



Connecticut's Trusted Internet Partner

Annual Report

2019 ACTIVITIES AND ACHIEVEMENTS

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Overview

CEN Members,

The Connecticut Education Network (CEN) finishes 2019 marking significant progress on a new direction for the Network that will carry us into the next decade. A new, five-year strategic plan was developed in concert with our members, updating our mission and vision, and capturing the needs of the community as CEN looks to leverage the platform and engage, innovate, and expand service offerings; advocate for each other's needs; and drive additional value for the membership and state.

With hype about 5G cellular services bringing more promise than solution and growing concerns about how the repeal of Net Neutrality may limit access to content, CEN remains steadfast in our approach to delivering flexible, high-performance Internet and network-based services to Connecticut's community anchor institutions and open-access members.

The distinct design of the Network helps ensure delivery of high-quality, resilient, and secure services. The overall operation and approach help the state avoid millions of dollars in cost annually when compared to distributed activities and commercial alternatives. CEN's statewide, all-fiber network connects more than 1.8 million students, educators, researchers, state and municipal employees, and citizens in for learning, workforce development, and economic growth.

Connecticut remains one of the most digitally connected states, yet still has areas in need of quality connections. Established in 2000 and expanded through the years to suit the needs of Connecticut's community anchor institutions, CEN provides critical infrastructure that could not be re-built for its replacement cost today. CEN connects most anchor institutions, offering unparalleled and equitable service to urban and rural areas alike. The Network provides robust services at scale, operates on a cost-recovery model, and fosters a strong customer-provider partnership model that doesn't exist elsewhere in the state.

As we close out this decade and look forward to 2020, we celebrate 20 years of CEN at our annual conference in May. In the year 2000, early leaders of the Network didn't know what CEN would be become, but they did know it would make an appreciable difference to the Connecticut landscape. That vision remains alive today, with a shared dedication to grow the Network — built for stakeholders rather than stockholders — and deepen its benefit to the state.

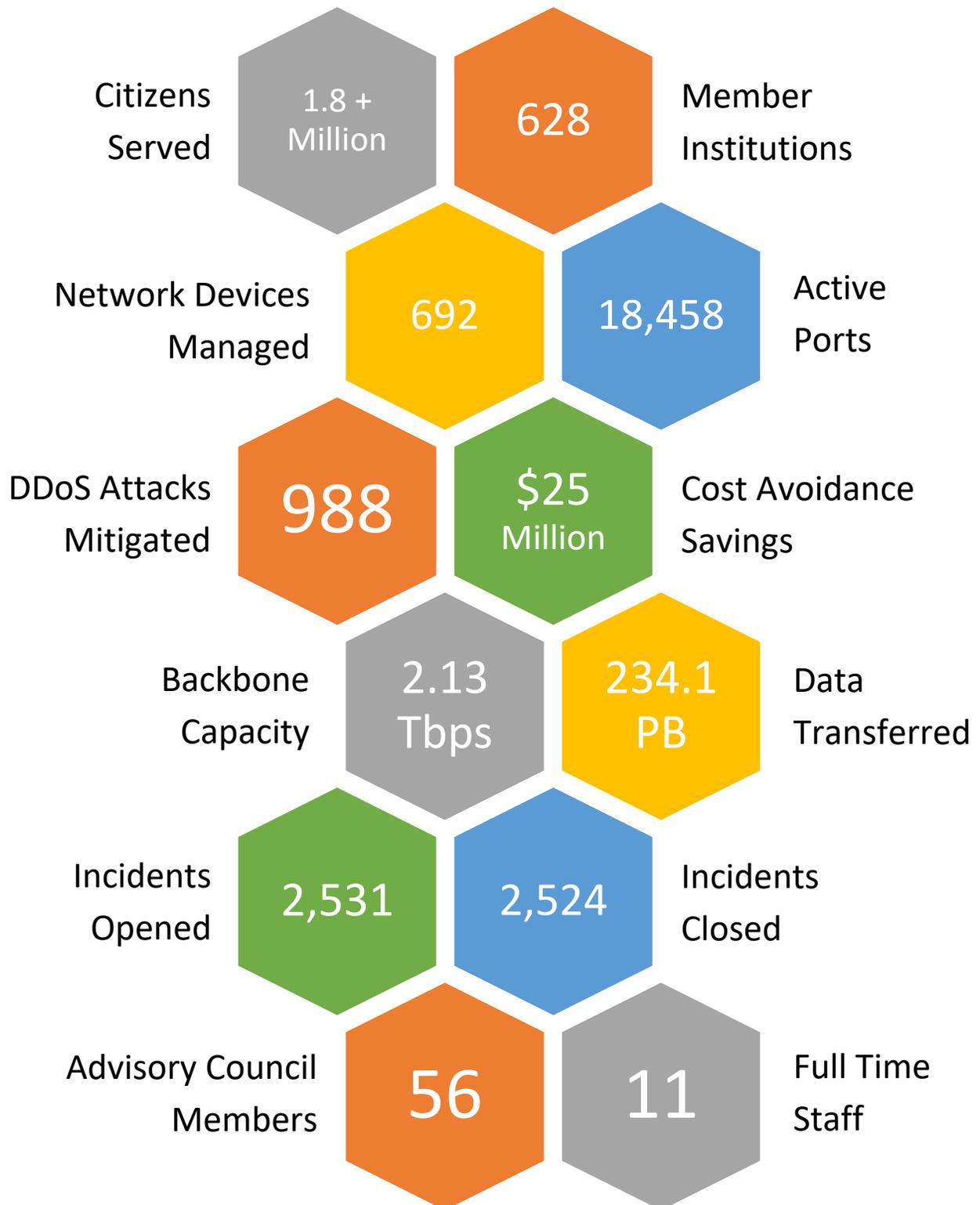
Thank you for your continued engagement and support.

