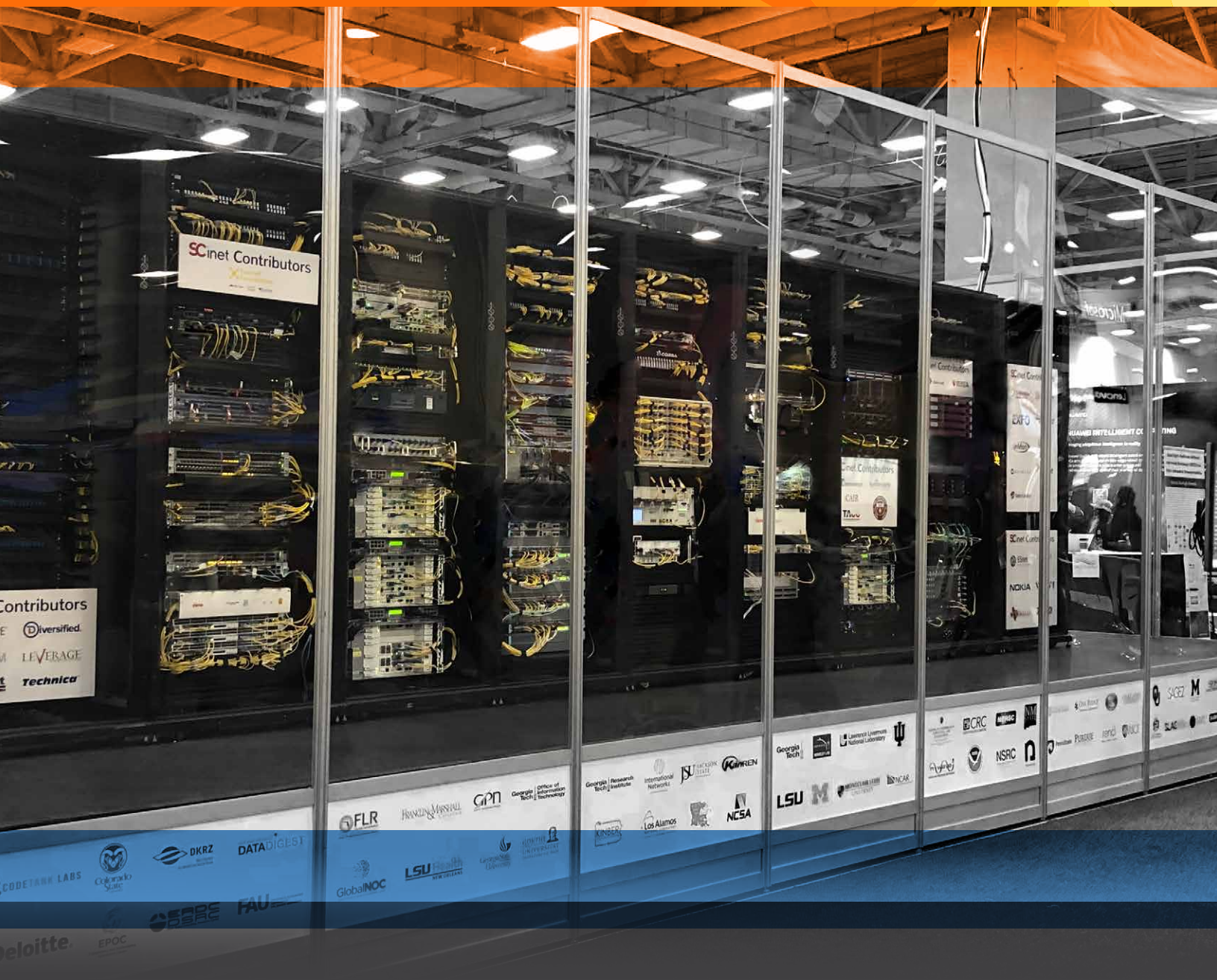
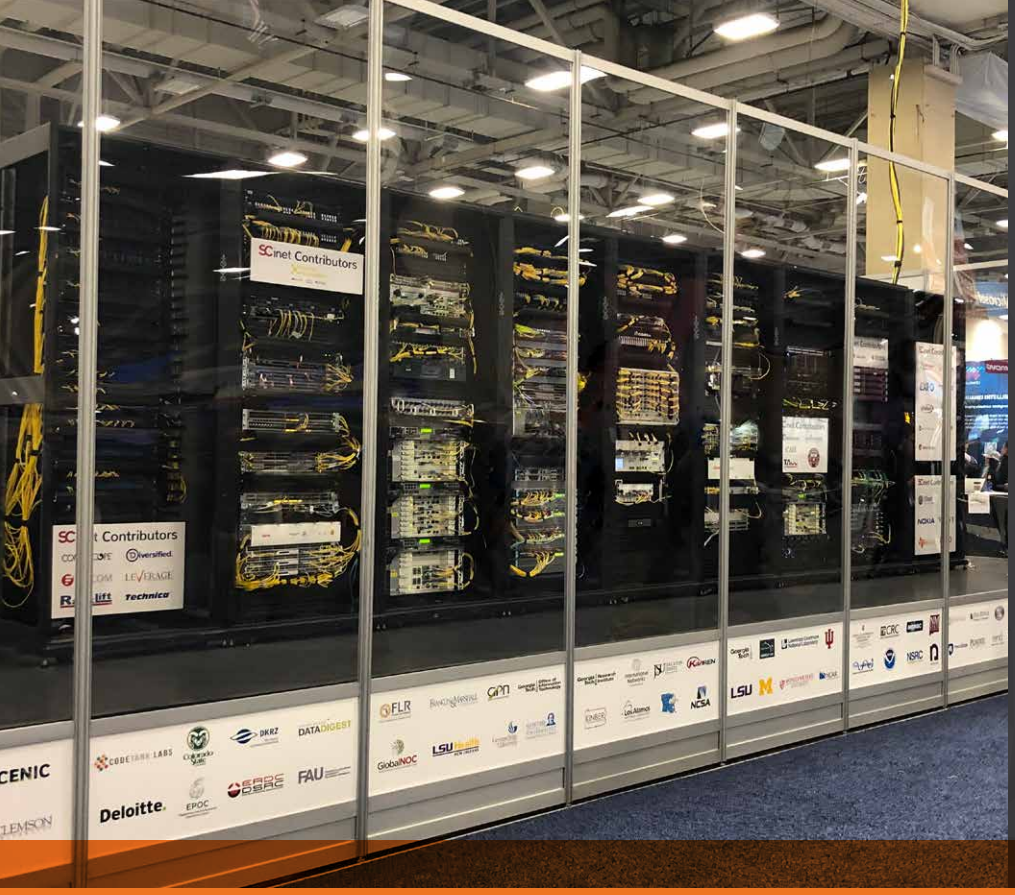
2018

ANNUAL REPORT



LEARN

LONESTAR EDUCATION AND RESEARCH NETWORK



ON THE COVER

Our cover displays SCinet's NOC at SC18 in Dallas. As you will read, LEARN played a critical role in building and operating the SCinet network. LEARN was pleased to play a key role in this event and to receive the inaugural SCinet Spirit of Innovation Award. LEARN was able to coordinate its end-of-year Board meeting with SC18 and enable our members' participation in what some have likened to "the Olympics of supercomputing."

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LEARN
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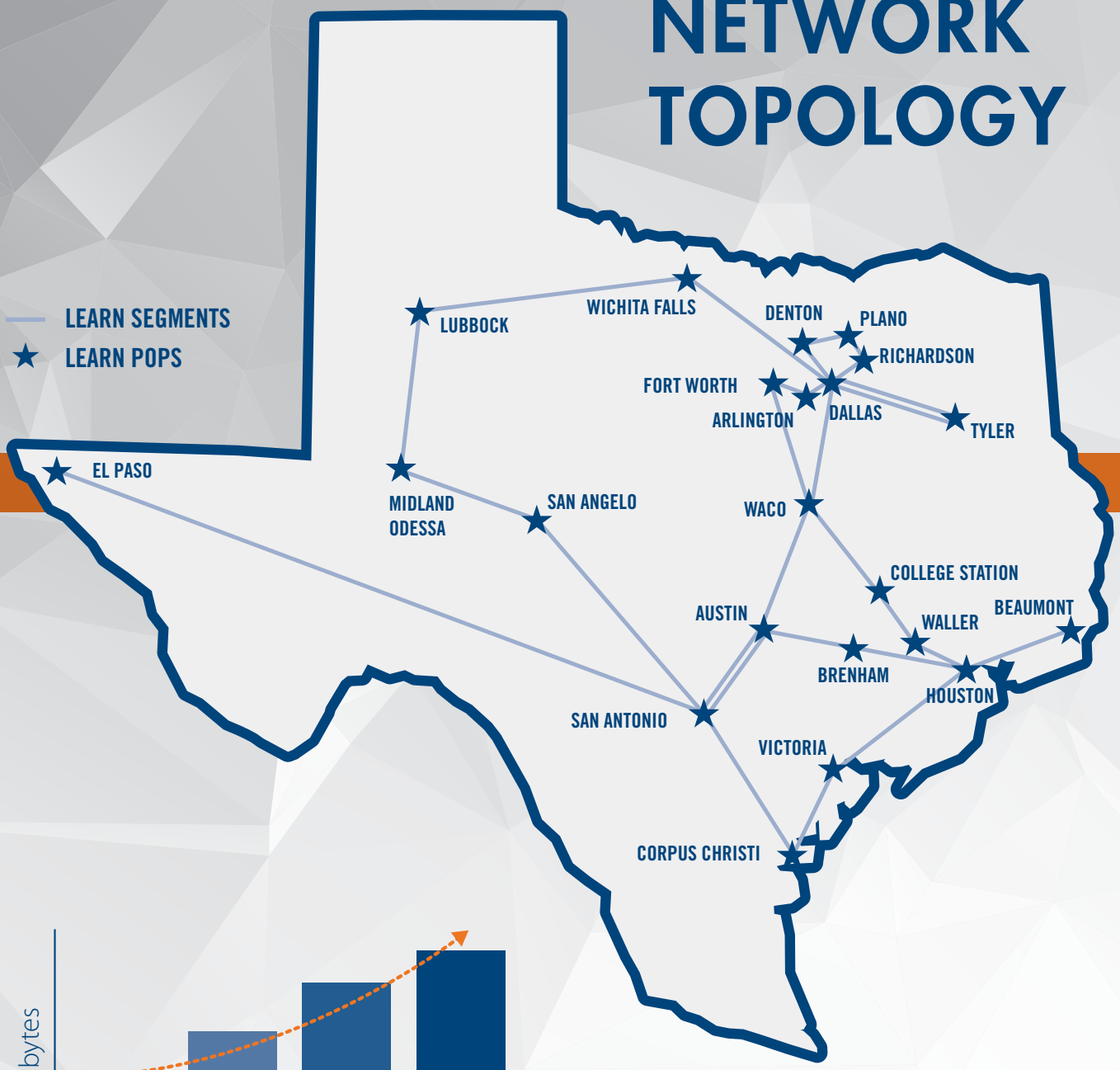
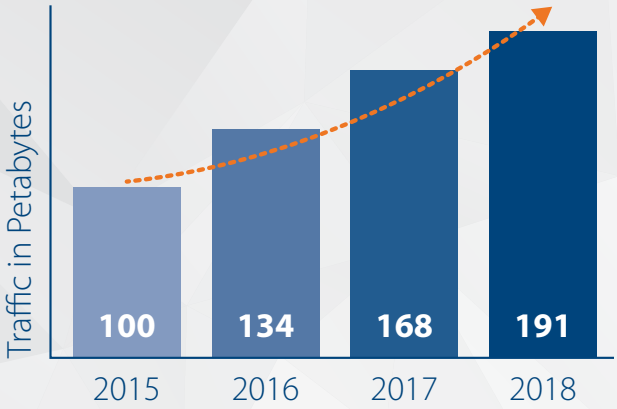
LEARN'S NETWORK TOPOLOGY





LEARN'S VISION

LEARN will be the most efficient and effective enabler of research, education, healthcare, and public service communities in Texas using technology and shared services.

