine in North America, producing approximately 41 million ounces of gold in its 126-year lifetime. The first physics experiment came to Homestake Mine in the mid-1960s when Dr. Ray Davis, a chemist from Brookhaven National Lab, began building his solar neutrino experiment. By the time Ray Davis received the Nobel Prize in Physics in 2002, the deep caverns of the mine were coveted for continued particle physics research.

Dr. Dongming Mei is the principle investigator and director for the Center for Ultra-Low Background Experiments in the Dakotas (CUBED), a collaboration involving South Dakota institutions focused on underground physics. His work represents an important resource for the underground science community and has contributed to the success of experiments at SURF.

With a recent \$4.35 million grant from the National Science Foundation's Partnership International Research and Education program, Mei is leading the Germanium Materials and Detectors Advancement Research Consortium, an international physics research project. The five-year effort will work to advance germanium materials for developing detectors and other technologies in the study of dark matter and neutrinos. The

consortium involves six universities in the United States, two national labs and four international institutes from Canada, China, Germany and Taiwan.

Following a nationwide trend toward multi-institution collaborations, Mei's work requires high-speed access to advanced digital resources and leverages the South Dakota Research, Education, and Economic Development (SD REED) network. SD REED connects South Dakota's six higher education institutions as well as the Sanford Underground Research Facility and the US Geological Survey's Earth Resources Observation and Science Center. SD REED enables high-speed data exchange between institutions as well as access to GPN and the Internet2 national research network. This data-driven workflow led USD to develop a Science DMZ network, funded by a 2014 grant from the NSF Campus Cyberinfrastructure program.

Mei's data accumulates constantly, with additional Neutrino detectors scheduled for deployment more than double Mei's data acquisition rate. In addition to growing data acquisition rates from underground Neutrino detectors, Mei's collaboration with the international Large Underground Xenon (LUX) project recently began processing research data originating at remote campuses. The LUX data is expected to grow by at least 6 TB per year.

Founded in 1862 and the first university in the Dakotas, the University of South Dakota is the only public liberal arts university in the state, with 205 undergraduate and 73 graduate programs in the College of Arts & Sciences, School of Education, School of Law, Sanford School of Medicine, School of Health Sciences, Beacom School of Business and College of Fine Arts. USD is a member of the Great Plains Network.

UETN'S EXPANDED OPERATIONS CENTER BOOSTS SERVICES TO STATEWIDE EDUCATION NETWORK



In a downstairs office at the Eccles Broadcast Center stands a large bank of windows, and a 48-foot wall of video monitors that would make any video gamer drool. But the 280 square feet of screens have a more serious purpose: to monitor the health and security of the network that connects Utah's libraries, universities, public schools, clinics and hospitals.

The Utah Education and Telehealth Network (UETN) launched its remodeled operations center in early November. "The updated operations center is a model facility that rivals high-end tech operation centers throughout the country," exclaimed Ray Timothy, executive director of UETN. "With it, our staff can quickly spot and respond to critical developments." The new facility offers real-time network visualization tools to allow the staff to manage the network, applications, and support services that UETN provides to its clients.

"We can see real time bandwidth utilization history and predict what

bandwidth utilization will be in the future. Thus, being able to upgrade the circuit prior to circuit max out and potentially causing network slowdown," said Louie Valles, UEN's video operations administrator.

The operations center allowed two arms of UETN technical staff to consolidate support operations in a single location. The network operations crew handles the day-to-day support for the statewide network, and the Interactive Video Conferencing department handles the first-line of support, as well as support for distance learning stakeholders. By combining resources from two departments, the UETN technical staff is able to proactively troubleshoot issues before they become noticeable to customers.

"UETN plays an important role in our great state, helping Utahns advance their education and receive telehealth services. I commend UETN for supporting critical technology and infrastructure," said Utah Governor Gary R. Herbert.

The new operations center was conceived and designed by the NOC/IVC leadership and IVC operations staff. It features a sound-dampening ceiling, the video wall and an open furniture layout that provides a space where 14 staff members can collaborate. Much of the technical and physical construction of the center was accomplished by the IVC Tier 2 engineering department, and the UEN Field Operations crew installed the video wall and cabling.

"The operations center technicians and engineers manage everything from slowdowns and connectivity interruptions to security threats in order to keep Utahns' libraries, public and higher education institutions, technical schools and hospitals seamlessly connected," said UETN's chief technology officer, James Stewart. "Our team is now located together in one place, and powerful additional capabilities including real-time network visualization and supplementary monitoring tools have been added, strengthening problem resolution."

UETN's origins reach back to 1956 when the University of Utah submitted a research proposal on educational use of closed circuit TV. Two years later, Utah's public television station KUED-TV signed on the air, formalizing a collaboration between the higher education and public education communities. In the 1970's, microwave technology made analog video conferencing possible, and in the early nineties, the Utah Legislature formally established Utah Education Network as the statewide delivery system for educational services in Utah.