Ryan Kocsondy



Ryan Kocsondy, Director of CEN

2019 By the Numbers



Strategic Plan Overview & Reporting

VISION

CEN serves as the trusted partner through which Connecticut’s digital and human networks connect, collaborate, and share resources to realize the full potential of digital learning, research, and citizenry.

MISSION

Empower our member institutions to execute their missions through technology, collaboration, and digital transformation with secure, reliable, and value-added network and Internet solutions.

PLAN GOALS AND STRATEGIES

The goals and strategies in this plan represent the needs of the community and what CEN must do to remain competitive and relevant (Goal 1), differentiate itself from commercial counterparts and ensure continual alignment with our members (Goals 2 – 4), and support the foundational platform on which all other goals depend (Goal 5).

2019-2024 STRATEGIC GOALS

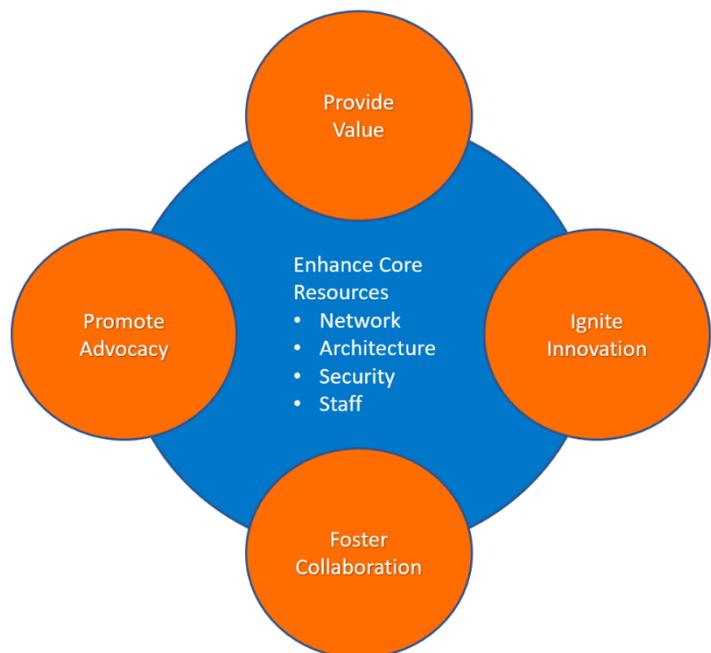
GOAL 1: PROVIDE VALUE — Expand the service portfolio to provide value and enhance Internet and network capabilities at scale, heighten security, and increase the overall knowledge and understanding of those technologies and services.

GOAL 2: IGNITE INNOVATION — Empower members through a suite of services tailored to their needs that encourage excellence and innovation.

GOAL 3: FOSTER COLLABORATION — Engage the local membership and national R&E community to provide technical and functional network services that serve the specific needs of CEN member communities.

GOAL 4: PROMOTE ADVOCACY — Pursue activities to enhance brand awareness so members and policy makers can articulate CEN’s value and impact public policy initiatives.

GOAL 5: ENHANCE CORE RESOURCES — Pursue opportunities to leverage, develop, and enhance CEN’s core technology and human resources for the foundational success of the program in pursuit of member needs.



Full plan can be viewed and downloaded at <https://ctedunet.net/strategic-plan/>

Goal 1: Provide Value

CEN's top priority is to provide value to its member institutions in the form of quantifiable cost avoidance as well as through the more intrinsic benefits of the unique set of services the Network offers. Both derive from high-quality, personalized, and responsive service delivered through a partnership rather than traditional provider – customer model. As we leverage the platform to provide scalable services and broaden the service portfolio, the Network will continue to provide unparalleled value to its members and the state.

Cost Avoidance

The following section provides details on the estimated cost avoidance that CEN customers appreciate. In total, we calculate approximately \$25 million in annual cost avoidance across the membership for Internet and related services. Cost avoidance savings are calculated as (cost of alternative acquired individually) minus (CEN provided at scale) and are as follows:

- \$386,500 savings for web content filtering
- \$6.6 million for Internet services for all CEN member constituent groups compared to average price across NY, MA, and RI. E-rate source data utilized for the basis of the calculations.
 - Savings using national average E-Rate cost is approximately \$11 Million per year.
- \$18 million for DDoS protections
 - Aggregate of third-party, emergency services
 - Does not include indirect cost of lost productivity

Similarly, federal E-rate base data was used in a recent study with assistance from Education Superhighway (www.educationsuperhighway.org) — which recognized CEN as a connectivity leader for the fourth straight year — connectivity costs for K – 12 institutions fall anywhere from 19% to 138% below the cost of similar services in neighboring states.

	Annual Cost	Annual Cost Difference	Percent Increase
CT (CEN)	\$3,017,146.80	—	—
CT with NY pricing	\$7,178,438.04	\$4,161,291.24	137.92%
CT with MA pricing	\$5,691,724.65	\$2,674,577.85	88.65%
CT with RI pricing	\$3,589,680.84	\$572,534.04	18.98%

New York and Massachusetts do not have Research and Education (R&E) regional networks that service K – 12, and cost is relative to the markets and incumbent providers who serve them. Rhode Island has a regional network serving K – 12 and is the closest to CEN in capability, though different in scale given the relative sizes of the states we serve.

As stated earlier, Education Superhighway recognized CEN as a connectivity leader in its 2019 State of the States report. That study's assessment of CEN's bandwidth, affordability, and fiber connectivity place Connecticut as one of the top K – 12 providers in the nation. In addition, Education Superhighway profiled Norwalk (CT) Public Schools through an engaging video (<https://youtu.be/oQacTGRKXM0>) for its

innovative use of broadband provided through CEN to support personalized learning as well as college and career readiness.