EXECUTIVE COMMITTEE

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KEN PIERCE

Texas State University
txstate.edu

Chair Elect:

JEFFREY GRAHAM

University of Texas
Rio Grande Valley
utrgv.edu

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University System
texastech.edu

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Baylor College of Medicine
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Finance Committee:

DOUG FOX

Angelo State University
angelo.edu

Chair, Operations
& Services Committee:

BOB HARTLAND

Baylor University
baylor.edu

Chair, Governance &
Participation Committee:

MARK STONE

Texas A&M University System
tamus.edu

President & CEO:

PANKAJ SHAH

LEARN
tx-learn.net

LETTER FROM THE CHAIR

On behalf of the LEARN Board of Directors, it is my pleasure to present LEARN's 2018 Annual Report. 2018 was a transformative year for LEARN, as the business landscape in the communications industry in Texas challenged us to think differently about our business model and to broaden our membership base outside of higher education. To put the year in context, we must reflect back on LEARN's mission and vision, which are:

Mission: Empower non-profit communities to execute their missions through technology and collaboration.

Vision: LEARN will be the most efficient and effective enabler of research, education, healthcare, and public service communities in Texas using technology and shared services.

Today LEARN connects its members and over 500 affiliated organizations through high performance optical and IP network services to support their research, education, healthcare and public service missions.

LEARN is 41 members strong and includes public and private institutions of higher education, community colleges, the National Weather Service, and K–12 public schools. This past year LEARN was successful in adding the Texas State Library and Archives Commission to our membership, Trinity University in San Antonio, and expanded our outreach in K–12, cities and countries.

Speaking of K–12, the LEARN team did a remarkable job at preparing LEARN's response to a major infrastructure Request for Proposal (RFP) from our K–12 partners in Texas. This was a grueling RFP that required us to submit three separate proposals in a compressed timeframe. This RFP represented LEARN's first foray into a partnership with a commercial provider for last mile services. It cannot be overstated the heroic efforts put forth by the LEARN team. Their hard work was not for naught, as LEARN was awarded the RFP, which will undoubtedly contribute to further the reshaping of LEARN in the future.

In addition to the continued growth of customers using our Unmetered Network Services (UNS), LEARN has also continued to look for new ways to support its customers, such as growth in our DDoS Service, expanded Peering Services and connecting to partner networks.

Serving LEARN as the Board Chair in 2018 was an honor and an amazing educational experience. The LEARN staff is an outstanding group of people and a pleasure to work with. We have a very capable CEO at the helm. This all contributes to a recipe for success for LEARN!

KEN PIERCE
Texas State University

LETTER FROM THE PRESIDENT & CEO

Dear Colleagues,

2018 was a year of growth for LEARN. We grew our team and now have 15 employees. We grew our services and now we offer Unmetered Network Services (UNS) to our members while adding more content providers and direct peers. We expanded outreach by engaging with more than 20 new possible members across K–12, Community Colleges, Cities and Counties. We increased our research engagements by participating in two National Science Foundation funded programs. And we grew professionally by contributing resources for Supercomputing 2018 (SC18), The Quilt and Internet2.

Notably at SC18, LEARN's Engineering team led by CTO Akbar Kara helped deliver the world's fastest network, delivering 4.02 terabits per second of network capacity. Furthermore, our team helped SCinet achieve a new milestone by successfully passing production traffic from national and international networks to Dallas using a single, 400 Gigabit Ethernet link over metro distances. This impressive effort speaks to the talent pool of the LEARN staff, which are available to all of LEARN's members. LEARN was honored to receive the inaugural SCinet Spirit of Innovation Award, along with Ciena, ESnet, Internet2, and UEN at SC18. Each organization exhibited a spirit of collaboration and cooperation to make the conference a success. LEARN was delighted to have participated with each of these outstanding organizations.

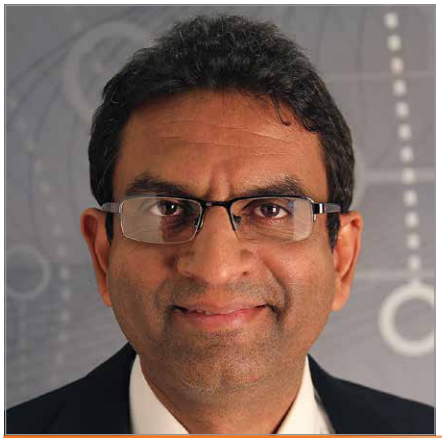
The LEARN Engineering team began a significant backbone upgrade in 2018, using our lifecycle replacement funds. The backbone upgrade will take place in four phases and is scheduled to be completed in June 2019. Meanwhile under the leadership of our CFO Kerry Mobley, we continue to work and innovate many back-office functions while creating a friction-free business model. In 2018, 16 members and 5 Affiliated Organizations added UNS to their portfolios.

LEARN is also participating in two National Science Foundation Funded projects — Working Towards a National Research Platform and EPOC (Engagement and Performance Operations Center).

Both programs directly bring support and resources to LEARN members in Texas. In early 2019, we will begin planning for community-wide engagements for both programs, while also preparing to participate in NSF CC* programs directly.

In 2019, our internal focus will be on automation. We will review our internal processes. We plan to introduce new applications and tools to streamline workflows as necessary. Externally, we will also continue to explore new services for various verticals thereby adding more value for our members. We will also maintain and enhance our statewide outreach efforts which began in 2018. We are building strong partnerships with the regional networks in Arkansas, Kansas, Louisiana, and Oklahoma, while also drawing interest from other Great Plains states.

LEARN and Texas have a lot to offer to the regional and national research and education networking communities and our strategy to create a strong research presence in Houston, coupled with a content Peering, Caching and direct connect hub in Dallas, catapults us into a leadership role in the region.



PANKAJ SHAH
LEARN

LETTER FROM THE CTO

Dear Colleagues,

To serve the needs of our constituents in all corners of Texas, LEARN has deployed a 3,200-mile fiber-based network using state-of-the-art dense wavelength division multiplexing (DWDM) optical and multiprotocol label switching (MPLS) packet technologies. DWDM and MPLS technologies are very scalable and allows LEARN to leverage our infrastructure to add capacity at marginal costs and grow with the needs of Texas.

LEARN has a unique approach that differentiates us—our network is over-provisioned and under-subscribed. LEARN adheres to a net neutrality policy over its entire network. This means that LEARN does not throttle, police, or shape traffic. Our best practice is to augment the backbone links as and when it consistently exceeds the 50% utilization threshold. LEARN operates proactively so that we can provide our members with a friction-free network to support their mission.

In 2018, LEARN staff extended the MPLS backbone to our West Texas nodes in Lubbock, Midland, and San Angelo. We also enabled new on-ramps in Arlington and Brenham, Texas. LEARN's IP infrastructure is designed to be resilient, each MPLS node has dual routing engines and power sources, and at least 2 diverse paths to the core backbone. A second path for our Beaumont Node is in progress. LEARN also enabled 300G of Research backbones, 100G to Energy Science Network, and 200G to the Pacific Wave Network, a project funded by the National Science Foundation to promote research between Texas and the Asia-Pacific Region.

LEARN has a long track record of aggregating services for its members therefore driving down total cost of ownership by harnessing the power of aggregation and achieving economies of scale in negotiating with service and technology providers. Our members are taking advantage of LEARN's rich Peering and Caching Services by offloading traffic to major content providers via low-latency high capacity uplinks via LEARN. In aggregate, LEARN has over 200G of Direct peering and 45G of Caching. Negotiations for new Direct settlement-free peerings are on-going to enhance LEARN's Peering and Caching Services.

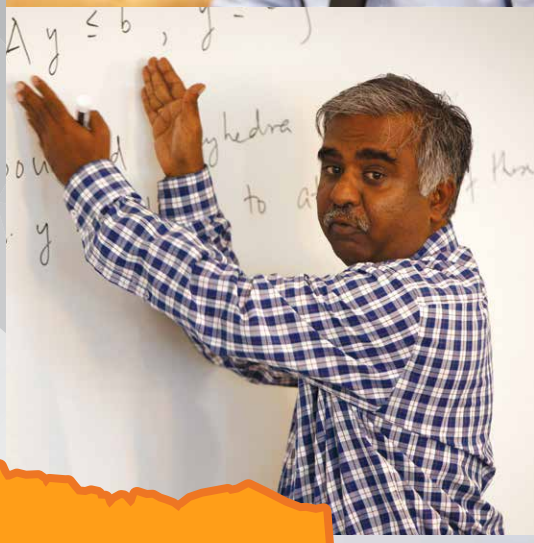
For Internet Services (IP), LEARN provides a blended IP solution that has a minimum aggregate of 100G direct Transit (Commodity) Peering with a global IP provider like CenturyLink (Dyn Research Baker's Dozen - #1), Telia Carrier (#2), and GTT (#5). Furthermore, LEARN is taking advantage of Internet2's value-add, Internet2 Peer Exchange (I2PX, formerly known as TR-CPS or Transit Rail Commercial Peering Service) by off-loading Commodity traffic via Internet2's 100G ports connected to LEARN's backbone via Dallas and Houston nodes. Diverse paths ensure a seamless congestion free path for members connecting at any LEARN POP or on-ramp to services that are available on the LEARN backbone ring. For example, LEARN members have access to 100G Commodity Internet capacity via 4 diverse hardened POPs in Dallas, Houston and San Antonio. It should be noted that LEARN CIS (Commodity Internet Service), Peering & Caching, and I2PX are burstable services, LEARN members are able to burst up to the port speed to seamlessly exchange traffic via LEARN during busy (e.g. flash events) and during normal times.

AKBAR KARA
LEARN

MEMBER ORGANIZATIONS

Angelo State University
Baylor College of Medicine
Baylor University
Blinn College
Lamar University
National Weather Service
Northeast Texas Consortium of Colleges & Universities (NETnet)
Prairie View A&M University
Rice University
Sam Houston State University
Southern Methodist University
Stephen F. Austin State University
Texas A&M Health Science Center
Texas A&M University
Texas A&M University - Corpus Christi
Texas A&M University System
Texas Association of Community Colleges
Texas Christian University
Texas Education Telecommunications Network (TETN)
Texas State Library & Archives Commission*
Texas State University
Texas Tech University
Texas Tech University Health Sciences Center
Texas Tech University Health Sciences Center El Paso
Texas Tech University System
Texas Woman's University
Trinity University
University of Houston System
University of North Texas System
University of Texas at Arlington
University of Texas at Austin
University of Texas at Dallas
University of Texas at El Paso
University of Texas at San Antonio
University of Texas Health Science Center at Houston
University of Texas Health Science Center at San Antonio
University of Texas Health Science Center at Tyler
University of Texas MD Anderson Cancer Center
University of Texas Medical Branch at Galveston
University of Texas Rio Grande Valley
University of Texas Southwestern Medical Center at Dallas
University of Texas System

*Beginning in 2019



OVERVIEW & HISTORY

WHO IS LEARN?

LEARN: Lonestar Education And Research Network (LEARN) is a 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, organized as a 501(c)(3) non-profit organization, connects its members and over 500 affiliated organizations through high performance optical and IP network services to support their research, education, healthcare and public service missions. LEARN is also a leading member of a national community of advanced research networks, providing Texas connectivity to national and international research and education networks, enabling cutting-edge research that is increasingly dependent upon sharing large volumes of electronic data.

A Brief History of LEARN

In 2003, a series of meetings of research universities and health science centers in Texas were held to forge a shared vision of creating a unified high-performance optical network for higher education that would partner with an emerging national network dedicated to research. Overcoming the legacy of competition among the attendees and the fiscal and organizational challenges that lay ahead, the universities and health science centers soon reached a consensus that it was strategically important to create an organization dedicated to high performance networking in Texas and to participate in the emerging national network.

In the fall of 2003, the nascent LEARN organization, realizing that it was imperative to have a legal structure around which to center its operations, decided to use the existing Houston-based Texas GigaPOP as the 501(c)(3) structure for the new statewide organization. The following January, officers of the new organization were installed at its first Board meeting on the Southern Methodist University campus in Dallas with the new organization being officially named "LEARN: Lonestar Education And Research Network." Thus, LEARN was officially created with a 30-member Board of Directors.