In 2014 the Utah Education Network and Utah Telehealth Network merged, forming UETN. Today, UETN administers a statewide broadband network, three public television channels, distance learning, telehealth services and a bank of online educational resources. UETN serves more than 800,000 learners, 14,000 teachers, and telehealth professionals.

ONENET'S MORE-OFFN FACILITATES GROUND-BREAKING RESEARCH AT REGIONAL UNIVERSITIES

A National Science Foundation (NSF) grant is helping connect four new institutions into Oklahoma's current dedicated research network. Providing regional universities with connections to Oklahoma's Friction Free Network (OFFN) will increase research opportunities for more rural students and researchers across the state.

The Multiple Organization Regional OneOklahoma Friction Free Network (MORE-OFFN) is a new extension of OFFN – a 10 Gbps network ring that leverages OneNet's existing network to provide research institutions with dedicated internet pathways to facilitate research that requires large data transfer and speed. This network improves research in Oklahoma by bypassing internet highways filled with traditional network traffic.

The MORE-OFFN collaboration began with a desire to expand the availability of OFFN to rural, regional, non-PhD granting universities in Oklahoma. Oklahoma has numerous regional universities that serve a large portion of the state's students. Providing more researchers and students with access to advanced data transfer channels increases their educational potential and improves education as a whole throughout the state.

Recipients of the NSF grant are Northeastern State University (NSU), Southwestern Oklahoma State University (SWOSU), Southeastern Oklahoma State University (SE) and Rogers State University (RSU). All of these institutions serve communities in rural parts of the state with less than 20,000 residents.

Dr. Richard Reif, chief information officer for NSU, sees the grant as a way to facilitate greater research collaboration across the state.

"NSU is excited to work with our partners to bring our faculty researchers increased access to the world of high-performance computing," Reif said. "We are especially grateful for the assistance given to us by OneNet and the members of the OneOklahoma Cyberinfrastructure Initiative group, an amazingly talented and collaborative group."

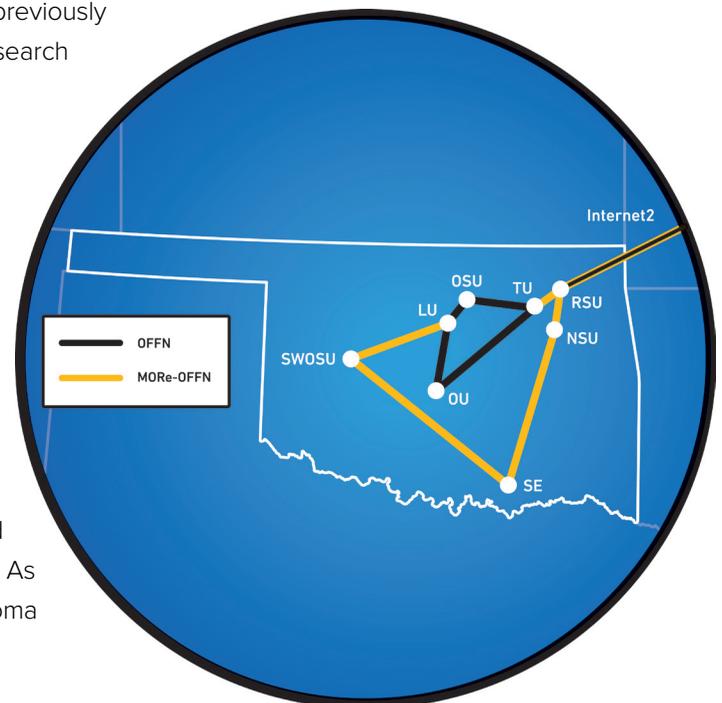
MORE-OFFN expands opportunities for current researchers at regional universities by providing increased data transfer speed and streamlined connections across the state and around the nation. From atomic gas turbulence research at RSU to molecular modeling for computational chemistry at SWOSU, professors and undergraduate students can expand their research scope to engage in ground-breaking projects previously only accessible at large research institutions.

OneNet plays a key role in facilitating MORE-OFFN by furnishing the network backbone that connects all participants across the state. In addition, OneNet provides these schools with a connection to Internet2, a nationwide internet network dedicated to education and research. As an extension of the Oklahoma State Regents for Higher

Education, OneNet is the only provider in Oklahoma connected to Internet2's robust research platform. Because of this partnership, members of MORE-OFFN now have improved data transfer options that will allow them to collaborate with researchers across the nation.

