Title
McLennan Community College Requirements Analysis Report

Authors
Zurawski, Jason
Meade, Brenna

Publication Date
2022-07-12

Peer reviewed

McLennan Community College Requirements Analysis Report

July 12th, 2022

Disclaimer

McLennan Community College Requirements Analysis Report

July 12th, 2022

The Engagement and Performance Operations Center (EPOC) is supported by the National Science Foundation under Grant No. 1826994.

ESnet is funded by the U.S. Department of Energy, Office of Science, Office of Advanced Scientific Computing Research. Carol Hawk is the ESnet Program Manager.

ESnet is operated by Lawrence Berkeley National Laboratory, which is operated by the University of California for the U.S. Department of Energy under contract DE-AC02-05CH11231.

This is a University of California, Publication Management System report number LBNL-2001467[1].

[1] https://escholarship.org/uc/item/3j40h3cs

Participants & Contributors

April Andreas, MCC Department of Engineering
Noah Daly, MCC Information Systems and Services
Byron Hicks, LEARN
Mario Leal, MCC Information Systems and Services
Jeremy McCormick, MCC Department of Computer and Information Systems (CIS)
Brenna Meade, Indiana University
Amy Shultz, LEARN
Paulina Sidwell, MCC Department of Engineering
Jason Zurawski, ESnet

Report Editors

Brenna Meade, Indiana University: meadeb@iu.edu
Jason Zurawski, ESnet: zurawski@es.net

Contents

1 Executive Summary

Deep Dive Review Purpose and Process

EPOC uses the Deep Dive process to discuss and analyze current and planned science, research, or education activities and the anticipated data output of a particular use case, site, or project to help inform the strategic planning of a campus or regional networking environment. This includes understanding future needs related to network operations, network capacity upgrades, and other technological service investments. A Deep Dive comprehensively surveys major research stakeholders' plans and processes in order to investigate data management requirements over the next 5–10 years. Questions crafted to explore this space include the following:

- How, and where, will new data be analyzed and used?
- How will the process of doing science change over the next 5–10 years?
- How will changes to the underlying hardware and software technologies influence scientific discovery?

Deep Dives help ensure that key stakeholders have a common understanding of the issues and the actions that a campus or regional network may need to undertake to offer solutions. The EPOC team leads the effort and relies on collaboration with the hosting site or network, and other affiliated entities that participate in the process. EPOC organizes, convenes, executes, and shares the outcomes of the review with all stakeholders.

This Review

In March of 2022, staff members from the Engagement and Performance Operations Center (EPOC) met with researchers and staff from LEARN and McLennan Community College (MCC) for the purpose of a Deep Dive into scientific and research drivers. The goal of this activity was to help characterize the requirements for a number of campus use cases, and to enable cyberinfrastructure support staff to better understand the needs of the researchers within the community.

This review includes case studies from the following campus stakeholder groups:

- Department of Computer Science
- Department of Engineering
- Campus Information Technology

Material for this event included the written documentation from each of the profiled research areas, documentation about the current state of technology support, and a write-up of the discussion that took place via e-mail and video conferencing.

The case studies highlighted the ongoing challenges and opportunities that McLennan Community College has in supporting a cross-section of established and emerging research use cases. Each case study mentioned unique challenges which were summarized into common needs.

The review produced several important findings and recommendations from the case studies and subsequent virtual conversations:

- McLennan Community College has programs that must adapt to changes from the fields they support. As such, Information Technology must constantly adapt to the changes to curriculum and workforce needs.

- McLennan Community College has programs that are integrated with the local community, and collaborates closely with industrial and educational partners.

- McLennan Community College's Department of Computer Science is pursuing grant opportunities that will require support from Information Technology: in particular understanding ways to safely operate networking and security related research projects.

- McLennan Community College's Departments have a heavy reliance on several software packages for the process of education and research. Pursuing options to ensure access to this software is important for the success of several programs.

- McLennan Community College has several programs that encourage student research with members of the community; these efforts are important for growing a prepared workforce.

- McLennan Community College does not have extensive data mobility requirements, but does need ways to provide for, and encourage, use of cloud-based storage solutions. Several have been used over the years and moving towards a unified solution will encourage adoption and scalability.

- McLennan Community College will continue to explore ways to securely operate in an era where remote access for students and faculty are becoming more common.