Also in the summer of 2003, the Texas Legislature endorsed the concept of providing an initial investment of $7.5 million dollars to construct the proposed optical network for Texas. That concept was fleshed out in 2004 as LEARN worked with the offices of the Governor, Lieutenant Governor, Speaker of the House and the Department of Information Resources (DIR) to study the merit of authorizing a Texas Enterprise Fund (TEF) grant for the optical network project. In the fall of that year, the elected leadership officers announced that the State of Texas would fund a TEF grant to provide the initial capital funds to acquire dark fiber and equipment or leased wavelengths for a "triangle" backbone connecting Dallas, College Station, Houston, San Antonio and Austin with additional connections to El Paso, Lubbock, Denton, Tyler/Longview, Beaumont, Galveston and Corpus Christi.

On February 28, 2005, the Governor signed the TEF grant agreement to provide $7.28 million in funding for the optical network project. LEARN now had the organizational, political and financial means to begin deploying the optical network for Texas.

Since its founding, LEARN has expanded both its membership and services. It now connects hundreds of thousands of students enrolled in higher education and in Texas' public schools. Over 500 organizations rely upon LEARN, either directly or indirectly through LEARN partners, for vital connectivity to local, statewide, national, and international network services.

Organization & Governance

LEARN's Board of Directors governs the overall affairs of the corporation with committees advising the Board on specific operational and policy issues. The

standing committees of the Board include Finance, Governance and Participation, and Operations and Services. Additionally, an Audit Committee consisting of three elected Board members and an independent advisor monitors the conduct of the annual independent audit. The Board also creates ad hoc committees of the Board as necessary.

Within the authority delegated by the Board, the Executive Committee comprised of the elected officers of the corporation and the Chairs of the three standing committees, develops the Board agendas and governs the affairs of LEARN between meetings of the Board. The Executive Committee is composed of the President and CEO, Chair, Chair Elect, Past Chair, Treasurer and Secretary. Other than the President, the officers are elected from the members of the Board of Directors.

The day-to-day business of LEARN is managed by the President and CEO of the corporation, who is elected by the Board. The CEO employs and supervises a professional technical and administrative staff to conduct and manage LEARN's operations, including a Chief Technology Officer who is responsible for the health of the network.

PATRICK JORDON
TAG Chair, University of Texas at Arlington

The Technical Advisory Group (TAG) is comprised of technical experts from each of the organization's member institutions. TAG representatives are appointed by the LEARN Board member from the institution they represent, and they elect the TAG Chair. TAG is an advisory body to the Board, President and LEARN's Chief Technology Officer and serves an important role in helping shape LEARN's architecture, operations and portfolio of services.

Network Infrastructure

LEARN's fiber network spans over 3,200 miles across the state, connecting its over 500 direct or affiliated organizations east to west from Beaumont to El Paso and north to south from Amarillo to Brownsville. LEARN is built on dense wavelength division multiplexing (DWDM) optical technology, providing the capability to transport multiple high capacity signals over a shared optical fiber by using the different color wavelengths of laser light. DWDM is state-of-the-art technology that is very scalable and permits LEARN to leverage its initial investment in optical fiber by adding additional capacity at marginal costs. LEARN has grown to 32 DWDM on-ramps within Texas.

LEARN's network relies on agreements with the private sector that provide the long-term use of optical dark fibers and/or long-term leases of optical wavelength capacity. When dark fiber is conveyed via an indefeasible right to use (IRU) agreement, LEARN provides the infrastructure to "light" the fiber and can add additional capacity as needed without having to revise a contract with the fiber owner. In wavelength capacity agreements, the service provider provisions the infrastructure and bandwidth under the terms and conditions of the agreement.

Deploying LEARN-owned high-performance routers at its 26 strategically-located Points of Presence (POPs), LEARN makes it possible for its members and affiliates to bridge the last mile with their own network connections at minimal cost. In most cases, LEARN's network segments are protected through rings that ensure continued operation of the network in case of a fiber cut or other disruption to a segment.

Several university members as well as the Texas Education Telecommunications Network (TETN) operate their own networks as overlay on LEARN, which in turn are linked into LEARN's statewide fiber and packet infrastructures, at LEARN's POPs. LEARN collaborates closely with those other organizations to ensure that high-performance networking is made available at the lowest cost, best reliability, and highest performance possible.

Membership & Network Services

Members are entitled to appoint an individual to the Board of Directors and to acquire network services from LEARN. Network services are designed and provisioned based on the needs of individual members through collaboration between those members and the LEARN staff.

Network services, which are funded by the members who consume the services at rates which are set by the Board, sustain current and future network requirements including capital refresh at periodic intervals to keep the network state-of-the-art.

Network Services include:

- Layer 1 Dedicated Transport Services Between LEARN Points-of-Presence (POPs),
- Layer 2 IP/MPLS Transport Services,
- SLA based Layer 2 connections to Cloud Service Providers (AWS, Google, & Azure),
- Routed Layer 3 Services,
- Connection Gateways to the National Research and Education Networks (Internet2 and Energy Sciences Network and as of mid-2018, on 100G ramps to reach Pacific Wave International Exchanges),
- Colocation Services at LEARN POPs,
- Commodity Internet Services (100G burst capacity spread across 4 POPs),
- Low-Latency High-Capacity Access to Content and Application Providers (Peering and Caching Services),
- DDoS Mitigation Service,
- Managed Network Service and Consultation, and
- Unmetered Network Service.

LEARN is currently listed as a telecommunication/ Internet service provider with the Universal Service Administration Company (USAC). Becoming a USAC telecommunications/Internet service provider permits LEARN's school, library, and rural health customers to receive significant discounts through the Universal Services Fund.

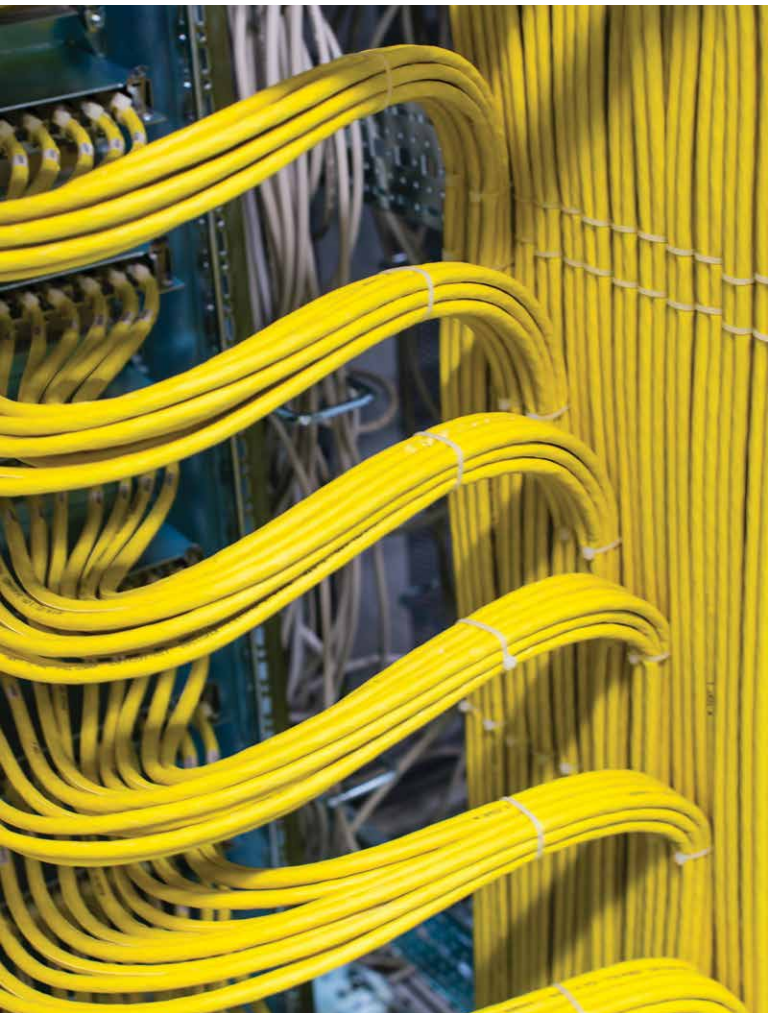
The Board and the staff are committed to ensuring LEARN remains the trusted and preferred means by which its members obtain network services in Texas. There is a broad consensus among LEARN's members that the organization has a unique role to play in the state in providing highly reliable, cost-effective network services to the higher education, K–12, and not-for-profit communities. LEARN is a trusted partner and convener in these communities.

Infrastructure Performance

LEARN has deployed and operates a sophisticated state-of-the-art fiber-based optical and IP network throughout the large state of Texas. That "carrier grade" optical and packet switching technology is highly reliable and capable of provisioning high-speed bandwidth between LEARN's customers in Texas cities and smaller communities throughout the state. While bandwidth capacity is important, LEARN recognizes that the reliability of the network is just as important to the daily operation of its customers who depend upon the network for most of their service functions.

To ensure that LEARN's network operates at "five nines" or greater reliability, LEARN operates a Network Operations Center (NOC) under an agreement with Texas A&M University, 24 hours a day, 7 days a week, 365 days a year. The NOC serves as the central point for monitoring and managing the overall health and performance of the network. LEARN engineers have a suite of network management tools at their disposal as well as the training they need to manage the configuration of the network, monitor the performance of the network segments and their components, diagnose and isolate the cause of performance issues, and manage incidents until they are resolved. LEARN's staff works closely with its members to align the network management practices and performance with their needs.

A critical component of LEARN's network reliability toolset is a comprehensive database of hardware assets, network configuration, circuits and other strategically important data that are essential to LEARN's overall strategy of continuously improving the operational performance and efficiency of its growing network. At the end of 2018, that database had over 4,500 entries with information such as the acquisition date, service records, contract expiration dates, projected replacement cycle, etc.



Network cable on a network HUB in the data center

The vast majority of LEARN's network topology is designed to provide network rings which serve as protected paths for customers in the event of a failure in the network infrastructure. If one leg of the ring suffers a fiber cut or equipment failure, the network automatically reconfigures itself to use the other leg of the ring to maintain connectivity. This design redundancy is a key element of the network's performance but despite the network design, failures of a network segment do occasionally occur. In order to reduce the time required to get the segment back into operation, LEARN has acquired and strategically deployed critical infrastructure spares throughout the network. Additionally, LEARN maintains maintenance and support agreements for its critical infrastructure with the vendors of both the fiber paths and the network gear.

The results of LEARN's efforts to provide a highly reliable network to its customers in 2018 were as follows:

- WaveNet Layer 1 Services on LEARN's Backbone
  – 100% Uptime
- FrameNet or Layer 2 Services
  – 99.99% Uptime
- Layer 3 Services on LEARN's Backbone
  – 99.999% Uptime
- Connection Gateways to Internet2
  – 100% Uptime
- WaveNet Services on the Beaumont Spur
  – 99.9% Uptime
- Commodity Internet Services
  – 100% Uptime

While these performance levels are very favorable compared with other telecommunications providers, LEARN's goal is to give its customers 100% reliability on all of its services. To that end, LEARN will continue to improve its technology, tools, training of its staff, and cooperation with its customers/partners and network staffs as it has done since the organization's inception.

ACTIVITIES & ACCOMPLISHMENTS

GOING THE EXTRA MILE TO BUILD

THE WORLD'S FASTEST NETWORK

LEARN plays a central role in engineering SCinet for the SC18 conference

LEARN staff in front of the SCinet NOC at SC18 in Dallas.

Written by Aaron Dubrow

Supercomputing 2018 (SC18), the international conference for high performance computing, networking, storage, and analysis, was held in Dallas, Texas in November 2018 and as the local leaders of the SCinet effort, LEARN's staff had a critical role to play. Participation in SCinet – SC's dedicated high-capacity network — is about more than meeting the conference's need for high-tech networks, bandwidth, and data. The 225 volunteers who build and operate SCinet provide insights into best practices in networking, and the group effort establishes a professional community of expertise.

"My team has been participating for several years," Akbar Kara, LEARN's CTO said. "You end up working with peers who bring a fresh perspective. That's part of growing as a professional and you become on a first name basis with really smart engineers in the

academic and vendor community. When companies send hardware worth ten million dollars, they also send smart people to make sure stuff works. The insights you learn and the relationships you develop are invaluable."