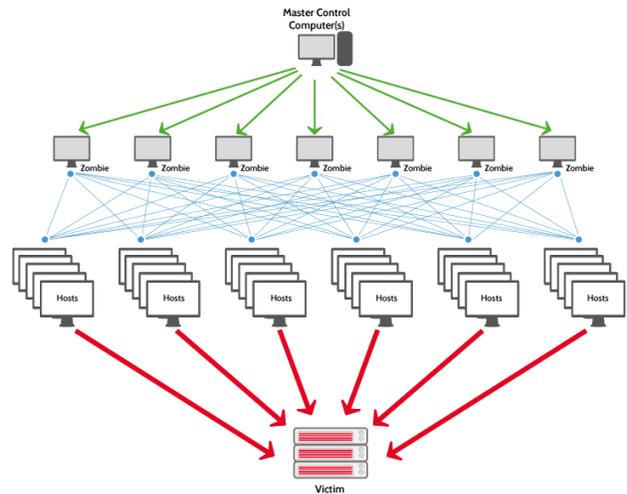
CT Library Fiber Consortium Project

Over the past five years, CEN has helped connect libraries throughout the state to its high-speed fiber network by leveraging federal E-rate funds and matching State Library bond dollars. Many project sites connect underserved communities where connectivity options have remained relatively unchanged for decades. This project provides high-quality service at reasonable costs to bridge gaps in the digital divide and help libraries continue to thrive as community assets. Eligible libraries that pursue funding, like their predecessors, will transition from digital subscriber line (DSL) or cable Internet connections (typically 25/3 Mbps asymmetric service) to CEN’s fiber optic network with symmetric speeds of 1 Gbps initially and capacity for growth to 10 – 40 Gbps. In 2019 CEN was awarded and executed on phase 5 and responded to the RFP for phase 6.

The total number of fiber-connected libraries across all phases (1 – 5) is 158 (including 47 branches), representing 66% of all 239 libraries statewide with an additional 10 committed as we close out the year. Total savings on previous four funding years is \$1,392,000 , based on USAC E-rate dark fiber IRU saving

DDoS

Distributed Denial of Service (DDoS) attacks flood targeted connections with massive amounts of data traffic, rendering affected institutions inoperable. When attacks take place, almost no legitimate traffic goes in or out of the target’s network connection, and all productivity is lost for regular end users and IT staff trying to troubleshoot. CEN’s DDoS Threat Management continues to be one of the most valuable services that CEN provides and is critical to maintaining smooth operations to the membership. The on-premise Arbor/NetScout solution mitigates attacks on a near-daily basis, with summary data as follows:



2019 DDoS Statistics

Mitigated Incoming Attacks	Total Volume of Mitigated (Dropped) Traffic	Volume of Largest Mitigation	Rate of Largest Mitigation	Duration of Longest Mitigation
988	33.8 TB	3.74 TB	20.03 Gbps	2 Days, 17 Hours, and 54 Minutes

The return on investment on DDoS mitigation services is well over 1,000% and provides an example of an aggregated service at scale helping members across the state avoid millions in direct costs if purchased individually and commercially, not to mention indirect productivity costs.

Continued Member Growth

The CEN Membership continues to grow and added 25 new members this year. Current member totals are as follows:

2019 Member Counts

	Public K – 12 Entities	Private K – 12 Schools	Public Colleges & Universities	Private Colleges & Universities	Public Libraries	Municipal Gov't	Public Safety	State Gov't Branches	Open Access
Connected	186	21	19	18	153	109	78	2	37
CT Total	194	n/a	19	20	238	169	n/a	3	n/a
% of Total	96%	n/a	100%	90%	64%	64%	n/a	66%	n/a

Note: CEN Connects 100% of CT's K – 12 districts. The K – 12 totals above represents districts and charter schools.

Welcome New Members in 2019

- 70 Audubon Association
- Andover Public Library
- Babcock Library - Ashford
- Danbury Fire Engine #25
- Flanders Fire Dept
- The Foote School
- Genie Innovations, Inc.
- Grove School
- Hamden Hall School
- Holy Cross High School
- Makerspace CT
- Marlborough Fire House
- Niantic Fire Dept
- Plymouth Police Dept
- Prospect Public Library
- Sacred Heart Academy
- Southwestern Regional Communications Center, Inc.
- St. Vincent's College
- Town of Litchfield
- Town of Orange
- Torrington Police Dept
- United Way of CT
- West Hartford-Bloomfield Health District
- Wolcott Volunteer Fire Department
- Willington Hill Fire Department

Disconnected in 2019: Discover Video

Goal 2: Ignite Innovation

The goal of igniting innovation comes through a delivery of services tailored to member needs. Offerings help deliver quality services at scale through advanced architecture, features, and rigorous testing. In addition, support for research-based activities will continue to expand and stretch the limits of the Network and help it stay ahead of the day-to-day needs of every member.

Firewall Services



The goal of the new firewall service is to provide a high quality, high capacity, next generation firewall experience that can scale dynamically with the growth of member bandwidth and provide a front-line defense for our organizations (see ctedunet.net/managed-firewall/ for details). The service is offered in two versions to suit the different member sizes and internal technical capabilities. These include the virtual firewall, for those who are able to manage their own rule sets and policies, as well as a fully managed firewall, where CEN will have our managed security services provider (MSSP) to oversee firewall configuration and operations for those who need that level of care. As we close 2019, there are 12 members committed and three already utilizing the service.