- McLennan Community College Information Technology will continue to explore ways to grow their workforce, and eliminate knowledge silos.

- McLennan Community College, in collaboration with LEARN, will explore new ways to increase connectivity and collaboration with other community partners.

2 Deep Dive Findings & Recommendations

The deep dive process helps to identify important facts and opportunities from the profiled use cases. The following outlines a set of findings from the McLennan Community College Deep Dive that summarize important information gathered during the discussions surrounding case studies, and possible ways that could improve the CI support posture for the campus:

- The McLennan Community College Department of Computer Science use case must constantly adapt to changes in the field in order to offer a practical educational experience. They work with a number of external parties to ensure that their offerings match what is desirable in the workforce. This includes advisory boards of technical experts and the Waco business community.

- The McLennan Community College Department of Computer Science use case regularly teaches topics that are not easy to support in the McLennan environment. These include accessing websites that may be blocked due to their location in a foreign country, or contain content that is dangerous from a cybersecurity perspective.

- The McLennan Community College Department of Computer Science use case is about to start a joint funded activity with members of the Waco community (local technical companies, Baylor University) that will require support from the IT department and LEARN. The requirements are still being developed, but could include networking support.

- The McLennan Community College Department of Computer Science use case relies heavily on the CompTIA platform for educational and certification reasons.

- The McLennan Community College Department of Computer Science use case has constructed an on-site 'cyber range' that melds the practical experience of building a network infrastructure, along with being able to run simulations that address common cybersecurity risks and mitigations.

- The McLennan Community College Department of Computer Science cyber range uses a private network connection to facilitate the use case of being able to operate outside of enterprise network operational standards.

- The McLennan Community College Department of Computer Science use case is open to exploring the use of other public and private 'cyber ranges' that are operated within the R&E community.

- The McLennan Community College Department of Computer Science use case is a heavy downloader (TB scale) of content to support the R&E activities, but does not produce or share on a large scale.

- The McLennan Community College Department of Computer Science use case is open discussions regarding the operation of their cyber range, which may include: recommendations on monitoring software, best common practices for networking and server management, and ways the infrastructure can be expanded in the future.

- The McLennan Community College Department of Engineering use case has a primary educational focus on preparing students in engineering curricula for transfer to 4-year universities through a 2-year program of course work and practical experience. There are courses offered to address the requirements of 10 affiliated engineering programs.

- The McLennan Community College Department of Engineering use case must be aware of changes to the curricula that are instituted by the Texas Board of Higher Education. As such, the coursework can change to address these.

- The McLennan Community College Department of Engineering use case helps to facilitate student research projects with external entities. Some of these are partnerships with non-profits, industry, academia, and governmental agencies.

- The McLennan Community College Department of Engineering use case regularly uses a number of software packages as a part of education and research. These include CAD software packages, math and statistics modeling software, and GIS software.

- The McLennan Community College Department of Engineering use case reports that there can be friction when students have to share work for group assignments, or with faculty. Files produced by some of the software packages can be too large for the e-mail system. This results in students sharing via cloud services, or via external media.

- The McLennan Community College Department of Engineering use case reports that the largest data volumes they experience is with student projects in software packages. These can be on the order of MB now, but may increase in the future.

- The McLennan Community College Department of Engineering use case has had challenges with communication during the pandemic, and notes that some solutions work better than others. They welcome feedback on best common practices from the IT division on standardizing which tools can be used to support instant communication, video, document sharing, and calendaring.

- The McLennan Community College Department of Engineering use case reports that some faculty have had trouble in accessing campus resources from remote locations, particularly those that are abroad. This policy has resulted in challenges in trying to support some activities.

- The McLennan Community College Department of Engineering use case reports that some software packages they use are old, and may stop being supported on certain platforms in the future. They look forward to working with the IT division to understand what options may be available.

- The McLennan Community College Department of Engineering use case notes that not all students have access to technology at home, and rely heavily on the resources that campus provides. They would like to work with the IT Division to ensure they are resources (e.g., laptops, desktops, computer labs) that are available for student use into the future.

- The McLennan Community College Information Technology use case has experienced several workforce problems in recent years. The first is that some activities are heavily siloed to specific individuals, and the second is that the workforce has risks associated with knowledge loss due to departure of staff. Both of these can be rectified with more training, and reducing specializations.