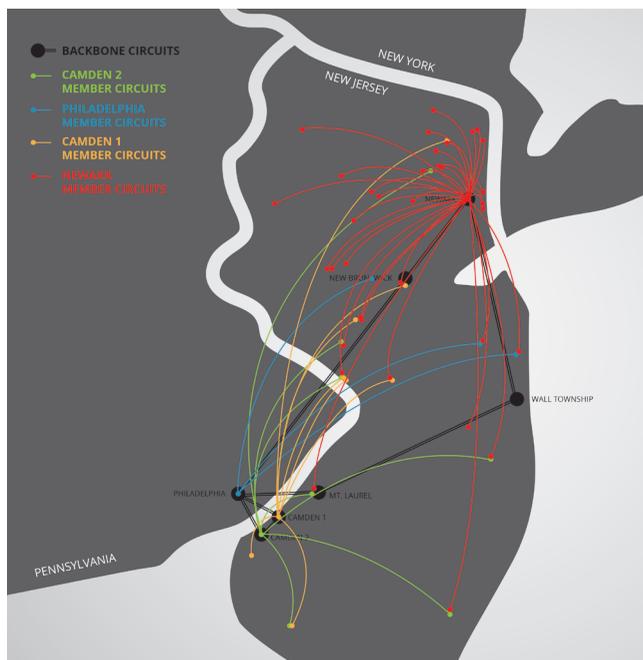
"OneNet's role is to facilitate research and education in Oklahoma," stated Von Royal, OneNet executive director. "By expanding access to research networks like MORE-OFFN, we hope to also increase the quality of education in our state."

As these regional institutions gain access to higher quality network channels and participate in more collaborative research projects, students and professors will have more opportunities to engage in ground-breaking initiatives that will impact Oklahoma and beyond. Through this collaborative initiative, OneNet, MORE-OFFN and the participating institutions are helping change the face of rural education.



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, nonprofit organizations and local, state and federal governments.

EXAFLOP AND BEYOND: A VIEW FROM THE EDGE



Recognizing that in the 21st century research and education networks function as the circulatory system for state, regional, national, and international learning and innovation, NJEdge continued its strategic commitment over the past year to accelerate scientific discovery and research capacity with the design and deployment of its third optical node, which works in concert with a newly provisioned direct physical connection to the Amazon Web Services (AWS) cloud. Serving statewide needs related to digital classrooms and online learning, as well as large-scale research computing collaborations, the need for high-performance, highly available, and high-bandwidth internetworking is continually increasing. In response, NJEdge has continued to invest in future-proofing its network and associated capabilities.

Pursuing a design where the NJEdge network performs as a scientific utility, the shift toward software defined networks and

network functions virtualization is underway. End-to-end network orchestration across virtual and physical domains remains challenging, but is becoming a reality as leveraging DEVOPS tools for research and provisioning high-performance computing resources as needed to meet the future on-demand exaFLOP computing requirements specified by our scientific research community is now characteristic in the NJEdge network.

To instantiate full redundancy, increase routing options, create new services, and build network resiliency, NJEdge collected data from domain research experts among our membership and from peers in the Quilt community to make an informed decision regarding the build-out of a third optical fiber network POP. Critical factors in a location decision included geographic location, available facilities and services, security, total cost of ownership, and scalability. As a result, a third optical fiber network POP was completed in the new New Jersey Fiber Exchange (NJFX) facility located in Wall, New Jersey. The NJFX facility is located at the point where subsea cables from the United States, South America, and Europe land.

Direct connectivity to Europe, South America and the Caribbean is now possible on the NJEdge network via the subsea cables landing directly at our exchange. In support of the future of scientific research and big data, NJEdge's fifth generation

network design not only meets member research demand for highly available, survivable optical transport but in the future will enable the creation of on-demand science demilitarized zones (DMZs) and other science and research. Moreover, NJEdge's new partnership with AWS, an instantiated direct physical connection to the Amazon Cloud, seamlessly brings together the essential components of network, storage, and high-performance computing. This configuration is designed to scale and will take the research community of New Jersey to exaFLOP and beyond.

In a recent statement, Dr. Steven Rose, NJEdge board of trustee chairman, responded to the AWS announcement by saying, "The availability of cloud computing and artificial intelligence technologies such as those provided through NJEdge's partnership with Amazon Web Services, will greatly benefit students and educators in New Jersey - particularly those from underserved and disadvantaged populations, by providing cost-effective access to AWS's advanced compute and storage infrastructure via NJEdge's high-performance, research and education network."

Concept design for our sixth generation network architecture envisions a fully meshed network that deploys automatic re-routing of member digital traffic around any and all carrier network and hardware outages. In practical terms, the NJEdge purpose built optical fiber network has never been more in-sync with the current and future FLOPS requirements.

NJEdge is a non-profit consortium created to support New Jersey's institutions of higher education in their pursuit of excellence in teaching, learning and research. NJEdge built a state-of-the-art technology network that is purpose built with standards-based digital education infrastructure.

MCNC EXPANDS SECURITY PORTFOLIO ON NCREN



Cybersecurity is a top concern for most organizations, and K-20 education, healthcare, and government organizations are increasingly at risk for cyber-attack. MCNC has responded to these threats by building a portfolio of security services to help the NCREN community stay protected.

MCNC introduced web content filtering and security for North Carolina K-12 schools in 2011. This service through Zscaler provides an efficient, effective way to help protect the web browsing for more than one million North Carolina students, teachers and staff.