Cloud Connect Service



The cloud connect service provides connectivity to cloud providers to enable more advanced and robust services at scale to benefit member business and service needs (see ctedunet.net/cloud-connect/). Announced in April and in partnership with Internet2, the Network provides no-cost transport for community anchor institutions to Amazon Web Services, Google Cloud Platform, and Microsoft Azure Express Route. Since announced in April, four members have committed to using this service and are in various stages of progress.

Eduroam K – 12 & Library Pilot



Eduroam (www.eduroam.us) is the secure, worldwide wireless access service developed for the international research and education community. Planning and pilots are underway to leverage Eduroam to help connect K – 12 and higher education students outside of their institutions (e.g., after school and on weekends). Using the established Eduroam solution, which has proven successful through a network of thousands of colleges and universities worldwide, should provide a more seamless network access experience for students and teaching staff connecting through CEN member locations. Current pilot collaborations include Hartford Magnet Trinity College Academy, the Hartford Public Library, and Trinity University; Middletown Public Schools, Middletown Library, and Wesleyan University; New Haven Public Schools; and Stratford Public Schools and Stratford Library. Tom Dillon, who chairs the Commission’s Infrastructure Advisory Council, is helping coordinate activities, with CEN providing modest fiscal support in the form of Eduroam end-user licenses.

National Science Foundation (NSF) Grant Activities



The Network team embrace opportunities to apply for National Science Foundation (NSF) grants. Direct or indirect awards would assist the Network’s growth and performance capabilities, further enhancing and advancing member needs. Grant-funded activities can introduce new technologies and capacities supporting research not otherwise possible through traditional means. In this space CEN provided a letter of support the University of Connecticut’s Richard Jones, Ph.D. for “Shared Computing Resources for Large-Scale Science Problems,” assisting with connectivity and route optimization to Jefferson Labs in Newport News, VA ([Award 1925716](http://Award.1925716)) . In addition, CEN and Yale University were part of 12 Universities

and 6 regional networks in the northeast to jointly submit for a “Mid-Scale Research Infrastructure (RI)-1” grant in February ([Solicitation 19-537](#)). The initiative’s intent was to provide federated, multi-platform, high performance compute (HPC) clusters to maximize the collective capacities of participating institutions. The NSF provided positive comments in response to the submission but, unfortunately, did not award the proposal.

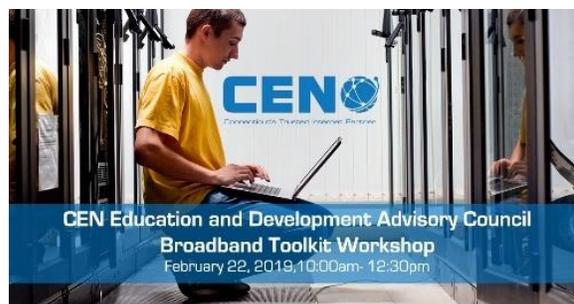
Goal 3: Foster Collaboration

At the heart of CEN is collaboration, where true partnerships are formed, and goals advanced together. Our approach has been to engage members through advisory councils and outreach events and to participate in national research and education (R&E) community activities. Both local and national communities create a fabric that is stronger together and provide insight and direction to the technical and functional network services that address the specific needs of CEN member communities.

Engagement and Development Advisory Council (EDAC)

The EDAG remains active with engagement activities and is settling into a regular cadence in its second year. Under the leadership of co-chairs Karen Warren (Wesleyan) and Rebecca Osleger (Suffield), the EDAG members design and deliver quarterly engagement events targeted at the needs of at least one segment of the CEN membership. The past year’s events include the following:

[Broadband Toolkit Workshop](#) (February 22). A total of 50 members attended this interactive, hands-on session designed to equip smaller member organizations and their often limited IT staff with the tools to understand and solve network technology challenges, diagnose and fix problems, assist local member institution staff with better diagnostics and problem descriptions, plan for the future, and become stronger advocates for infrastructure.



[Digital Accessibility Workshop](#) (June 6). This event provided an overview of global standards, the broad and narrow applications of digital accessibility, technology used to address accessibility and accommodations, guidance on how to draft a plan for universal institutional accessibility, and training resources for faculty, staff, and students.



[Cyber Defense Clinic](#) (October 3) Hosted at Central Connecticut State University (CCSU), and presented by CEN in collaboration with Cisco, provided hands-on interaction with the latest tools for IT professionals to hone cybersecurity expertise for nearly 80 members. Participants were able to play the role of the attacker and the defender learning techniques on hacking and protecting critical data.



[Ransomware Forum](#) (November 19) Hosted at CCSU, served 60 members by providing insights on protecting communities from ransomware attacks. Rebecca Osleger of Suffield and Michael Scott of Middletown as well as representatives from the Department of Homeland Security's CT Intelligence Center (CTIC), Connecticut's Computer Crimes and Electronic Evidence Laboratory, and SHI addressed common cybersecurity challenges and mitigation steps.



In addition to the above activities, the EDAG develops the Annual Conference program by helping solicit session proposals, ensuring alignment with program and member goals, and planning the day's activities to maximize exposure for each member segment for the day.

CEN Annual Conference



In May, CEN held its 7th Annual conference in Hartford at the Connecticut Convention Center (bit.ly/2BBJaku). The event was the most successful to date by many accounts. Themes of the day were Innovation & Education, Community Best Practices, Awareness, and Security. Member and vendor participation were at an all-time high with 674 registered, 613 attending, and 44 supporting vendors. The day's program contained tracks with multiple options for each member group, with 28

total sessions across 4 morning and 4 afternoon time slots, an all-day security incident response workshop, and 4 closed meetings for affiliate groups that received meeting space from CEN at no additional charge.