- The McLennan Community College Information Technology use case has interest in exploring options related to backup strategies and disaster recovery, and can work with LEARN to facilitate options with either commercial entities, or other LEARN members.

- The McLennan Community College Information Technology use case continues to refresh hardware and software on campus to meet faculty and staff needs. There will be a focus to remove older technology, and replace it with new where applicable, as well as consolidating resources to fewer areas around campus to make it easier to support.

- The McLennan Community College Information Technology use case has multiple WAN providers, and would like to understand the best way to manage these from a policy standpoint. They will be looking to LEARN and EPOC for advice on best common practices.

- The McLennan Community College Information Technology use case can work with the CS/Cyber use case to better integrate student experiences by investigating ways to operationalize certain security tools and practices.

- The McLennan Community College Information Technology use case would like advice from LEARN and EPOC on best common practices for monitoring of networks.

- The McLennan Community College Information Technology use case will continue to work with faculty to understand requirements and reduce friction.

The following outlines a set of recommendations from the McLennan Community College Deep Dive is as follows:

- McLennan Community College Information Technology and Department of Computer Science will continue discussions about the right approach to allow use cases that exceed the risk tolerance of regular enterprise IT operations. This includes, but is not limited to: working to streamline the process used to request access to certain internet-based resources, putting in place protections and safeguards to protect the campus community without compromising the educational experience, incorporating student experience with operational security projects, and discussing ways the cyber-range can be efficiently operated, maintained and expanded.

- McLennan Community College Information Technology, Department of Computer Science, and LEARN will discuss the joint activity with Baylor University to understand the requirements, synergies, and ways cooperation will enable success.

- McLennan Community College Information Technology and Department of Computer Science will continue to collaborate on access to the CompTIA program given its critical role in education for the program.

- McLennan Community College Information Technology and Department of Computer Science will explore options for joint operation of the cyber-range. This will allow the Department of Computer Science program to focus on the educational requirements and drivers while outsourcing some of the operational duties of the network. This resource sharing will better utilize resources, and increase the utility of the infrastructure.

- McLennan Community College Information Technology and Department of Computer Science will explore the use of other community cyber-range resources as a way to augment the experience at McLennan.

- McLennan Community College Information Technology and Department of Computer Science will collaborate to document and create a network map of the cyber-range. This will assist with creating an operational security plan for the campus.

- McLennan Community College Information Technology and Department of Engineering will continue to research options for critical R&E software packages such as those that are used for CAD, mathematics, statistics, or GIS. This support could be assistance in acquiring commercial licenses, or suggestions on open source alternatives. LEARN can also assist if community members have experience or advice on certain packages. In particular, some software packages are aging and may require research to determine the most operationally prudent and secure way to operate these, or related versions, in the future.

- McLennan Community College Information Technology and Department of Engineering will continue to collaborate on student research activities on campus that require technological support. This may take the form of access to R&E software, supporting experimentation, or providing access to resources in collaboration with LEARN.

- McLennan Community College Information Technology and Department of Engineering will collaborate to understand the bottlenecks and limitations that students, faculty, and staff experience in sharing data with each other. This investigation should include recommending best common practices for use of cloud software, configurations and testing of local hardware and software, and working with LEARN to ensure WAN performance is sufficient.

- McLennan Community College Information Technology will recommend best common practices to faculty, staff, and students, in the form of documentation and direct help with respect to available software packages for common use cases (communication, document sharing) and workflows that will eliminate friction.

- McLennan Community College Information Technology and Faculty Representatives will collaborate on understanding use cases that require access to the internal university resources from potentially blocked external locations. This will involve auditing the risks, and putting in place sensible mitigations that allow accesses while still adhering to operational security requirements.

- McLennan Community College Information Technology will continue to investigate ways to upgrade campus resources to support students without access to technology off site. This will take the form of consolidating existing resources, and replacing those that are aging.

- McLennan Community College Information Technology, LEARN, and EPOC will explore ways to educate the McLennan workforce to prevent knowledge loss and creation of silos in future years.

- McLennan Community College Information Technology and LEARN will begin community-based conversations on DR and backup strategies. These can take the form of creating network paths between collaborating members, or fostering relationships with commercial entities.

- McLennan Community College Information Technology, LEARN, and EPOC will collaborate on future upgrades to campus connectivity, and ways that multiple WAN providers can be efficiently balanced to ensure failure and peak performance. Possible discussion topics include ways to manage routing protocols, use of advanced monitoring and measurement tools, and education for staff to ensure knowledge transfer.