In 2015, we implemented Enhanced DDoS Protection on NCREN, which provides world-class DDoS attack mitigation as part of standard NCREN service. Two years later, MCNC passed a SOC 2 Type II audit for its RTP Data Center, assuring customers that MCNC implements and effectively operates a rigorous set of controls for its enterprise and data center operations.

MCNC continues to help protect customers today from the damaging effects of cyber-attacks. This year, we introduced two new

services in the MCNC Security Portfolio: DNS Security Filtering and Continuous Monitoring and Risk Assessment.

MCNC DNS Security Filtering
MCNC DNS Security Filtering is built on Akamai's Enterprise Threat Protector DNS platform and is a quick-to-configure, easy-to-deploy cloud solution that requires no hardware or software to deploy or maintain. It leverages real-time Akamai Cloud Security Intelligence and Akamai's globally-distributed recursive DNS platform to proactively identify and block targeted threats such as malware, ransomware, DNS data exfiltration, and phishing. External recursive DNS traffic throughout the enterprise is directed to MCNC's DNS Security Filtering service, requested domains then are checked against Akamai's real-time domain risk scoring threat intelligence, and proactively blocks employees from accessing malicious domains and services.

MCNC Continuous Monitoring and Risk Assessment. The Center for Internet Security recommends continuous,

automated monitoring and reporting as the most effective way of implementing necessary controls. In response to this guidance, MCNC is offering customers its Continuous Monitoring and Risk Assessment service.

This service scans a customer's network perimeter to identify systems, catalogs the attack surface, and detects the presence of known vulnerable configurations on these systems. This vulnerability data is automatically imported into Kenna Security's risk assessment platform, where it is enriched with third-party threat intelligence to determine which vulnerabilities are most likely to pose a real threat to the customer. Risk scoring algorithms prioritize which issues a customer should address first, and the system then provides customers actionable guidance.

Security Opportunities

Based on customer inquiries, MCNC is expanding the security team to provide cybersecurity expertise and consulting in technical controls, security designs and architecture, risk assessments, or assessments of an organization's security program. Our goal is to help our customers improve their overall security posture.

MCNC creates opportunity for North Carolina in education, economic development, government, and health care by helping our community leverage our technology infrastructure. Increased reliance on digital resources means customer success depends on an ability to protect these digital resources.

MCNC security services is making it easier for our community to succeed.

MCNC, a technology nonprofit that builds, owns and operates the North Carolina Research and Education Network (NCREN), has served research, education, non-profit health care and other community institutions with Internet connectivity in the state for more than 30 years.

MERIT NETWORK: BUILDING THE CYBERSECURITY WORKFORCE OF THE FUTURE



Michigan and the U.S. as a whole are facing drastic shortages in cybersecurity professionals. Unfilled demand is expected to total in the millions by 2020. It is critical to generate student interest and exposure to security and technology careers to address the widening gap in our talent pool between qualified individuals and the demand for those skills.

As a solution, the Michigan Cyber Range, operated by Merit Network, and the state of Michigan partnered to develop the Governor's High School Cyber Challenge. This program combines self-study, after-school programs and gamified learning in a multi-round competition that tests students' skills in networking, programming and operating system security. In February, Merit and the state of Michigan received a CSO50 award which recognizes organizations for a security project or initiative that demonstrates outstanding business value and thought leadership.

The Governor's High School Cyber Challenge, which launched in 2016, features three rounds of competition. Students compete from their homes or schools in teams of up to three. Round 0 provides non-qualifying cybersecurity quizzes to assist students with preparation for Round 1. Round 1 is an online four-day competition that focuses on networks, programming, hacking, security and more. Merit is able to leverage its high-performance, 4,000-mile network that extends throughout the state to further the reach of both the contest and the Michigan Cyber Range.

The top ten highest-scoring teams from Round 1 are selected to advance to the Round 2 finals, held at the North American International Cyber Summit. During Round 2, teams compete in a virtual Capture The Flag exercise designed to test their skills with an intensive, timed series of gamified cybersecurity-focused challenges. Every round of the competition was offered at no cost to schools or students, thanks to support from partners and

sponsors. In 2016, 94 teams and 282 students participated in the challenge. In 2017, 188 teams and 564 students competed in the event. Following each annual competition, Merit is flooded with requests from teachers for additional materials and resources. Gamified cybersecurity resonates deeply with students, who are eager to continue their learning after the event.

"Merit is providing a fabulous opportunity for high school students interested in expanding their tech skills. I can say that it is easily one of the highlights of the school year for our high school tech program," says Shannon Houtrouw, a computer science instructor at the Kalamazoo Area Math Science Center.

Merit aims to grow the program both within urban and rural areas of the state, such as Northern Michigan and the Upper Peninsula. It is our hope to continue efforts like the Governor's High School Cyber Challenge to create a state that is cyber-ready and secure.

Merit Network is the nation's longest-running research and education network. Merit owns and operates 4,000 miles of fiber optic infrastructure throughout Michigan. We offer networking, security and community services to nonprofits. The Michigan Cyber Range, powered by Merit, is the largest unclassified, network accessible cybersecurity training platform in the U.S.