Service Management Advisory Council (SMAC)

The SMAC, chaired by Matt Ross (Farmington Public Schools) and Jonathan Garbutt (Southern Connecticut State University), has been active in helping determine the next generation of services CEN could pursue and add to the portfolio. Engaging with the effort are many technical and functional partners who, with the support of CEN staff, developed a survey to help gather feedback on the need and timeframe of

specific services at scale. The intent was to bring the strength of the membership to the table when developing and negotiating solutions. The survey attracted 165 individual members across almost as many institutions. Responses will help serve as the guiding reference point in 2020 and beyond as we look to add services to the CEN portfolio. In addition, the group is active in assessing the current and future Web content filtering to allow K – 12 institutions and libraries to meet the Children’s Information Protection Act (CIPA) requirements. In addition, the SMAC members are helping develop community criteria for a service lifecycle for CEN to consider when pursuing new technologies as well as what criteria would be triggered to initiate a sunseting action.

Technical Advancement Advisory Council (TAAC)

The TAAC, chaired by Kevin Ross (Plainville Public Schools and Town) and Tim Sheets (Yale University) have been charged with helping develop community standards for the next generation of the Network as well as assisting the SMAC with CIPA filtering options at a more technical level. Many of the meetings this year addressed the current CEN architecture, technologies, and vendors as a baseline for future expansion of the Network.

CXO Roundtable

CEN continues to support the CXO series by facilitating biannual meetings of Connecticut’s higher education technology leaders. The goals of the meetings are: increasing communication among Connecticut’s higher education institutions, identifying opportunities for collaboration through the network, and, where applicable, pursuing specific aggregated needs of the community. The Roundtable was hosted and co-moderated this Fall by Jean Kilbride, AVP for IT at Connecticut College. In the spring, the Roundtable was hosted by CEN at the annual conference and joined by representatives from Internet2 as well as Massachusetts Green High-Performance Compute Center (MGHPCC). This is a C Suit only forum for discussing shared interests, challenges, and initiatives.

New Web Site

In April the new <http://ctedunet.net> Web site was launched to address member content needs, increase usability, highlight program offerings, and provide a more professional online presence. Lead by CEN’s Rachael Collard with help from Richard LeFave and the UConn Web Development Lab, a nearly yearlong endeavor to modernize our Web presence was finally complete and moved over to UConn’s Aurora hosting platform powered by WordPress.

CEN Member Town Halls



Late in the year, town hall meetings took place at member institutions throughout the state to engage our constituents on questions regarding strategy, service updates, community training and future requests, an expanded member conference, and time for open-ended questions. Feedback remains positive for these events, which served 200 members total. Town hall locations took place in the following locations:

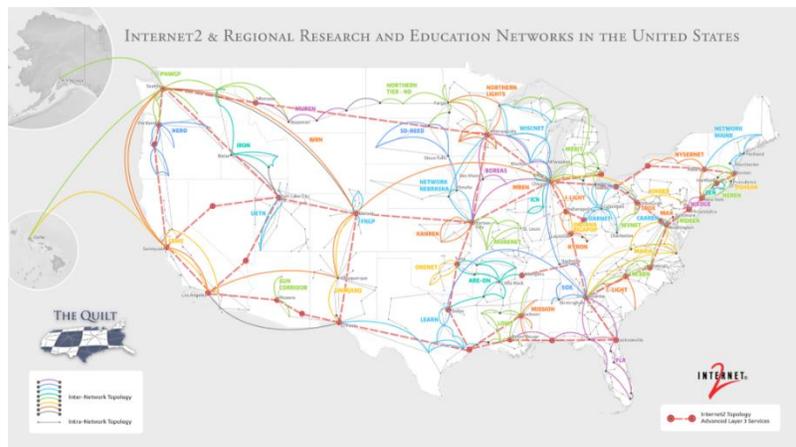
- Nov. 5: CEN Headquarters (Hartford)
- Nov. 15: SCSU (SCSU)
- Nov. 22: UConn Avery Point (Groton)
- Dec. 6: Fairfield University
- Dec. 13: EdAdvance (Litchfield)

Regional and National Collaboration

Participating in the R&E community — at a regional level with The North East Research and Education Network (NEREN) and Northern Crossroads (NoX) as well as The Quilt and Internet2 nationally — provides an opportunity for CEN to collaborate, learn, and share information in a non-competitive environment and represent CEN and Connecticut’s interests at regional and national levels.

Regionally CEN supported and promoted the NEREN ‘Bridging the Gap’ series of day-long seminars devoted to proposing and advancing ideas for regional collaboration in research computing and networking. The event on October 4th focused on AI and Machine Learning and attracted top researchers, CIOs and network operators from the region.

Director Kocsondy was elected as The Quilt (thequilt.net) CEO Roundtable Vice Chair, then later as the Secretary of the Quilt Executive Committee (QEC). The Quilt is the national coalition of non-profit U.S. regional R&E bodies representing 40 networks across the country. Quilt members provide advanced network services and applications to more than 900 universities and thousands of other educational and community anchor institutions. The goal of The Quilt is to promote consistent, reliable, interoperable, and efficient 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 education and research.



Director Kocsondy was also elected to the Advisory Committee of Northern Crossroads (NoX, nox.org), a regional network managed by the Massachusetts Institute of Technology that facilitates advanced

networking among research institutions in New England. Participants include institutions of higher education and partner organizations that support research, education, and economic development.

Goal 4: Promote Advocacy

In 2019 CEN pursued activities that enhanced brand awareness and equip members and policy makers to understand and articulate CEN's value.