Being part of this community has come in handy this year as LEARN installs a new backbone to their network, providing capacity up to 400 gigabits per second. "Being part of the SCinet community allows me to reach out to talented people in industry and academia to make sure we're building things in the right way," Kara said.

"This resource is going to be here long after SC leaves town. It's going to enable the city of Dallas and future SC conferences to leverage the fiber," Kara said. "It's very Boy Scout-like — leave things better than you found them."

Building the World's Fastest Network

Participants witnessed a feat of network engineering as SCinet delivered a record-breaking 4.02 Terabits per second of network bandwidth to attendees, presenters and exhibitors.

"We're always trying to push the envelope in terms of what we can build," said Jason Zurawski, the 2018 SCinet chair.

Setting up SCinet required 225 volunteers from 85 Institutions; $52 million in contributed networking gear; 14 racks of hardware weighing 4.25 tons; and nearly 70 miles of fiber optic cables.

But none of this would have mattered if the LEARN team hadn't first found a way to get high-speed access to the Convention Center in the first place. "We couldn't have done it without LEARN," Zurawski said. "They were able to move mountains on their end to make sure their local infrastructure was capable of meeting SCinet's needs."

One often hears about the "last mile problem" – the difficulty of providing the final leg of a telecommunications network to customers. During the build out of the network for the SC conference, the team faced a literal last mile problem, getting 96 strands of fiber optic cables, each two miles long, from LEARN's point of presence (POP) at the Databank Data Center to the K. Bailey Hutchinson Convention Center one mile away.

"We were fortunate that one of the major aggregation points of the network on many backbones happens to be less than one mile away from the convention center," Kara said. "This is where Internet2, ESnet, LEARN and Century Link — research and education networks as well as carriers — terminate their capability, their networks and their fibers."

LEARN receives the SCinet Spirit of Innovation Award. (L to R) Tim Woodbridge, Kurt Freiberger, David Nichols, Byron Hicks, Ivan Amigo, Ralph A. McEldowney, Sal Ghani, Akbar Kara, Bob Hartland, Jason Zurawski, Pankaj Shah, Kerry Mobley, Ken Pierce, Kay Rhodes, Mark Stone, and Sudarshan Gururaj.

Doing so meant identifying a path through the bowels of City Hall, under the Dallas Library, beneath city streets and across the Convention Center parking lot, and convincing disparate partners, including city officials, to allow them to install the fiber.

While trying to connect the backbone to the Convention Center with minimal disruption, they discovered that the Dallas Library adjoined City

Hall and that the City Hall garage connected to the Convention Center garage. In the end, only 25 feet of digging was required to get fiber optic cable across one mile of dense Dallas city blocks.

"The fiber is the nervous system for the show," Kara explained. "Every booth requires some level of connectivity to support the demonstrations and some of these demonstrations required up to 1.6 Tb or 1,600 gigabits-per-second of bandwidth that was plumbed between the network operations center to the booth to support science."

Demonstrating the Capabilities of a High-Speed Network

In addition to providing fiber and wireless connectivity to SC's 13,000+ attendees and 360 exhibitors, SCinet allowed organizations on the show floor to show off incredible scientific demonstrations that were only possible because of the availability of a high speed, low-latency network.

For instance, researchers from Caltech demonstrated high-volume intercontinental data flows from the Large Synoptic Survey Telescope construction site in Chile to Dallas via Brazil and Miami, and onward to Korea via Chicago and Miami at close to wire speed. Also, using the first 400 gigabits-per-second data network on the SC floor, they exhibited a steady flow of data at close to 800 gigabits-per-second between the Caltech and University of Southern California booths.
More information: bit.ly/2OUtcYd

In collaboration with national and international partners, Northwestern University's International Center for Advanced Internet Research (iCAIR) worked with the SCinet WAN team and LEARN to provision 13x100 Gbps paths from the StarLight International/National Communications Exchange in Chicago and 6x100 Gbps from Washington, D.C. These circuits were used to showcase 35 demonstrations of innovations for next generation data intensive petascale science. Specifically, the demonstrations showcased new techniques for high energy physics, geophysical sciences, bioinformatics, weather prediction, astrophysics, radio astronomy, and atmospheric modeling.

"We're pleased at the support we received from the SCinet WAN team and LEARN," said Joe Mambretti, Director of iCAIR. "They provided excellent facilities support and expertise."
More information: bit.ly/2G3RUmm

2x100 Gbps circuits from the StarLight facility in Chicago to the StarLight booth on the SC18 show floor.

A third demonstration, led by Basil Decina and Linden Mercer of the Naval Research Laboratory (NRL), demonstrated the ability to dynamically process large volumes of data across a set of computer and network resources organized in response to resource availability and changing application demands. The team showed a real-time processing pipeline from SC18 to the NRL in Washington, D.C, with high volumes of bulk data transferred concurrently across the same data paths using a software-controlled network.

"Working in the SCinet Network Research Exhibition allowed us to gain valuable experience and test results from a very large-scale network environment that exceeds any we can assemble solely on our own," said Basil Decina, Director of NRL's Center for Computational Science.
More information: bit.ly/2G75vZ1

Pioneering New Technologies

Beyond the bulk capacity provided by SCinet, the technology infrastructure included a new type of high-speed network, developed by Ciena, that delivered 800 gigabits per second of long-haul bandwidth to the conference — a super-channel of connectivity from Chicago to Dallas.

Five organizations were instrumental in providing this capability: LEARN, Ciena, Energy Sciences Network (ESnet), Internet2, and Utah Education and Telehealth Network (UETN). The effort netted the collaborators the inaugural "Spirit of Innovation Award" from the conference for embracing "the spirit of collaboration and cooperation that showcases the best there is to offer in demonstrating, implementing, and operating leading-edge solutions to challenging problems," according to Zurawski.

The path between Chicago and Dallas used Ciena's WaveLogic 3 Extreme modems without optical-electrical-optical regeneration, reducing equipment cost and latency. The metro configuration between the Akard POP and the Convention Center used Ciena's WaveLogic Ai technology to deliver 400 gigabits per second per wave for increased spectral density and decreased cost per bit.

The project was made possible by network hardware loans from ESnet, LEARN, and UETN as well as space and power donations by both Internet2 and LEARN.

Pankaj Shah, President and CEO of LEARN said, "LEARN dedicated its entire engineering team to assist in the architecture and building of the SC18 infrastructure. This is a year-long effort. SC is one of the most fertile grounds for engineers to experience state-of-the-art bleeding edge technologies, while making life-time peer relationships from across the world. LEARN held its end-of-year Board of Directors meeting in conjunction with this international event, thereby further exposing the Texas R&E community to Supercomputing and Advanced Networking. We are grateful to the organizers and participants for the recognition given to LEARN via the inaugural Spirit of Innovation Award."

BY THE NUMBERS

4.02 + 1,000,000

World's fastest network, delivering **4.02** terabits per second of network capacity to **1,000,000** sq. ft. of exhibit space

14 + 4.25

14 equipment racks weighing **4.25** tons

25 + 4

Connecting **25** cities on **4** continents with data intensive demos and experiments

40 + 52

Contributions of **40** industry-leading vendors, who in total donated $**52** million in hardware, software, and services

225 + 85

225 volunteer experts from **85** organizations that span industry, academia, and government

300 + 1

Installed **300** wireless access points in **1** week to deliver Wi-Fi for all attendees

800 + 5 + 6

To deliver a bandwidth of **800** gigabits per second, volunteers from **5** organizations spent **6** months planning, testing, & delivering the necessary connections to KBHCC. These organizations were recognized with the SCinet Spirit of Innovation Award: Ciena, ESnet, Internet2, LEARN: Lonestar Education and Research Network, & UETN

UNS & MANAGED SERVICES

LEARN creates services to meet members' bandwidth and budget needs

Students are always online: streaming videos and movies from their dorms, checking social media, video chatting with friends and family, completing online course work, and more.

Written by Zach Woodbridge

Unmetered Network Services

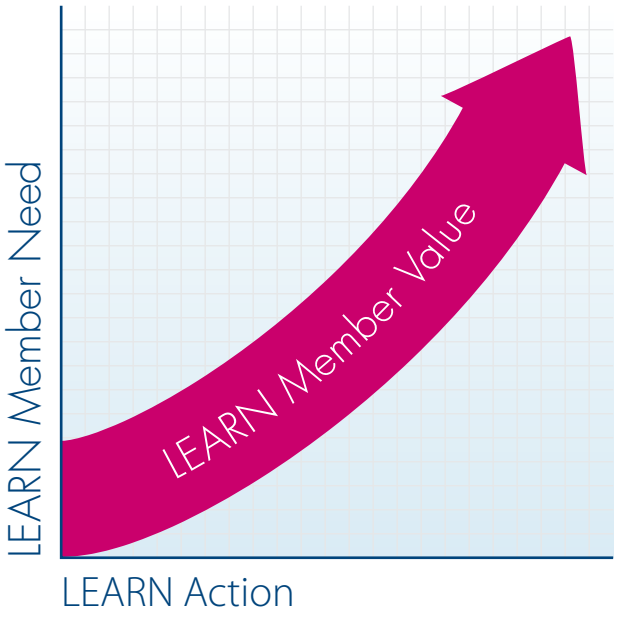
Prior to 2018, LEARN charged members based on usage. This meant a large organization like Texas Tech University (TTU) or the University of Texas at Dallas (UTD) would pay varied amounts depending on how much data students used. In our current digital age, web traffic doesn't die off in the evenings. Students are always online streaming videos and movies from their dorms, checking social media, video chatting with friends and family, completing online course work, and more. With an ever-changing digital landscape to adjust to, many LEARN members requested an unmetered network option, and LEARN delivered it.

Switching to an Unmetered Network Service (UNS) model allowed members to forego the worries of varying traffic levels through different months, creating a single price point. This eliminated variances in budgets and offered the opportunity for a cost reduction for members.

UTD no longer worries about "bursting" or higher outputs because of data usage fluctuations. "The budget stays steady," says John Patterson, Director of Networking and Infrastructure at UTD. Usage was increasing at a rapid rate. "LEARN allowed us to do preferred routing with some other provider costs." Peering and Caching from multiple ISPs gave us the comfort of not messing with costs and variances." Patterson noted that IT infrastructure is a subject their office doesn't worry about anymore. "LEARN's technology and support is top notch. They eliminated a lot of those 'questions' we had to consistently ask."

Texas Tech University System (TTUS) was the first member to be involved with using the UNS model.

UNS POTENTIAL



An initial meeting between LEARN President and CEO, Pankaj Shah and Sam Segran, Chief Information Officer for TTU in December 2016 led to the development of the UNS model as an innovative network services approach for LEARN members. After this meeting, Segran approached CIOs from the other TTUS institutions, Texas Tech University Health Sciences Center, Texas Tech University Health Sciences Center El Paso and Angelo State University. "For me, it made perfect sense," says Segran. "We already outsource our WAN Services to LEARN. We are able to use up to the bandwidth capacity that is available to us in the West Texas LEARN network infrastructure so that unused capacity is not wasted when there is a need." He also noted that telecommunication companies require new contracts, budgets and meetings when growth occurs. Through LEARN, they're able to sit back and watch the traffic grow without increasing budget and bandwidth. "We're looking to increase port capacities based on traffic in the near future," noted Segran. "UNS from LEARN has allowed us to strategically plan our internal network infrastructure growth requirements as the University grows in terms of students, academic programs, online education and research. We may need to increase our bandwidth soon."

Peering & Caching

One way LEARN reduces traffic while offering UNS is through Peering and Caching. By partnering with content providers such as Amazon, Netflix, social media and more, LEARN is able to cache repetitive content onto their servers. This allows students and staff to access the same online content without re-downloading it for every person. For example, if fifty students on campus are all watching the same movie, instead of streaming it fifty times, it was cached once, saving fifty or more gigabytes. LEARN also provides research-based Peering and Caching, allowing access to the large files involved without redundant traffic, and at higher speeds.

Overall, LEARN's Peering and Caching ensures 80% of member traffic never leaves the LEARN network.

This means only 20% of a member's traffic ever has to reach the commercial Internet, creating lower costs for large organizations such as universities.