I-LIGHT SUPPORT CONTRIBUTES TO NSF GRANT TO IMPROVE UNIVERSITY CYBERINFRASTRUCTURE

I-Light member, DePauw University, has been awarded funding from the Campus Cyberinfrastructure (CC*) grants through the National Science Foundation (NSF). The CC* grant, in combination with an anonymous gift of \$10 million earmarked for new technology innovation at the university, improves campus cyberinfrastructure and strengthens DePauw's commitment to computer science education.

DePauw's dedication to computer science education began with Robert Thomas, a professor in the mathematics department who began teaching the subject in 1958—without a computer. After Thomas retired in 1991, three faculty members joined forces to form an independent computer science department that continues to thrive.

In 2013, Thomas, now professor emeritus of mathematics and computer science, and his wife, Doris, made a gift to the university to create the DePauw Computer Science Founders Fund for Excellence, with a goal of keeping the university at the forefront of computer science education.

A portion of the \$10 million gift to the university is dedicated to increasing the Founders Fund. DePauw plans to use the remainder of the \$10 million gift to create the Technology Center and Visualization Laboratory, a space for students to develop tech skills, and to create a new leadership position for technology programming.

CC* grants are intended for improvements to campus networks, with a specific focus on science applications and distributed research. DePauw identified the following three areas for improvement:

- Increasing their network connection to I-Light from 1GB to 10GB
- Obtaining a second fiber optic link for redundancy in connecting to I-Light
- Prioritizing science data flows with high performance data transfer

Improvements in these areas address immediate research needs for DePauw projects, providing more effective data exchange and better use of remote applications across national research and education networks.

Over the last few years, I-Light has focused on supporting its higher education members with their grant proposals. The support ranges from simply notifying institutions about available grants to consulting on network designs.

I-Light also draws on relationships built throughout the local and national R&E communities to assist schools in gathering the letters of collaboration they need to back up their campus initiatives.

“With every applicant, we request letters of collaboration from Indiana University, I-Light, The Quilt and Internet2,” said Marianne Chitwood, director of I-Light. “We’re showing through those letters that there’s a robust community, including the Quilt and Internet2, supporting the applicant.”

For I-Light, the opportunity to support smaller institutions like DePauw through the grant process is at the heart of its mission—each campus's achievements strengthen the overall network. “They’re our members, they’re why we’re in existence,” Chitwood said. “The grants are good for each recipient, our state, our network, and our research community.”



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.

CONNECTICUT EDUCATION NETWORK (CEN): NEW LEADERSHIP, NEW DIRECTIONS

The Connecticut Education Network (CEN) remains a model of efficient and effective service delivery providing high-performance, high-speed internet connections to the state's schools, libraries, and institutions of higher education. In recent years, CEN has supported the growth of research, healthcare, business, and cultural institutions with the addition of "open access" members such as Jackson Laboratories, UCONN Health, and the XL Center in Hartford. The network connects over 550,000 K-12 school students, 1.5M+ library patrons, nearly 200,000 college students, and 107 towns and councils of government across its 485 members.

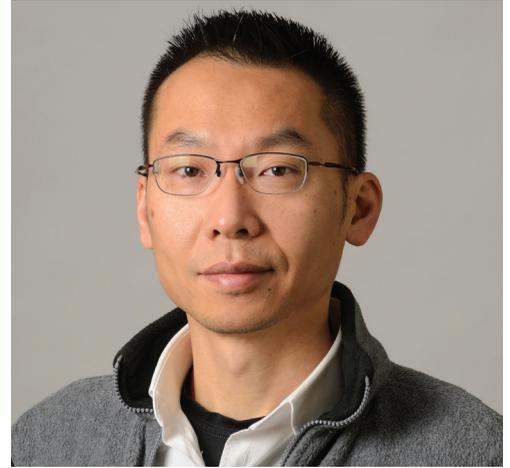
Building and expanding on this strong foundation and growth trajectory, Director Ryan Kocsondy is leading CEN with a strategy focused on growing network membership and services, enlisting guidance from member advisory councils, and improving CEN market presence and brand positioning. Over the last year, Ryan has recruited and built the team to support the underlying programs and initiatives. This began in 2017 with the addition of Rick Cheung as senior network engineer to lead CEN's team of network engineers. More recently, Paul Tarsa was promoted to member relations manager to guide business development, marketing, and communications. As the newest member of the business team, Rachael Collard joined CEN in February as publicity and marketing coordinator. CEN's team now comprises ten full-time professionals and five part-time UConn students.

Growing network services begins with member participation in helping the CEN team define needs and solutions for better

outcomes at lower cost. CEN's proposed Member Advisory Councils will focus on three areas: network service management, technical advancement, and educational development. All member verticals: K-12, higher education, libraries, government/municipal, and open access will be represented. The member response to Ryan's invitation has been outstanding, and inaugural meetings are planned in the near future. These Member Advisory Councils will enhance CEN's value proposition as much more than the state's internet service provider. CEN connects communities, organizations, and their people.