Education Superhighway (ESH)



As stated earlier, Education Superhighway recognized CEN as a “Connectivity Leader” for the fourth year in a row in its State of the States report (stateofthestates.educationsuperhighway.org). As the largest provider in the state servicing K – 12 schools and connecting every district, the report places Connecticut among the highest performing states in the country. Connecticut meets or exceeds the FCC minimum bandwidth goals (100 kbps per student), which ESH calculated as a median measure across all districts at 791 kbps. In addition to the bandwidth availability target, ESH highlights the affordability of CEN cost structure, where the median cost per Mbps nationally is \$2.24 compared to CEN's \$.69.

While this report is helpful and favorable to the progress CEN has made over the years, it misses many qualities about the service that are not included in a simple Kbps/person or \$/Mbps calculation. The feature sets of CEN internet service are tailored to our community, include things like DDoS at no additional cost, are delivered in resilient fashion for fault tolerance, and have no caps on bandwidth. These additional dimensions are not accounted for in these types of reports.

State Educational Technology Directors Association



In April, Connecticut and CEN were profiled in the “K – 12 Broadband Leadership 2019” report from the State Educational Technology Directors Association (SETDA). In addition, Director Kocsondy presented via Webinar to the national SETDA community about the CEN delivery model and approach to supporting Connecticut schools. CEN members participating in the webinar praised the services provided and partnership model we pursue and answered questions on CEN's behalf to their colleagues nationally. This was an unexpected outcome and good show of Connecticut solidarity when the members stepped up as our strongest advocates.

In our presentation we highlighted a few districts as case studies, of which Norwalk Public Schools was highlighted for leadership in the integration of technology, digital learning, and Internet accessibility. Highlighting Norwalk's excellence in leveraging technology for teaching and learning led ESH to highlight the district through its State of the States report and YouTube channel. All mention of CEN services and support was edited out of the final cut for public consumption, though those interviewed made it a point to reach out with apologies.

- Report: <https://www.setda.org/master/wp-content/uploads/2019/05/Broadband-State-Leadership-2019-Final-a.pdf> (page 18 of doc, page 21/37 of the .pdf)
- Webinar Recording: <https://home.edweb.net/webinar/digitalcontent20190409/>
- Norwalk Video: <https://youtu.be/oQacTGRKXM0>

Statement on Network Security

In August, CEN released a statement on network security (<https://ctedunet.net/policies/>) intended to clarify CEN's role, current capability, and plans to continue securing the Network. The statement came in response to district requests and to promote cybercrime reporting to the Connecticut Intelligence Center (CTIC). The statement also sparked conversations with CTIC, Homeland Security, and State Police about the ability of CEN to fend off DDoS attacks and how agencies can better collaborate with each other.

CSDE Performance Matters Forum

In October, Douglas Casey and Ryan Kocsondy presented at the CSDE Performance Matters Forum held at the Connecticut Convention Center in downtown Hartford. The topic was 'State Technology Resources and Student Success' and highlighted Commission and CEN resources focused on K – 12 communities. The session provided an opportunity to share our work and plans with educators and leaders who typically aren't directly involved in Commission and CEN activities.

CAPSS Technology Committee

In October, Director Kocsondy presented to the Connecticut Association of Public School Superintendents (CAPSS) on cybersecurity, malware, ransomware, phishing, and backups. All of these topics have been points of concern as some schools had been victims of ransomware and need help with incident response plans and education for their communities.

CAS Conversations — Cybersecurity Podcast

In October, the Connecticut Association of Schools (CAS) invited Directors Kocsondy and Casey to participate in its "CAS Conversations" podcast, addressing the issue of cybersecurity. East Hartford Chief Information Officer and CEN EDAC member Roberta Pratt also participated.

- Web Page: <http://cas.casciac.org/?p=13846>
- Podcast: <https://storage.googleapis.com/files-gcs.casciac.org/casconversations/Episode14Cybersecurity.mp3>

Goal 5: Enhance Core Resources

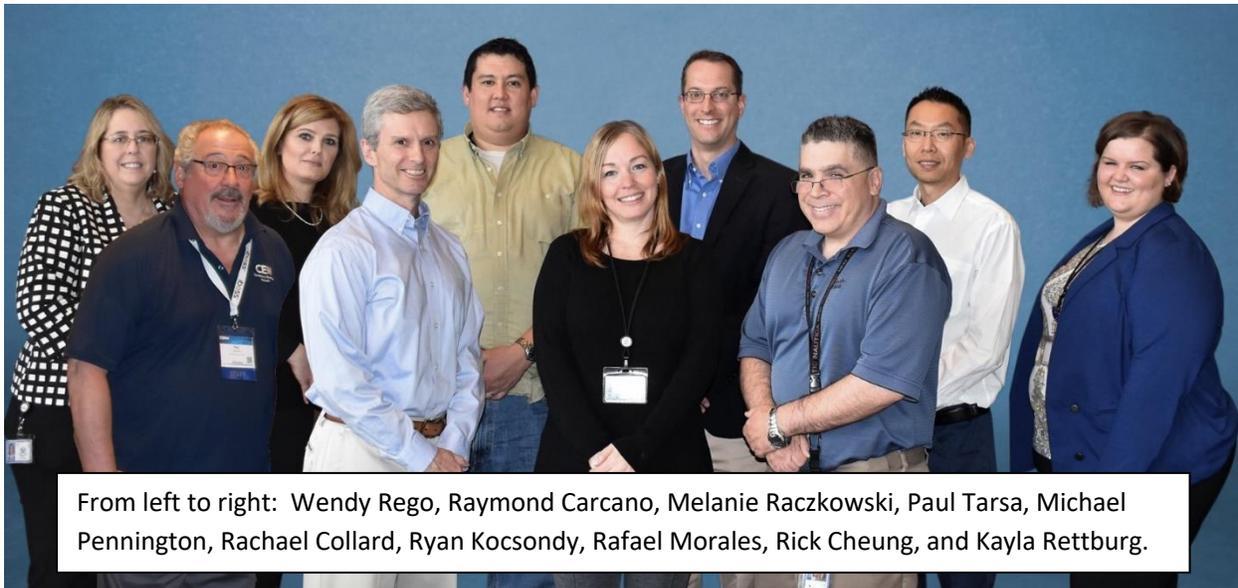
All CEN activities depend on the physical network and the staff who support it every day. CEN will continue to pursue opportunities to leverage, develop, and enhance CEN's core technology and human resources for the foundational success of the program in pursuit of member needs.