By the end of 2018, over half of LEARN's members and a growing number of LEARN's Affiliated Organizations agreed to UNS. UNS through LEARN is now gaining interest among smaller universities and private colleges and LEARN plans to expand the service as its members support the model.

Managed Services

For some organizations and universities, hiring and maintaining large resources such as a Wide Area Network (WAN) — and the staff to implement said resources — can be costly and inefficient. LEARN has implemented Managed Services to alleviate the burden of needing skilled engineers, lending LEARN's expertise in the field of information technology.

LEARN has employed a remarkable team of engineers with decades of success and knowledge. These engineers have extensive experience in successfully implementing and maintaining any system a member may need. These engineers offer Layer 1 and Layer 2 Infrastructure, and the expertise in those areas. LEARN staff has over 124 years combined experience in research and education (R&E) along with over 208 years combined experience in telecommunications and IT. Various staff members also boast decades of experience in education support, accounting, project management, IT security and more.

"LEARN manages everything," noted Shannon Cepica, Senior Director of Administrative and Client Services at UTD. This allowed UTD to transition internal people to other major projects such as a campus core replacement and a wireless makeover. The UTD staff didn't have the required routing experience so utilizing LEARN made sense with their needs. "We were having to replace our routers and LEARN was able to provide the quote that we went with," says Cepica. Capital expenditure dollars are difficult to secure in higher education. Being able to move to an operating expenditure model while still purchasing the routing equipment enabled UTD to allocate the expenses more efficiently, all while lowering staff costs. "Because UTD is in a very competitive market in the Dallas area networking space, it's difficult to budget for senior engineers.

LEARN provided the senior engineer expertise without trying to compete, while still lowering costs," says Cepica.

Texas Education Telecommunications Network (TETN) provides network services for the twenty education centers across Texas. Sixteen centers were served by LEARN as of 2018, including Layer 3 and Transport Services. "TETN only has one network engineer," says Lea Castillo, Manager of the TETN. "It doesn't make sense for us to manage our own networking." Having the LEARN staff is beneficial cost-wise to reduce necessary personnel and bring invaluable expertise. "No more buying expensive additional equipment since LEARN manages everything for us." Castillo says. She also praised LEARN for the redundancy, efficiency and stability of the bandwidth TETN receives. As an education network directly affecting classrooms and online education efforts, TETN is highly dependent on the up-time of their network.

For Texas Tech University System, Segran says Managed Services has freed up a few of their staff resources, allowing them to focus on expanding their Wi-Fi and internal Local Area Network (LAN) infrastructure on campus, and shift more services to the cloud. "UNS has sustained the growth of our institutions without having to increase our staff. LEARN has enabled that," says Segran. Freeing up staff has helped TTU handle the increasing needs of students, faculty and staff. Segran concluded by saying LEARN helps to support TTU's teaching, learning, research and outreach missions.

TOP 5 BANDWIDTH USERS

A look at the top five members utilizing LEARN's network

Written by Zach Woodbridge

Every LEARN member uses bandwidth for its own benefits. As such, these bandwidth amounts vary widely from day to day. Overall, there are five organizations that used the greatest amount of bandwidth in 2018. In order from greatest to least are: the University of Texas at Austin's Texas Advanced Computing Center, Texas Tech University System, Texas State University, Texas Education Telecommunications Network, and the University of Texas Arlington.

1 University of Texas at Austin - Texas Advanced Computing Center (TACC)

Because of their mission and the organizations they support, TACC uses the largest amount of bandwidth every year. Piping massive quantities of data to and from Texas universities, as well as research organizations across America, means unbelievable networking costs for TACC on a traditional Commodity ISP. LEARN has enabled their continued growth in high-performance computing, benefitting the entire state of Texas.

LEARN is TACC's connection to Internet2, ESnet, & PacificWave, supplying their access to Texas universities, as well as national organizations. The high-end simulations processed on TACC supercomputers create complex, massive data that must be transported in and out.

Bill Barth, Director of High-Performance Computing for TACC, says their system Stampede2 is supporting the National Science Foundation. During the four years the original Stampede was operational, its more than 11,000 users from various organizations ran over eight million successful jobs, accounting for over three billion hours of computation. Now with Stampede2, researchers and scientists are running extremely complex visualized simulations in a fraction of a second while transporting huge datasets via LEARN.

Users at NASA in the Jet Propulsion Laboratory (JPL) utilize TACC's LoneStar 5 high-performance

TACC's Stampede2 supercomputer.

computing system under a contract wherein TACC provides supercomputers, networks, computational expertise and more resources for NASA. JPL is the branch of NASA devoted to robotic exploration of our solar system, including the construction and utilization of robotic spacecraft, as well as NASA's Deep Space Network. JPL researchers can use LoneStar 5 to supplement NASA systems they have internally as well, but the fundamental research is expected to use TACC systems exclusively.

"LEARN is an important way for us to reach our broader community," says Barth. "They get our data in and out, and without LEARN, we wouldn't know what to do."

2 Texas Tech University System (TTUS)

The Texas Tech University System encompasses Texas Tech University (TTU), Texas Tech University Health Sciences Center (TTUHSC), Texas Tech University Health Sciences Center El Paso (TTUHSCEP), and Angelo State University (ASU), all of which are involved with LEARN. After the success that followed the West Texas Pilot Program in 2017, the test network services implemented on a trial basis have become permanent. "Working closely with the LEARN staff has been extremely useful. It gives us the confidence that this model will be beneficial and sustainable for years to come," says Sam Segran, Chief Information Officer (CIO) at TTU.

TTU appreciates how LEARN communicates, offering insights and information unlike telecommunications companies. "LEARN is always open about what is happening," says Segran. He also praised Akbar Kara, LEARN's Chief Technology Officer (CTO), and the LEARN engineers for making LEARN more resilient in terms of redundancy, as TTUS depends on LEARN for most of its traffic.

TTU has a significant amount of ongoing research. The most noteworthy projects that require connectivity include those of high energy

physics professors. They work with the European Organization for Nuclear Research, better known as CERN, involving the Compact Muon Solenoid experiment. This experiment involves the search for the recently discovered Higgs Boson particle and researches new physics phenomena. The TTU CIO's Office also partners with TACC for large-scale, high-performance computing solutions needed for the research projects of TTU research scientists from Chemistry, Chemical Engineering, Mechanical Engineering, Physics and Geosciences.

Like TTU, TTUHSC and TTUHSC El Paso also utilize the LEARN network for distance learning. As online courses continue to expand, distance learning becomes more integral to their educational mission every year. Online teaching environments use a cloud service through LEARN called TechLink. In fact, many programs at TTUHSC host lectures via TechLink. The TTUHSC and the TTUHSC El Paso campuses also often use the network for connections to other LEARN members, sharing research and collaborating on projects.

3

Texas State University

Texas State has implemented many changes over the past few years to relocate on-premise services to the cloud. Office 365, where we had our email managed on-site is now in the cloud," says Mike Krzywonski, Director of Network Operations and Technology Resources for Texas State. This offered fast, direct access to email without the risk of down-time, a welcomed benefit of cloud access.

With LEARN's Peering and Caching, Texas State was able to significantly reduce costs that traditional broadband ISPs provide. Because students are always plugged in and common services are constantly used by students, faculty, and staff, Peering and Caching has become an integral part of the services provided by LEARN.

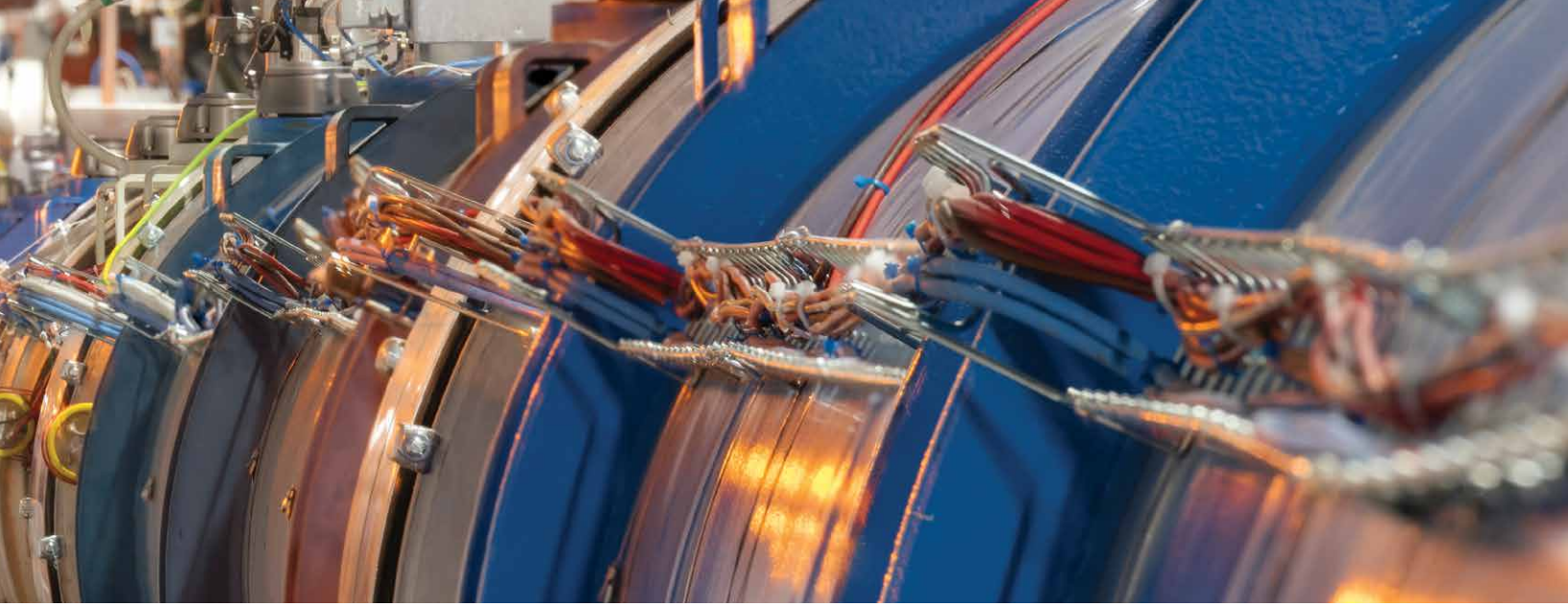
Texas State, located in San Marcos, is over 200 miles from the Dallas area. "LEARN brings the statewide network so we can connect with Dallas-area universities for research, collaboration, and resource sharing," says Krzywonski.

One research project started in 2018 was a study of neuroblastoma and its components. Neuroblastoma is a common and lethal childhood cancer. The goal of this collaborative project between chemistry, biochemistry, cell biology and animal studies is to identify new feasible anti-cancer drugs that can treat neuroblastoma. This research may lead to the identification of new therapies for neuroblastoma patients that are resistant to the current treatments.

4

Texas Education Telecommunications Network (TETN)

As a state, Texas has massive requirements for local ISDs and integrated education networking. With 16 out of 20 Regional Education Service Centers utilizing the LEARN network in 2018, their needs were diverse. Some services using LEARN's resources are online textbooks, online testing, and video conferencing.



CERN's Large Hadron Collider tunnel during a technical stop. ***Photo courtesy of CERN.***

LEARN enables TETN to offer classes and dual credit courses via web stream, giving students all over the state access to college professors in an instant. In Region 5, Beaumont schools provide Spanish classes across the state, affecting around 50 classes. Also, supplemental content from museums is available for students to visit online, bringing the learning outside the museum and into the classroom for further education.

"Network services including security offerings provided by LEARN are vital to keeping our schools running," says Lea Castillo, Manager of TETN.

University of Texas Arlington (UTA)

The most noteworthy research happening at UTA that requires high amounts of bandwidth is their high energy physics group. "The research team is closely connected to LEARN," assures Jason Hardy, Director of Infrastructure and Operations Development at UTA. UTA allocates 30 gigs of bandwidth to research and 13 or more gigs are in constant use.

"One of the drivers for working with LEARN was their Unmetered Network Service offering, which allows us to freely use bandwidth for all of our education and research needs," says Hardy.