CEN's Library Project has been the source of our greatest membership growth in recent years. In 2017, CEN entered year two of this four-year project to move libraries off older (slow) connections to high-speed broadband circuits. Thanks to \$3.6M in grants from the CT State Library, as well as funding from the federal E-rate program, 55 public libraries will install high-speed fiber connections to CEN in 2017 and 2018. By the conclusion of the project, CEN will bring fiber optic internet access to 136 of the state's 193 main libraries.

CEN's growth in network infrastructure and services is highlighted by our march to NYC. With our NEREN (Northeast Research and Education Network) partners, CEN's 100Gbps connection to the expansive data center at 32 Avenue of the Americas (NYC3) will provide members access to one of the nation's most sought-after locations for network connectivity. When completed in mid-2018, CEN will gain access to valuable ISP and cloud service provider peering relationships.



Rick Cheung, Senior Network Engineer



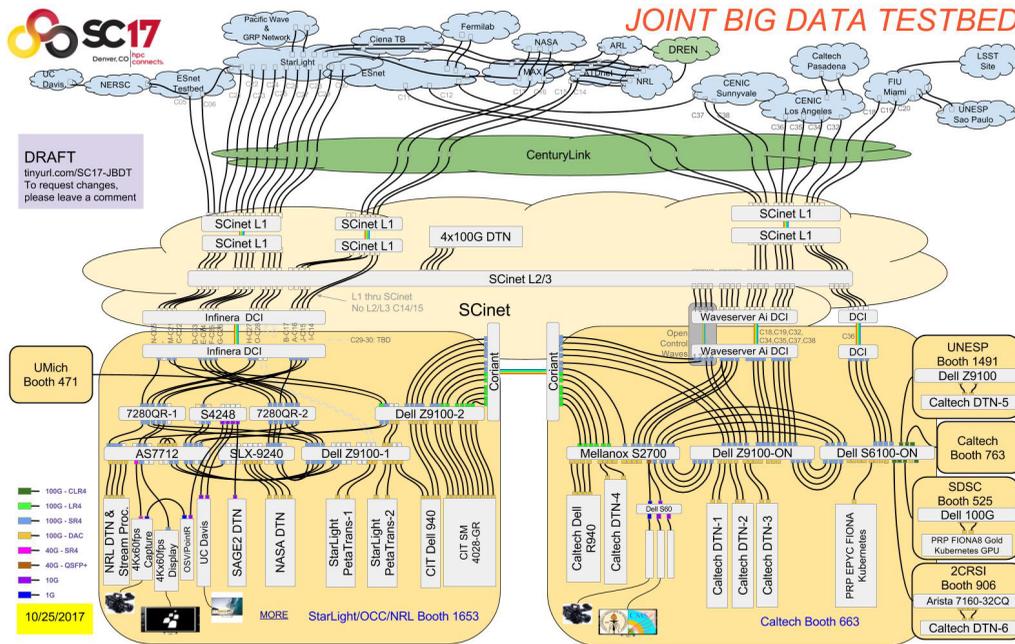
Paul Tarsa, Member Relations Manager



Rachael Collard, Publicity and Marketing Coordinator

Connecticut Education Network (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 and municipalities throughout Connecticut.

ADVANCED NETWORKING SERVICES BEING DEVELOPED BY MREN



MREN Supported SCinet SC17 National/Venue Network

There are three macro themes in emerging capabilities for next generation communication services and technologies. One is providing large scale WAN capacity, not only 100 Gbps paths but also 400 Gbps and Tbps paths, including those based on bonded lightpaths provisioned over superchannels. Another macro theme is network programmability, especially by using Software Defined Networking (SDN) techniques, made possible by virtualization, including through implementing new types of orchestration techniques (such as network slicing) and technologies that enable highly granulated network customization, enabling a migration from “one-size-fits-all” networks to highly distributed platforms that can support many different types of networks required for different services, applications and communities. With its local, regional, national, and international partners, MREN has undertaken multiple initiatives to address these issues.

For the international supercomputing conference (SC17) in Denver, Colorado, the 29th annual Supercomputing Conference for High-Performing Computing, Networking, Storage, and Analysis, MREN, the StarLight consortium, and multiple national and international research partners, designed and staged a series of 32 sets of demonstrations to showcase emerging services and capabilities for advanced data intensive science networks. To provide a foundation for these demonstrations, MREN and its partners, including StarLight, SCinet, ESnet, Caltech, the Mid-Atlantic Cross Roads (MAX), and CenturyLink, implemented ten 100 Gbps paths from StarLight to the conference venue in Salt Lake City, as well as four 100 Gbps paths from MAX to the venue and three 100 Gbps paths from Washington, D.C., to the StarLight facility. On the show floor, MREN, in partnership with StarLight, and SCinet implemented 3 Tbps of capacity in the StarLight booth and a Tbps link to the CalTech booth.