CEN Staff

CEN's staff are key to the success of the program. The close of 2019 saw an expansion of the team and a departure of one of our colleagues to accept a position with our parent organization at UConn. CEN currently has 12 full-time staff members, 6 part-time student workers, and 1 volunteer (1 day per week). Brad Tudisca started September 13 as a Network Technician, and Michael Harris started November 8 as our Business Services Supervisor. Prior to the close of the year, an offer was made to a new Program Administrator, and we had an open posting for an additional senior level network technician. We also thank Melanie Raczkowski for serving CEN for nearly eight years and congratulate her on her move back to UConn Information Technology Services (ITS).

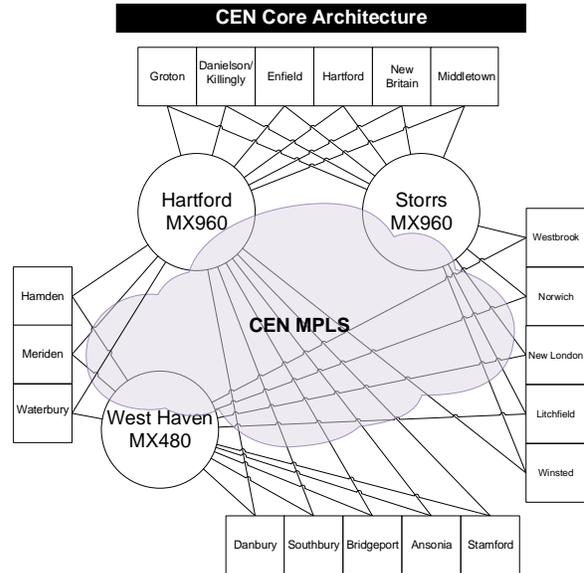


Michael Harris Bradley Tudisca



The Network

The platform for all CEN activities is the physical network itself and key to the overall success of the program. The network as an asset is comprised of multiple layers of fiber and network equipment that provide unparalleled connectivity to all corners of the state. With the Network’s resilient design of a triangle core, meshed distribution layer, and multiple rings at the edge, members regularly attain 99.99% uptime, even when failures impacting the core and backbone connectivity. The Network has once again reached new heights for regular and peak daily download speeds at 104 Gbps, compared to 90 Gbps last year.



2019 Network Statistics

Backbone Capacity	Total Traffic (Up/Down)	Network Devices Managed	Active Interfaces (ports)	Peak Daily Traffic	Backbone Availability	Core Node Availability	Aggregate Availability
2.131 Tbps	234.098 PB	692	18,458	104 Gbps on 2019-11-18 09:21:00	99.98%	99.98%	99.99%

Internet Routing Registry Updates

The Internet Routing Registry (IRR) is a globally distributed routing information database. Established in 1995, the purpose of the IRR is to ensure the stability and consistency of Internet-wide routing by sharing information between network operators. The IRR consists of several databases where network operators publish their routing policies and routing announcements so that other network operators can use this data. Consistent with the previous year’s effort to become MANRS compliant, CEN performed comprehensive IRR updates in both ARIN and RADB for all directly attached members ensuring member information to IP address allocation is current. This multi-month endeavor was important due to major carriers and service providers such as Hurricane Electric and Google announcing filtering policies (IE. dropping traffic) based on incomplete or missing IRR information.

E-rate Provider Services

CEN partnered with E-rate Provider Services (EPS) in an effort to gain additional capacity and maximize eligibility for E-rate services to our eligible community. The company, based in Burlington, Connecticut,

works with customers nationally and will lend significant expertise to the CEN team. This partnership also reunites CEN with Bob Richter, EPS President and former City of Hartford employee, who helped with some of the original E-rate applications when the CEN network was being built in the early 2000s.

State Funding Support

In 2019 the State of Connecticut lent additional monetary support to the network even while initiating a “debt diet” (reduced bond commitments) for the 2020 – 21 biennia, resulting in a pause of bonded monies across all agencies. CEN’s requested amounts of \$914,000 (FY19) and \$820,000 (FY20) out of the Capital Equipment Purchase Fund (CEPF) monies were *not* made available as a result decreases in State bond commitments. Later in the year, a \$1.5M bond was authorized and allocated to CEN, a continuance of a previous authorization, during the June 26, 2019 Special Bond Commission Meeting. Monies from this allocation are to target the distribution layer of the network that is approaching end-of-life/end-of-support. Proof-of-concept testing for replacement devices with two leading vendors in this space took place in the last two quarters of 2019, with a target decision by March 2020.

Special note: Due to a trade dispute and ongoing negotiations between the USA and China, federal tariffs on all products manufactured in China resulted in a 10-25% increase in equipment costs across all vendors.