CERN (The European organization for Nuclear Research) is also a major source for bandwidth for UTA. "We bring data to the U.S. then on a regional basis, people get the data from UTA. It's the premiere research project for the UT System," noted Hardy. This high-profile research deals with particle acceleration, utilizing the world-famous Large Hadron Collider, the most powerful collider in the world. "It's a worldwide project and UTA is one of the few data distribution points in America."

UTA has partnered with LEARN since LEARN's inception. UTA is a connection in the North Texas GigaPOP that eventually became part of LEARN. "We're a big part of their mission to expand higher education in the state. Our missions align closely," says Hardy. UTA is a public institution but provides services to the entire state. Being part of LEARN is critical to goals. "We think it's great that it's expanding to community colleges and smaller organizations. That's very important; cost is very important. And as research traffic increases, our expectation is that our data will be shipped to other area institutions. LEARN helps un-limit our ability to do this thanks to the cost cuts," says Hardy.

Strategically, UTA is looking to partner with LEARN and other organizations to relieve their operational responsibilities, which allows them to manage risk. With LEARN, Hardy says he has an excellent team and great up-time. He praised the DDoS Services that helped move some protections of their network off-site to LEARN. LEARN is a partner that continues to support UTA's growth.

FUTURE PROJECTS

A peek into upcoming key LEARN projects in 2019

Written by Zachary Woodbridge & Aaron Dubrow

Building a Frictionless Disk-to-Disk Cyberinfrastructure for the Nation's Researchers

Say a researcher at Caltech needs to sequence 1 million DNA samples using a high-throughput gene sequencer at Baylor University in Waco, Texas, then analyze the data using supercomputers at the Texas Advanced Computing Center in Austin and share the results with colleagues in Massachusetts and Washington State.

The process relies not only on specialized sequencing technology and high-performance computing, but also on high-speed networks capable of sharing huge amounts of data in a timely way.

"When a researcher is trying to collaborate with another researcher across the continent, often there are issues that become visible because of the amount of data they're looking to share," said Akbar Kara, LEARN's CTO.

Though a campus may boast a 1 gigabit connection, the researcher may only be getting 5 megabits per second of throughput due to all of the layers of different networks that must be tapped to accomplish the task.

"When a performance problem occurs, what does a researcher do?" Kara asked. "Usually he or she gives up."

Recognizing this as an obstacle to scientific progress, the National Science Foundation (NSF) has taken steps to address the problem in a number of ways over the

past decade: supporting high-speed connections at the campus level, regionally, and nationally, as well as integrating networks across all three.

Science DMZs

One important model that has risen to prominence in recent years is the Science DMZ — a way of isolating research-driven traffic from the everyday traffic of thousands of students and protecting the integrity of data.

Since 2012, NSF has funded more than 220 Science DMZ projects at campuses across the nation through the Campus Cyberinfrastructure - Network Infrastructure and Engineering (CC-NIE) program. In Texas, 12 universities have received CC-NIE funding; and of those 12 universities, 3 are active awards. All connect to LEARN, which facilitates the network traffic from the campus level across the state to regional and ultimately national networks like Internet2 and ESnet, the high-speed computer network serving the United States Department of Energy.

Kevin Thompson, NSF Program Director said, "The CC-NIE program opened the door to collaboration to tens of thousands of researchers and advanced science by making important datasets available no matter where a scholar may reside."

Stitching Networks with FIONAs

Despite this ambitious effort, connectivity challenges still persist even in places where fast networks are present. This is in part due to the patchwork nature of the nation's network infrastructure.

"End-to-end is a difficult problem to solve in general because the networks between ends typically traverse multiple network management domains: campus, regional, and national," said Larry Smarr, founding director of the California Institute for Telecommunications and Information Technology. "No one organization owns the responsibility for providing scientists with high-bandwidth disk-to-disk performance."

A project called "Toward a National Research Platform," led by Smarr and funded by a $2.5 million grant from NSF in 2018, addresses this challenge. Building on the regional Pacific Research Platform (PRP), it aims to greatly improve end-to-end network performance across the nation.

"This is akin to the way cities, in the first half of the twentieth century, built freeways. The next step was the construction of interstate highways to connect the freeways," Smarr said. "We're building the big data superhighway."

The PRP connected universities and labs in California, Oregon, and Washington, and, more recently spread eastward to Chicago and Colorado and westward to Hawaii and the Pacific Rim. The National Research Platform continues the network's march south and east across the U.S.

"The PRP worked with Texas, Oklahoma and the Great Plains networks to extend a really fast backbone link further east," said Akbar Kara. "Together we received additional funds from NSF to bring in a 100-gigabit facility that came into Houston and Dallas, where we have points of presence. LEARN connected to both Dallas and Houston, so researchers can tap into resources connected to new Pacific research network facilities."

The vision of the National Research Platform goes beyond simply unifying the nation's high-speed research networks. It aspires to serve as a cloud-like, distributed supercomputer for the nation and beyond.

One way to do so is by deploying Data Transfer Nodes (DTNs) – an approach to computer network architecture that seeks to address the data transfer issues in heterogeneous networks – at sites across the U.S.

Specifically, the National Research Platform will utilize FIONAs (Flash I/O Network Appliance): clustered DTNs carefully optimized for storing, forwarding or using large amounts of data (10s to100s of terabytes) on 10, 40, or 100 gigabit per second networks.

"The campuses have been interconnected at high speeds via the regional optical networks like CENIC (Corporation for Education Network Initiatives in California) or LEARN," Smarr said. "The idea was to put these FIONAs on the campus and then, over the campus DMZs and through the regional providers, provide end-to-end, disk-to-disk performance at 9.6 gigabits per second."

The LEARN-routed FIONA, located at the Texas Advanced Computing Center (TACC), began operations in February 2019 and has been constantly monitored for performance. Discussions are underway with major research groups including the Dell Medical School and the cryo-electron microscopy (cryo-EM) facility at the University of Texas at Austin to test the network to showcase its utility for research and collaboration.

"We're realizing a dream of a fully distributed, big data supercomputer with no core, all data and storage at the edge, and edge points at TACC or the San Diego Supercomputing Center, or your local FIONA, or the cloud," Smarr said. "The goal of the National Research Platform is to spread this vision across the county."

LEARN plays an important role in the project. As a major regional testbed, they will help the National Research Platform develop and test use cases for difficult data transfer needs.

"Of all the regionals, LEARN was one of a handful nationally that wanted to be at the head of the class," Smarr said. "It's not for everybody. You have to have the technical people. Leadership is one of the key things that LEARN showed."

Roadside Assistance to Resolve Network Performance Problems

A third effort, the Engagement and Performance Operations Center (EPOC), serves as "roadside assistance" for researchers and campus IT staff. Awarded a three-year, $3.5 million grant from NSF in 2018, it acts as a production platform for operations, applied training, monitoring, and research and education support, with a goal of enabling frictionless data movement across the nation and around the world to improve collaboration and research. LEARN is one of the six regional network collaborators in this grant.

LEARN is teaming with EPOC to present a day-long workshop in June 2019 for Texas researchers and IT staff to help disseminate best practices and identify and fix problems.

"EPOC will train IT staff on how to talk to and work with researchers on campus," Kara said. "How do you clean up campus or regional network architecture, so you don't have issues and train staff to do the right thing up-front, so you don't have problems?"

In addition, EPOC has been working with the LEARN engineering team to pilot services that could be available at LEARN in the future, whether it be performance monitoring or a faster network path that takes advantage of new technology as LEARN updates its network.

"We want to improve networking from the national level all the way to the campus layer and ultimately to the research equipment," Jason Zurawski of ESnet said. "On a full path like that, the problems are most likely right in the vicinity, where the researcher is physically sitting – same laboratory, building, campus, or connectivity to the regional network. That's what we'll be working on with LEARN and other partners."

LEARN's President and CEO Pankaj Shah summarized it as, "We want to remove all friction from various cyber-infrastructure layers in Texas, so that Researchers and Educators can spend time on their critical projects rather than underlying technologies. Whether by enabling Science DMZs, integrating advanced networking equipment like FIONAs, or partnering with EPOC on education and training efforts to maximize human capital, LEARN is helping researchers collaborate and compute better, in Texas and around the world."

San Angelo Collaboration

After Mayor Brenda Gunter was elected to office in San Angelo, she began working on a technology committee with goals to improve the many aspects of Internet service in San Angelo and the surrounding areas. Asked to spearhead this new taskforce was Del Velasquez, Executive Director of Downtown San Angelo, Inc. Velasquez was the perfect candidate to lead the collaboration due to his decades of experience in telecommunications, working for companies such as AT&T and Verizon.

The committee encompassed many of the major institutes and bandwidth users within San Angelo. Area-specific organizations such as the San Angelo City office, county offices, the Chamber of Commerce; local legislator Rep. Drew Darby; education-based institutions - Angelo State University, Howard College, San Angelo ISD and the Region 15 Education Service Center; large, influential corporations that are heavily technology-based such as VGI Technology, Time Plot Plus and Cal-Tech; and local medical facilities including

Shannon Medical Center and the Community Medical Center. Together, their goal was to examine the state of San Angelo's technology. "Our goal is always to retain our businesses in San Angelo," says Velasquez. "They need the bandwidth, capacity, redundancy and other aspects of a robust infrastructure."

Velasquez noted the goal from a city perspective is to improve the Internet capabilities of San Angelo, from bandwidth to security, to help entice large businesses looking for a new location. While this taskforce searched for service providers to present possible solutions and improvements, LEARN was invited to speak, as Angelo State University was already a LEARN member. The presentation helped familiarize the taskforce with LEARN's mission and start the dialogue between all the involved institutions on how to secure more capacity, redundancy, security, etc. "We need that safety net LEARN can provide to ensure San Angelo functions at the level this community needs for business and education," says Velasquez. Multiple meetings have been held since the initial presentation from LEARN, and the dialogue has continued beyond 2018.

With the Region 15 Education Service Center being given $40 million to build 770 miles of fiber in the Region 15 area, and the Texas State Data Center at ASU, San Angelo is increasing its research and education influence throughout the state. San Angelo is also the hub for medical treatment in the Concho Valley, noted Velasquez. With telemedicine on a continual rise, the need for dependable, fast Internet is vital to the success of hospitals - something LEARN may provide.

"We're having diverse voices reach our legislature about the need for broadband in rural communities," says Velasquez. With Rep. Drew Darby involved, San Angelo is becoming a state-wide advocate for rural broadband, a task LEARN can be involved with. "We can be a shining example of what can happen," says Velasquez.

LEARN can play a major role in every aspect of the San Angelo Technology Committee. From healthcare to business affairs, city efforts and education, LEARN can influence the economic development in the Concho Valley area. Talks with LEARN are continuing, assures Velasquez. What began with a collaboration of local businesses, institutions and government agencies, continues as decisions are made in 2019 and beyond. LEARN can be part of benefiting Texas economics, education and healthcare in the San Angelo area for years to come.

Regional Collaboration

LEARN is Texas' research and education network, but every state around Texas has a similar network. States near Texas such as Arkansas, Louisiana, Oklahoma and the Great Plains area are working together with LEARN to consolidate efforts and in some cases, they are bringing on mutually-beneficial data storage. Regional partners will share resources and connect to the content provider-rich Dallas area, Cloud, and Transit peers in Dallas. A regional collaboration will bring redundancy for LEARN members, supplying connections through Louisiana for members in East Texas.

Colocation

While some LEARN members supply everything themselves, some use LEARN's Multiprotocol Label Switching (MPLS) Services, IP network, raw bandwidth and more. Many members require the space to house electrical power, cooling, fiber jumpers and other aspects of successfully maintaining servers. While other companies already supply these colocation services to LEARN members, LEARN has the resources through multiple data centers to supply this service, and looks to provide it to members in the coming years.

Disasters unfortunately happen, and in the IT space, there's never a guarantee a server won't fail due to flooding, power outage, fire, or natural disasters. LEARN-provided colocation can offer a secondary server location in case of server failure. Even during a massive system upgrade, servers require downtime. Colocation through LEARN allows members to continue their services without interruption. This gives members access to email, vital applications, the organization's website and more, all from a remote location.

Not all LEARN members have the resources for disaster recovery. It requires a secure facility with reliable space and power, as well as a connection to LEARN if they are to maintain the same experience as if from their original data center. Remote data center capabilities through LEARN could cut costs for these members and offer the redundancy necessary to resume regular functions during an outage.