During the conference, the capabilities of two Software Defined Exchanges (SDXs) implemented at the StarLight facility were showcased: one supported by the National Science Foundation’s (NSF) Global Environment for Network Innovations program and the other supported by the NSF’s International Research Wavesserver Connections program. These SDXs were used to demonstrate advanced services for data intensive sciences, including those that use E2E single 100 Gbps streams across national and international WANs.

Among the 100 Gbps based capabilities showcased were those for data intensive bioinformatics, weather data filtering and analytics, remote I/O and controlled pipelining, dynamic WAN provisioning, ultra resolution visualization, large scale data transfer services, data transport for space sciences, large scale file transfers for airline data, application driven intelligent data movement for Large Hadron Collider high energy physics, high performance distributed file systems, AI enabled data stream steering, 400 Gbps server to server transport across two thousand mile WANs, AI enabled simulations, network slicing, network provisioning using the P4 network programming language, new SDN techniques, network disaggregation, including optical disaggregation, programmable privacy-preserving network measurement for network usage analysis and troubleshooting, multicore-aware data transfer middleware, high performance data transfer nodes, real time network analytics, and scheduling for large scale data flows.

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.

MAX AND CIENA PARTNER TO EXPAND OPPORTUNITIES FOR COLLABORATIVE RESEARCH IN THE SCIENCE AND HIGHER EDUCATION COMMUNITIES

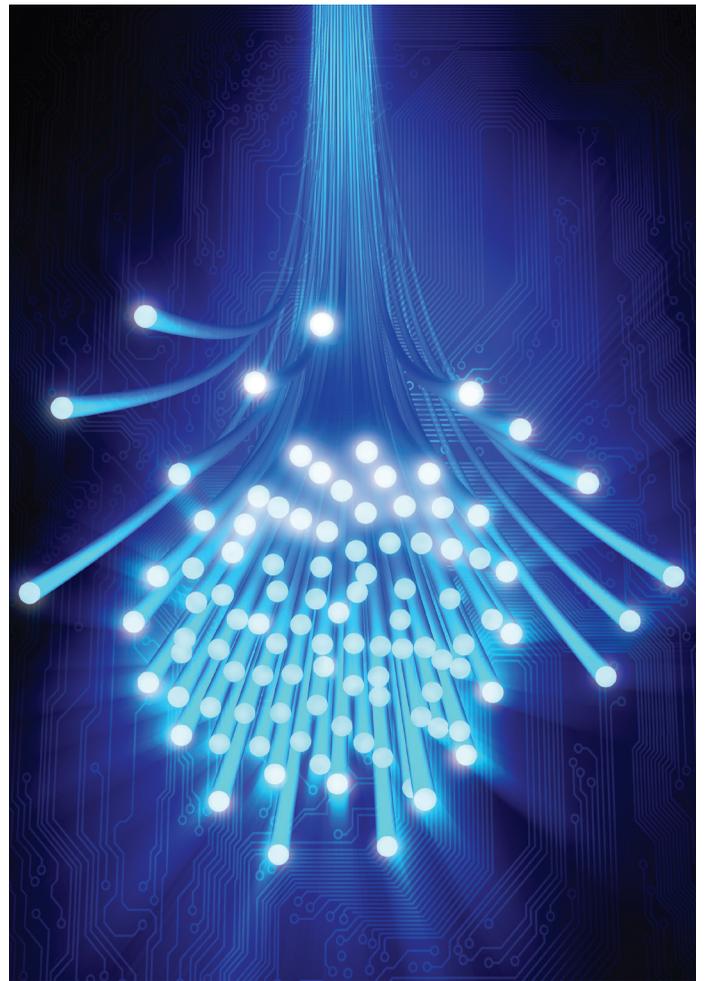
In mid-November 2017, Mid-Atlantic Crossroads (MAX) seized a great opportunity to partner with Ciena, a network strategy and technology company, to create a 200G network connection which joined together their robust research infrastructures to facilitate technology development and testing in the areas of multi-domain, multi-layer software-defined networking (SDN), along with distributed systems integration. As a result, this interconnection now allows both organizations to expand the reach of their testbed facilities as well as their research activities, thus opening up new opportunities for scientific collaboration and innovation.

The connection, which was made in Baltimore, Maryland, now expands access to Ciena's SDN research testbed which unites all of the key packet, optical, and software building blocks required to demonstrate the benefits of software-defined, multi-layer wide area networks (WANs). This testbed provides a high-scale, programmable infrastructure that can be controlled and adapted by network-level applications. Furthermore, it provides open interfaces to coordinate computing, storage, and network resources in a unified, virtualized environment. In collaboration with Ciena, community partners CANARIE, ESnet, Internet2, and StarLight, were also instrumental in the development of this unique resource.

The partnership was showcased at the 2017 Supercomputing Conference in Denver, Colorado. The MAX staff and the connector organizations were able to utilize the new infrastructure to show a variety of demonstrations in the areas of multi-domain SDN, multi-100 Gbps end-system to end-system performance across the wide area, and high-performance distributed file system access.