Fiber Contract IRU Renewal

CEN’s nearly 2600 route-mile fiber network leverages contracts to connect many sites throughout Connecticut. The Network was established in 2000, and 20-year indefeasible right to use (IRU) contracts on the original fiber were coming due. IRUs are considered capital assets, and the market norm is to re-purchase the assets for another 20 years at the end of the term. DAS and CEN leaders, through a multiyear negotiation, successfully updated the contract terms and avoided the purchase of new 20-year IRU fiber assets. The new terms also extend maintenance on the existing fiber network for three optional 10-year extensions and adjust new build costs to market rates. The approach avoided a nearly \$11,700,000 cost to re-purchase the IRUs staggered over the next twelve years and extend the maintenance at a pre-determined rate schedule. The cost avoidance for network replacement or new buildout is closer to \$130,000,000.

GlobalNOC



CEN’s Network Operation Center (NOC) services are essential to front-line operations of monitoring the Network, incident management, and proactively communicating with our members. In October, our NOC services were renewed for an additional three years with the Indiana University GlobalNOC, extending the partnership that originally began in 2014. GlobalNOC, established in 1998, provides high-quality NOC services for the R&E networking community and uses an array of custom-built monitoring and management tools tailored to our members’ needs. Unlike a typical NOC, they also research, develop, test, implement, and provide instruction on the latest innovations in network services, hardware, and software. CEN has utilized GlobalNOC for Tier 1 helpdesk support, network monitoring, and incident management.

Extranet Realignment & Expansion

Capacity management of CEN's core network resources is key to maintaining "friction free" connectivity so that bandwidth supply outpaces demand and slowdowns don't occur, even when members access Internet-based resources during the busiest times of the year or during a core node failure. Efforts in 2019 were made to realign the external networks, or extranets, for increased connectivity by enabling an east-west strategy of reaching into Boston and New York to diversify our Tier 1 Internet carriers, Internet exchanges points (IXPs), and Internet 2 options.

CEN along with its NEREN partners the University of Massachusetts, Network Maine, the University of New Hampshire, New York's NYSERNET, Rhode Island's OSHEAN, and the University of Vermont, have collaboratively built out the NEREN optical network to 32 Avenue of the Americas in lower Manhattan, one of the busiest telecommunications areas in the world. When complete, the project will provide a number of benefits to the Network and its members. The New York City connection will provide direct access to a diverse marketplace that offers lower commodity Internet rates; increased commercial peering to contain transfer costs; backhaul opportunities to hubs such as Ashburn, VA, and Chicago; and settlement-free peering with other regional optical networks (RONs) within the R&E space. While base connectivity takes place in partnership with NEREN, and overall project procurement issues remain unfinished, CEN's New York node can now accept connections.

Also in collaboration with the NEREN partnership and shared optical ring, CEN enhanced connectivity in the Boston and Cambridge MA areas. Connectivity in Cambridge was enhanced by upgrading the equipment and backhaul to the core to 2x100G links. This new connectivity will enable additional peering capacity to the northern R&E networks and local exchanges. A new network node added connectivity to 1 Summer Street in Boston, known as the Markley Building. This site is the largest Internet and peering exchange point in New England and houses some of the top global Internet carriers. In 2019, CEN installed a 2x100 Gbps backbone and turned up a 100 Gbps handoff with a 20 Gbps committed data rate of service to GTT for Tier 1 backbone Internet connectivity at this location.

When complete in 2020, the extranet project will provide symmetrical services at each core location of 100 Gbps to Internet 2 as well as 100 Gbps to diverse Tier 1 carrier Internet providers. The project will also allow CEN to participate in major peering exchanges in two of three core locations. The Network's core is already built for resiliency and capacity, and these expansion and realignment activities will optimize capacities while allowing for continued growth in years to come.

Fiscal Overview

FY19-2020 CEN Operational Budget (in \$)

Revenue	FY 19 Actual	FY 20 Projected
State Appropriation	0	0
Member Billing	5,261,947	6,045,000
Member Billing AR	208,971	0
USAC (E-rate)	668,869	1,878,000
Reimbursement		
Member Conference	245,490	340,000
Member Conference AR	11,710	0
Total Revenue	6,396,988	8,263,000
Expenses		
Staff (Salary & Benefits)	1,558,283	1,979,322
CET (Salary & Benefits, SW)	298,806	321,160
Contractual	1,191,910	1,526,350
Fiber & Fiber Maintenance	1,561,621	2,311,050
Hardware	502,277	580,050
HW & SW Maintenance	537,452	726,566
Member Conference	208,468	285,400
Professional Services	0	6,000
Total Expenses	5,858,817	7,729,897
Profit/(Loss)	538,171	533,103

Note: FY20 Revenue for USAC (E-Rate) Reimbursements and Expenses for Fiber & Fiber Maintenance include fiber builds for CLFC project

2020 Outlook

As we look to 2020, CEN's member-led model will help drive new offerings, continue to meet the needs of the membership, and add value to the membership and state. CEN will look to expand the network and upgrade capacity through additional member growth, completion of the Extranet project, and replacement of the distribution layer of the network. In addition, CEN will celebrate 20 years of progress at the 8th CEN Annual Conference on May 7-8 in Hartford, CT <http://bit.ly/CENMemberCon2020>.

Acknowledgements

CEN Leadership as part of this annual report is formally acknowledging and thanking the following individuals and groups:

- The CEN staff for their dedication and diligent work in operating and expanding the network.
- The CEN membership for their loyal and active participation in developing a community network whose collective value exceeds the sum of its individual parts.
- Members of the Connecticut Commission for Educational Technology for their leadership and advocacy on behalf of the program.
- Mark Raymond and Michael Mundrane, who serve as trusted advisors to CEN.
- Richard LeFave, for his time and numerous contributions as a volunteer.
- George Claffey and CCSU for volunteering their facilities for many CEN engagement activities.
- CT DAS and UConn ITS, for their partnership and unfettered staff support.
- CT Executive and Legislative branches of government, whose support is critical and integral to CEN's long-term success.