APPENDICES

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Texas State University

SAM SEGRAN
Vice President, Information Technology & CIO
Texas Tech University

BOARD OF DIRECTORS (CONTINUED)

VINCENT (VINCE) FELL
Vice President, Information Technology & CIO
Texas Tech University Health Sciences Center

GERARDO (JERRY) RODRIGUEZ
Associate Vice President, Information Technology & CIO
Texas Tech University Health Sciences Center El Paso

KAY RHODES
Associate Vice Chancellor & CIO
Texas Tech University System

RAECHELLE (RAE) CLEMMONS
Associate Vice President, Technology & CIO
Texas Woman's University

JAMES (JIM) BRADLEY
Chief Information Officer
Trinity University

DENNIS FOUTY
Associate Vice President, Information Technology & CIO
University of Houston System

RAMA DHUWARAHA
Associate Vice Chancellor & CIO
University of North Texas System

JEFFERY (JEFF) NEYLAND
Chief Information Officer
University of Texas at Arlington

CHRIS SEDORE
Vice President, Information Technology Services & CIO
University of Texas at Austin

FRANK FEAGANS
Vice President, Information Technology & CIO
University of Texas at Dallas

STEPHEN RITER
Vice President, Information Resources & Planning
University of Texas at El Paso

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Interim Vice Provost, Information Technology & CIO
University of Texas at San Antonio

DEREK DRAWHORN
Executive Director, Communications Technology
University of Texas Health Science Center at Houston

YEMAN COLLIER
Vice President, Info. Management & Services & CIO
University of Texas Health Science Center at San Antonio

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Vice President, Technology & CIO
University of Texas Health Science Center at Tyler

CHUCK SUITOR
Associate Vice President & CTO
University of Texas MD Anderson Cancer Center

TODD A. LEACH
Vice President, Information Services & CIO
University of Texas Medical Branch at Galveston

JEFFREY GRAHAM
Chief Information Officer
University of Texas Rio Grande Valley

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Associate Vice President, Information Resources & CTO
University of Texas Southwestern Medical Center at Dallas

CLAIR GOLDSMITH
Chief Technology Officer
University of Texas System

FINANCIAL STATEMENTS

Ingrid Edwards CPA PC

8500 N. Mopac, Suite 605,
Austin, TX 78759
512-582-0118

Member of American Institute of Certified Public Accountants

Member of Texas Society of Certified Public Accountants

INDEPENDENT ACCOUNTANT'S COMPILATION REPORT

To the Board of Directors
Lonestar Education and Research Network
Lubbock, TX

Management is responsible for the accompanying financial statements of Lonestar Education and Research Network (a nonprofit organization), which comprise the statement of financial position as of December 31, 2018, and the related statement of activities for the year then ended in accordance with accounting principles generally accepted in the United States of America. I have performed a compilation engagement in accordance with Statements on Standards for Accounting and Review Services promulgated by the Accounting and Review Services Committee of the AICPA. I did not audit or review the financial statements nor was I required to perform any procedures to verify the accuracy or completeness of the information provided by management. Accordingly, I do not express an opinion, a conclusion, nor provide any form of assurance on these financial statements.

Management has elected to omit substantially all of the disclosures and statement of cash flow required by accounting principles generally accepted in the United States of America. If the omitted disclosures and statement of cash flow were included in the financial statements, they might influence the user's conclusion about the Organization's financial position, changes in assets, and cash flow. Accordingly, these financial statements are not designed for those who are not informed about such matters.

February 25, 2019

Certified Public Accountant
Austin, TX

STATEMENT OF FINANCIAL POSITION

DECEMBER 31, 2018

ASSETS

	Total
CURRENT ASSETS	
Cash and cash equivalents	$ 11,417,729
Investments - short term (at cost):	
Certificates of deposit	1,575,000
Fixed Income Bonds	1,746,729
Total Short Term Investments	3,321,729
Accounts receivable	421,531
Prepaid expenses	174,542
Funds held by others	1,900
Total Current Assets	15,337,431
INVESTMENTS - LONG TERM (at cost)	
Certificates of deposit	2,025,000
Fixed Income Bonds	3,135,519
Total Long-Term Investments	5,160,519
PROPERTY AND EQUIPMENT	
Network equipment	10,855,020
Furniture and equipment	59,181
	10,914,201
Less accumulated depreciation	(8,825,804)
Property and Equipment - net	2,088,397
OTHER ASSETS	
Network and IRU access rights	9,843,212
Less accumulated amortization	(6,584,867)
Total Other Assets	3,258,345
TOTAL ASSETS	$ 25,844,692

LIABILITIES AND NET ASSETS

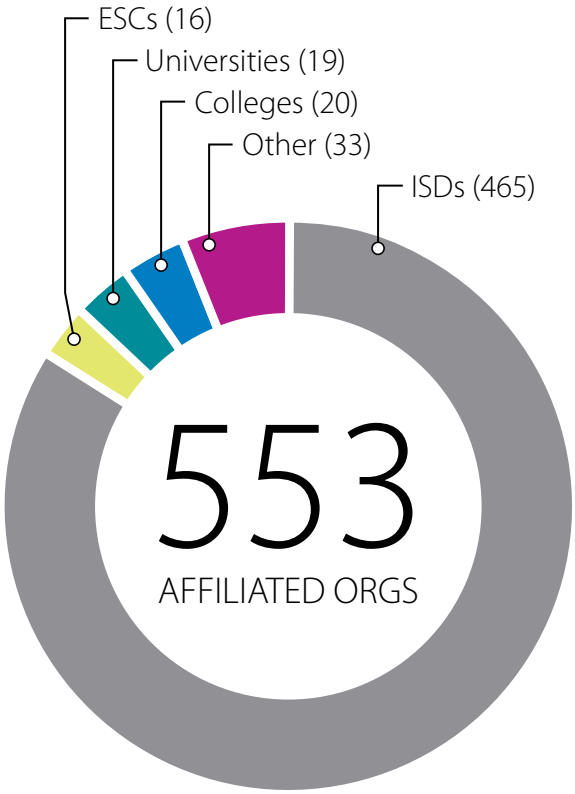
CURRENT LIABILITIES	
Deferred revenue	$ 531,212
Accounts payable	230,141
Accrued vacation pay	28,441
Credit cards payable	6,435
Capital leases payable - current portion	15,000
Total Current Liabilities	811,229
LONG TERM LIABILITIES	
Capital leases net of current portion	8,306
Total Liabilities	819,535
NET ASSETS	
Unrestricted net assets	13,717,805
Unrestricted board designated net assets	
Life cycle replacement	11,241,329
Member balances	66,023
Total Net Assets	25,025,157
TOTAL LIABILITIES AND NET ASSETS	$ 25,844,692

STATEMENT OF ACTIVITIES

FOR THE YEAR ENDED DECEMBER 31, 2018

	Current Operating Funds		
	Unrestricted		Total
	Program Services	Management and General	
REVENUES AND OTHER SUPPORT			
Network services	$ 6,390,581	$ -	$ 6,390,581
Membership dues	-	800,000	800,000
Affiliate fees		100,100	100,100
Investment income	282,011	-	282,011
TOTAL REVENUES AND OTHER SUPPORT	6,672,592	900,100	7,572,692
EXPENSES			
PROGRAM SERVICES			
Connections and fibers	1,466,691	-	1,466,691
Network maintenance	987,411	-	987,411
Network parts and supplies	583,793	-	583,793
Amortization	632,795	-	632,795
Depreciation	802,717	-	802,717
Total Program Expenses	4,473,407	-	4,473,407
SUPPORTING SERVICES			
Professional fees:			
Administration	660,464	568,175	1,228,639
Auditing	-	20,750	20,750
Accounting	-	7,576	7,576
Legal	-	48,144	48,144
Other	21,805	55,990	77,795
Salaries and wages	354,832	138,510	493,342
Travel	118,009	58,311	176,320
Insurance	-	50,407	50,407
Sponsored meetings	-	51,421	51,421
Membership dues	-	22,970	22,970
Software subscriptions	11,430	42,077	53,507
Payroll taxes	17,841	10,388	28,229
Office expenses	3,515	30,199	33,714
Office rent	-	24,310	24,310
Marketing and awards	-	9,353	9,353
Office utilities and maintenance	-	5,401	5,401
Telephone	315	1,539	1,854
Books and subscriptions	-	142	142
Depreciation	-	2,484	2,484
Total Supporting Services	1,188,211	1,148,147	2,336,358
TOTAL EXPENSES	5,661,618	1,148,147	6,809,765
CHANGES IN NET ASSETS	1,010,974	(248,047)	762,927
NET ASSETS:			
Beginning balance at January 1, 2018	23,585,629	676,601	24,262,230
Ending balance at December 31, 2018	$ 24,596,603	$ 428,554	$ 25,025,157

AFFILIATED ORGANIZATIONS



COLLEGES

Austin Community College
Brazosport College
Del Mar College
Galveston College
Grayson College
Hill College
Houston Community College
Kilgore College
Lamar Institute of Technology
Lamar State College - Orange
Lamar State College - Port Arthur
Midland College
Navarro College
Northeast Texas Community College
Panola College
Paris Junior College
Texarkana College
Trinity Valley Community College
Tyler Junior College
Victoria College

EDUCATION SERVICE CENTERS (ESCs)

Education Service Center - Region 1
Education Service Center - Region 2
Education Service Center - Region 3
Education Service Center - Region 4
Education Service Center - Region 5
Education Service Center - Region 6
Education Service Center - Region 7
Education Service Center - Region 9
Education Service Center - Region 13
Education Service Center - Region 14
Education Service Center - Region 15
Education Service Center - Region 16
Education Service Center - Region 17
Education Service Center - Region 18
Education Service Center - Region 19
Education Service Center - Region 20

ISDs

Abernathy ISD
Academy of Careers & Technologies Charter School
Adrian ISD
Alamo Heights ISD
Albany ISD
Alief ISD
Alpine ISD
Alto ISD
Amarillo ISD
Amherst ISD
Anderson-Shiro CISD
Andrews ISD
Angleton ISD
Anson ISD
Anton ISD
Apple Springs ISD
Archer City ISD
Aspermont ISD
Austin ISD
Austwell-Tivoli ISD
Baird ISD
Balmorhea ISD
Bandera ISD
Bangs ISD
Bartlett ISD
Basis Texas
Bellevue ISD
Benjamin ISD
Bexar County Academy
Big Sandy ISD
Big Springs Charter School
Blackwell CISD
Blanco ISD
Blanket ISD
Bob Hope Charter School
Boerne ISD
Boling ISD
Booker ISD
Borden County ISD
Borger ISD
Bovina ISD
Bowie ISD
Boys Ranch ISD
Brackett ISD
Brady ISD
Brazos ISD
Breckenridge ISD
Brenham ISD
Bronte ISD
Brookeland ISD
Brookesmith ISD
Brooks Academy of Science & Engineering
Brownfield ISD
Brownwood ISD
Buckholts ISD
Buena Vista ISD
Buna ISD
Burkburnett ISD
Burkeville ISD
Burnet CISD
Burton ISD
Caldwell ISD
Calvert ISD
Canadian ISD
Canyon ISD
Carpe Diem Schools
Carrizo Springs CISD