University of Maryland's assistant vice president and chief technology officer, Tripti Sinha, stated, "This partnership with Ciena creates a very powerful resource that will better the scientific community and advance critical discoveries."

Moreover, Jeff Hollingsworth, interim chief information officer and professor of computer science at the University of Maryland said, "As one of the nation's and one of the world's premier research institutions, the University of Maryland will benefit greatly from access to this new resource created from the MAX-Ciena partnership."



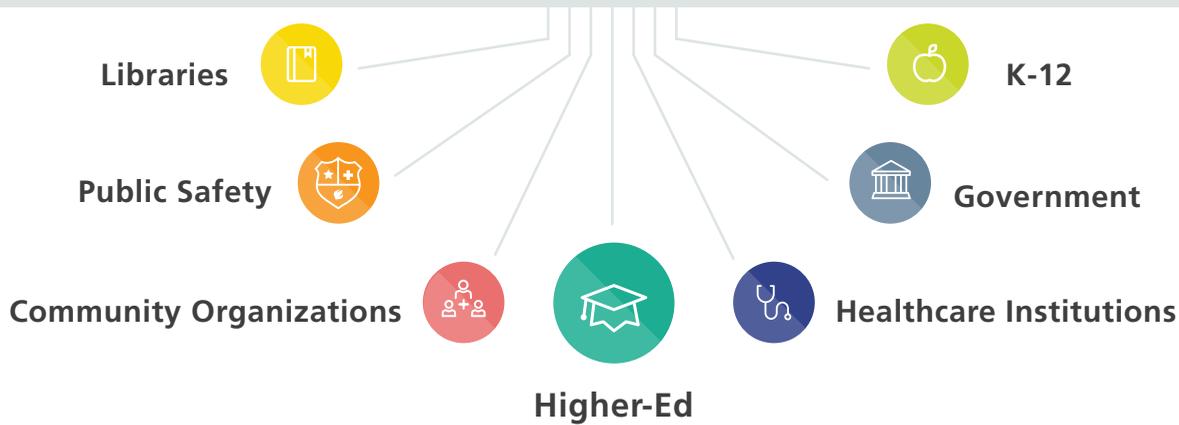
There is great optimism for the future of this partnership. It will provide insight into programmable networks and how to service-enable key features within the testbed and enable the work of science. It will also focus on creating a next generation networking research infrastructure which researchers and experimenters can use to further their science.

Mid-Atlantic Crossroads (MAX) is a center at the University of Maryland that operates a multi-state advanced cyberinfrastructure platform. 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. MAX participants include universities, federal research labs, and other research-focused organizations in the Washington and Baltimore metropolitan areas.

Research and Education Networks:

Enabling Breakthrough Innovations that Power the Greater Good

Non-Profit Research and Education Networks provide secure, high-capacity, high-performance network infrastructure and related technical and operational support for:



Fastest, Most Advanced Technical Infrastructure	Trusted Network-to-Network Collaboration	Resource Sharing and Cost Reduction
<p>Purpose built and dedicated to meeting the needs of our communities.</p> <p>Unparalleled levels of performance, reliability and security.</p> <p>Redundant connectivity to other regional, national and international research and education networks.</p> <p>Separate experimental networks, which foster networking or application research or very large point to point data transfers.</p> <p>Multiple colocation facilities providing participants with geographically separate locations to land different connections.</p> <p>Networks offer Netflix and Akamai caching to offset commercial traffic draws, as well as direct peering with entities such as Google, which all result in better end use experience with better network performance.</p>	<p>Secure and lightning-fast networks connect schools to hospitals to research centers and beyond – enabling exciting new research and education opportunities.</p> <p>Networks are often part of multi-state regional partnerships that provide shared network services across communities as well as diverse backup and connectivity options.</p> <p>Nationwide research and education communities regularly share technical and operational information and expertise for the betterment of all.</p> <p>Networks create a trust fabric between research and educational communities.</p> <p>Member driven collaboration – not a vendor / customer relationship.</p>	<p>Participants enjoy reduced costs for the entirety of services provided due to the shared expertise and services, increased buying power and economies of scale participants obtain from being part of the larger R&E networking group.</p> <p>As non-profit entities, equitable and shared cost recovery models minimize costs and maximize benefits across the membership by offering participants a way to be a part of regional or national buying aggregation efforts.</p> <p>R&E networks can offer another avenue for participant advocacy, outreach and education around common topics or areas that may benefit from a larger, aggregated voice.</p>

Research & Education Networks are the Ultimate Facilitators of Innovation, including:

- Access Control
- Big Data Solutions
- Climate Modeling
- Cloud Computing
- Cybersecurity
- Disaster Recovery
- Genomic Research
- Global Research
- Healthcare
- Museum Science Centers
- Supercomputing
- Telemedicine
- Transportation
- University Research
- Video Collaboration
- Video Streaming

THE QUILT



National Regional Networks Consortium

Advanced regional networking in support of research and education