Cayuga ISD
Center Point ISD
Centerville ISD
Channing ISD
Charlotte ISD
Chester ISD
Childress ISD
Chillicothe ISD
Christoval ISD
Cisco ISD
City Center Health Careers
City View ISD
Clarendon ISD
Claude ISD
Clint ISD
Clyde CISD
Coahoma ISD
Coldspring-Oakhurst CISD
Coleman ISD
Colmesneil ISD
Colorado ISD
Comanche ISD
Comfort ISD
Compass Academy Charter School
Comstock ISD
Cotton Center ISD
Cotulla ISD
Crane ISD
Crockett County Consolidated CSD
Crockett ISD
Crosbyton CISD
Cross Plains ISD
Cross Roads ISD
Crowell ISD
Crystal City ISD
Culberson County-Allamoore ISD
Dalhart ISD
Danbury ISD
Darrouzett ISD
Dawson ISD
De Leon ISD
Denton ISD
Denver City ISD
Devine ISD
Deweyville ISD
D'Hanis ISD
Dilley ISD
Dime Box ISD
Dimmitt ISD
Divide ISD
Doss Consolidated CSD
Dumas ISD
Eagle Pass ISD
Early ISD
East Central ISD
Eastland ISD
Eden CISD
Edgewood ISD
Ehrhart School
Eleanor Kolitz Hebrew Language Academy
Electra ISD
Etoile ISD
Eula ISD
Evadale ISD
Falls City ISD
Farwell ISD
Fayetteville ISD
Flatonia ISD
Floresville ISD
Floydada ISD
Follett ISD
Forsan ISD
Fort Elliott CISD
Fort Stockton ISD
Frankston ISD
Fredericksburg ISD
Frenship ISD
Friona ISD
Fort Davis ISD
Fort Sam Houston ISD
Gause ISD
George Gervin Academy
Giddings ISD
Glasscock County ISD
Gold Burg ISD
Gonzales ISD
Good Shephard Network
Goodrich ISD
Gorman ISD
Grady ISD
Grandfalls-Royalty ISD
Grandview-Hopkins ISD
Granger ISD
Grape Creek ISD
Grapeland ISD
Great Hearts Texas
Greenwood ISD
Groom ISD
Groveton ISD
Gruver ISD
Gustine ISD
Hale Center ISD
Hamlin ISD
Happy ISD
Hardin-Jefferson ISD
Harlandale ISD
Harmony Science Academy (San Antonio)
Harper ISD
Harrold ISD
Hart ISD
Hartley ISD
Haskell CISD
Hawley ISD
Hedley ISD
Henrietta ISD
Henry Ford Academy Alameda School
Hereford ISD
Hermleigh ISD
Higgins ISD
Higgs Carter King Gifted & Talented
Highland ISD
Highland Park ISD
Holliday ISD
Holy Cross
Hondo ISD
Hunt ISD
Idalou ISD
Ingram ISD
Iowa Park CISD
Ira ISD
Iraan-Sheffield ISD
Irion County ISD
Jacksboro ISD
Jarrell ISD
Jim Ned CISD
John H. Wood Jr. Public Charter District
Johnson City ISD
Jourdanton ISD
Jubille Academic Center
Judson ISD
Kelton ISD
Kennard ISD
Kermit ISD
Kerrville ISD
Kinkaid School
Kipp San Antonio
Kirbyville CISD
Klondike ISD
Knippa ISD
Knox City-O'Brien CISD
Kountze ISD
Kress ISD
La Grange ISD
La Pryor ISD
La Vernia ISD
Lackland ISD
Lake Travis ISD
Lamesa ISD
Laneville ISD
Lapoynor ISD
Latexo ISD
Lazbuddie ISD

AFFILIATED ORGANIZATIONS (CONTINUED)

Leakey ISD
Lefors ISD
Leggett ISD
Leon ISD
Levelland ISD
Leveretts Chapel ISD
Lexington ISD
Liberty Hill ISD
Lighthouse Charter School
Littlefield ISD
Lockhart ISD
Lockney ISD
Loop ISD
Loraine ISD
Lorenzo ISD
Lovelady ISD
Lubbock ISD
Lubbock-Cooper ISD
Lueders-Avoca ISD
Luling ISD
Lytle ISD
Madisonville CISD
Malakoff ISD
Marathon ISD
Marfa ISD
Martins Mill ISD
Mason ISD
May ISD
Mccamey ISD
Mcdade ISD
Mclean ISD
Meadow ISD
Meadowland Charter School
Medina ISD
Medina Valley ISD
Memphis ISD
Menard ISD
Merkel ISD
Meyersville ISD
Miami ISD
Midland Academy Charter School
Midway ISD
Milano ISD
Miles ISD
Monahans-Wickett-Pyote ISD
Montague ISD
Montesorri of San Antonio
Moran ISD
Morton ISD
Mount Enterprise ISD
Muleshoe ISD
Munday CISD
Murchison ISD
Natalia ISD
Navarro ISD
Navasota ISD
Nazareth ISD
Neches ISD
New Braunfels ISD
New Deal ISD
New Frontiers Public Schools Inc
New Home ISD
Newcastle ISD
Newton ISD
Nixon-Smiley CISD
Nocona ISD
Normangee ISD
North East ISD
Northside ISD
Northside ISD
Nueces Canyon CISD
Nursery ISD
O'Donnell ISD
Olfen ISD
Olney ISD
Olton ISD
Onalaska ISD
Orangefield ISD
Overton ISD
Paint Creek ISD
Paint Rock ISD
Pampa ISD
Panhandle ISD
Panther Creek CISD
Patton Springs
Pearland ISD
Pearsall ISD
Pecos-Barstow-Toyah ISD
Perrin-Whitt CISD
Petersburg ISD
Petrolia CISD
Plains ISD
Plainview ISD
Pleasanton ISD
Plemons-Stinnett-Phillips CISD
Por Vida Academy
Port Arthur ISD
Positive Solutions Charter School
Post ISD
Poteet ISD
Poth ISD
Prairie Lea ISD
Prairie Valley ISD
Presidio ISD
Pringle-Morse CISD
Quanah ISD
Radiance Academy of Learning
Ralls ISD
Randolph Field ISD
Ranger ISD
Rankin ISD
Raven School
Reagan County ISD
Richards ISD
Richland Springs ISD
Rising Star ISD
River Road ISD
Robert Lee ISD
Roby CISD
Rochelle ISD
Rockdale ISD
Rocksprings ISD
Roosevelt ISD
Roscoe Collegiate ISD
Rotan ISD
Round Rock ISD
Round Top-Carmine ISD
Rule ISD
Runge ISD
Sabinal ISD
Sabine ISD
Sabine Pass ISD
Saint Jo ISD
San Antonio ISD
San Antonio Preparatory Academy
San Antonio School for Inquiry & Creativity
San Antonio Technology Academy
San Isidro ISD
San Perlita ISD
San Saba ISD
San Vicente ISD
Sands CISD
Sanford-Fritch ISD
Santa Anna ISD
Santa Maria ISD
Santa Rosa ISD
Schertz-Cibolo-U City ISD
Schleicher ISD
School of Excellence in Education
School of Science & Technology
School of Science & Technology Discovery
Schulenburg ISD
Seagraves ISD
Seminole ISD
Seymour ISD
Shallowater ISD
Shamrock ISD
Shekinah Radiance Academy
Shepherd ISD
Shiner ISD

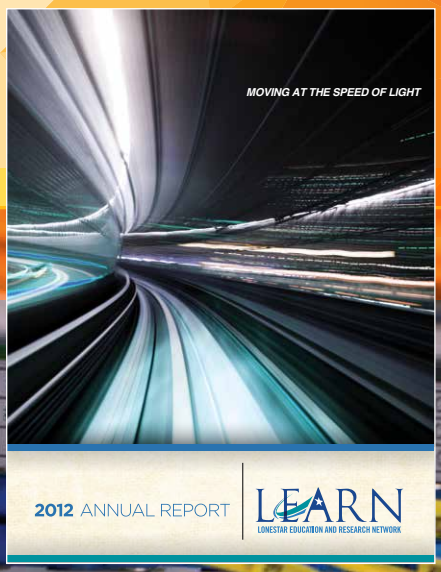
Sidney ISD
Silverton ISD
Slaton ISD
Smyer ISD
Snyder ISD
Somerset ISD
Sonora ISD
South Plains Academy Charter District
South San Antonio ISD
Southland ISD
Southside ISD
Southwest ISD
Southwest Preparatory School
Spearman ISD
Spring Creek ISD
Spring Hill ISD
Springlake-Earth ISD
Spurger ISD
St Francis De Sales Catholic School
Stamford ISD
Stanton ISD
Sterling City ISD
Stockdale ISD
Strake Jesuit College Preparatory
Stratford ISD
Sudan ISD
Sundown ISD
Sunray ISD
Sweet Home ISD
Sweetwater ISD
Tahoka ISD
Terlingua ISD
Terrell County ISD
Texas Leadership
Texas School for The Blind & Visually Impaired
Texhoma ISD
Texline ISD
Thorndale ISD
Thrall ISD
Trent ISD
Trinidad ISD
Tulia ISD
Utopia ISD
Uvalde CISD
Valentine ISD
Vega ISD
Veribest ISD
Vernon ISD
Victoria ISD
Vidor ISD
Vysehrad ISD
Waelder ISD
Walcott ISD
Wall ISD
Warren ISD
Water Valley ISD
Wellington ISD
Wellman-Union CISD
Wells ISD
West Orange-Cove CISD
West Rusk County Consolidated ISD
Westbrook ISD
Westhoff ISD
Wheeler ISD
White Deer ISD
Whitharral ISD
Wichita Falls ISD
Wildorado ISD
Wilson ISD
Wimberley ISD
Windthorst ISD
Wink-Loving ISD
Woodson ISD
Woodville ISD
Wylie ISD
Zephyr ISD

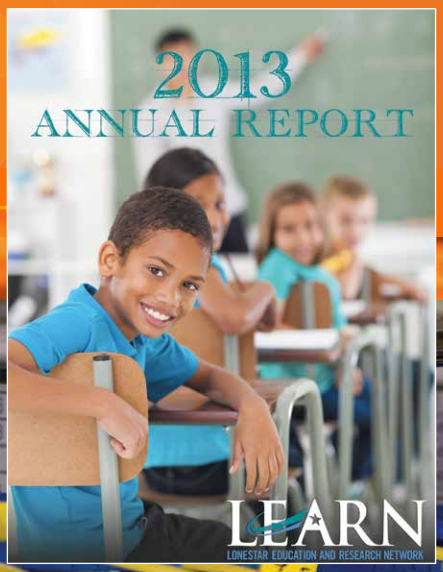
UNIVERSITIES

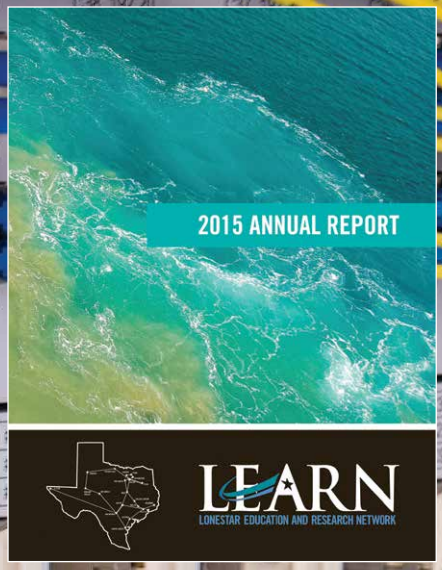
Sul Ross State University
Sul Ross State University Rio Grande College
Tarleton State University
Texas A&M International University
Texas A&M University at Commerce
Texas A&M University at Galveston
Texas A&M University Central Texas
Texas A&M University Kingsville
Texas A&M University San Antonio
Texas A&M University Texarkana
University of Houston Clear Lake
University of Houston Downtown
University of Houston Victoria
University of North Texas at Dallas
University of North Texas Health Science Center
University of Texas at Tyler
University of Texas HSC at Tyler
West Texas A&M
University of Texas Permian Basin

OTHER

Alamo Area Council of Governments
Brazos Valley Affordable Housing
Brazos Valley Council of Governments (BVCOG)/ Workforce Solutions
Brazos Valley Council on Alcohol & Substance Abuse
Brazos Valley Small Business Development Council
Bryan/College Station Chamber of Commerce
Citizen's Medical Center - Victoria
City of Austin Info. Services
Duncanville Public Library
Guadalupe Valley Hospital
Houston Methodist Hospital
Houston Metro
Lower Colorado River Authority
Mesquite Public Library
Mission Hospital
Newton County Library
NOAA
Orange County
Parkland Memorial Hospital
Project Unity
Texas Agrilife Extension Service
Texas Agrilife Research
Texas Children's Hospital
Texas Engineering Experiment Station
Texas Engineering Extension Service
Texas Forest Service
Texas Transportation Institute
Texas Vet. Diagnostic Lab
The Houston Museum of Natural Science
Travis County
University Medical Center
Washington County
Wharton County Library







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LONESTAR EDUCATION AND RESEARCH NETWORK

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