- McLennan Community College Information Technology and LEARN will collaborate to make recommendations on campus operational needs, including automation for servers and networks, as well security and performance monitoring software options and best practices.

3 Process Overview and Summary

3.1 Campus-Wide Deep Dive Background

Over the last decade, the scientific community has experienced an unprecedented shift in the way research is performed and how discoveries are made. Highly sophisticated experimental instruments are creating massive datasets for diverse scientific communities and hold the potential for new insights that will have long-lasting impacts on society. However, scientists cannot make effective use of this data if they are unable to move, store, and analyze it.

The Engagement and Performance Operations Center (EPOC) uses the Deep Dives process as an essential tool as part of a holistic approach to understand end-to-end research data use. By considering the full end-to-end research data movement pipeline, EPOC is uniquely able to support collaborative science, allowing researchers to make the most effective use of shared data, computing, and storage resources to accelerate the discovery process.

EPOC supports five main activities

- Roadside Assistance via a coordinated Operations Center to resolve network performance problems with end-to-end data transfers reactively;
- Application Deep Dives to work more closely with application communities to understand full workflows for diverse research teams in order to evaluate bottlenecks and potential capacity issues;
- Network Analysis enabled by the NetSage monitoring suite to proactively discover and resolve performance issues;
- Provision of managed services via support through the Indiana University (IU) GlobalNOC and our Regional Network Partners; and
- Coordinated Training to ensure effective use of network tools and science support.

Whereas the Roadside Assistance portion of EPOC can be likened to calling someone for help when a car breaks down, the Deep Dive process offers an opportunity for broader understanding of the longer term needs of a researcher. The Deep Dive process aims to understand the full science pipeline for research teams and suggest alternative approaches for the scientists, local IT support, and national networking partners as relevant to achieve the long-term research goals via workflow analysis, storage/computational tuning, identification of network bottlenecks, etc.

The Deep Dive process is based on an almost 15-year practice used by ESnet to understand the growth requirements of Department of Energy (DOE) facilities[2]. The EPOC team adapted this approach to work with individual science groups through a set of structured data-centric conversations and questionnaires.

[2] https://fasterdata.es.net/science-dmz/science-and-network-requirements-review

3.2 Campus-Wide Deep Dive Structure

The Deep Dive process involves structured conversations between a research group and relevant IT professionals to understand at a broad level the goals of the research team and how their infrastructure needs are changing over time.

The researcher team representatives are asked to communicate and document their requirements in a case-study format that includes a data-centric narrative describing the science, instruments, and facilities currently used or anticipated for future programs; the advanced technology services needed; and how they can be used. Participants considered three timescales on the topics enumerated below: the near-term (immediately and up to two years in the future); the medium-term (two to five years in the future); and the long-term (greater than five years in the future).

The case study process tries to answer essential questions about the following aspects of a workflow:

- ***Research & Scientific Background***—an overview description of the site, facility, or collaboration described in the Case Study.
- ***Collaborators***—a list or description of key collaborators for the science or facility described in the Case Study (the list need not be exhaustive).
- ***Instruments and Facilities: Local & Non-Local***—a description of the network, compute, instruments, and storage resources used for the science collaboration/program/project, or a description of the resources made available to the facility users, or resources that users deploy at the facility or use at partner facilities.
- ***Process of Science***—a description of the way the instruments and facilities are used for knowledge discovery. Examples might include workflows, data analysis, data reduction, integration of experimental data with simulation data, etc.
- ***Computation & Storage Infrastructure: Local & Non-Local***—The infrastructure that is used to support analysis of research workflow needs: this may be local storage and computation, it may be private, it may be shared, or it may be public (commercial or non—commercial).
- ***Software Infrastructure***—a discussion focused on the software used in daily activities of the scientific process including tools that are used locally or remotely to manage data resources, facilitate the transfer of data sets from or to remote collaborators, or process the raw results into final and intermediate formats.
- ***Network and Data Architecture***—description of the network and/or data architecture for the science or facility. This is meant to understand how data moves in and out of the facility or laboratory focusing on local infrastructure configuration, bandwidth speed(s), hardware, etc.
- ***Resource Constraints***—non-exhaustive list of factors (external or internal) that will constrain scientific progress. This can be related to funding, personnel, technology, or process.
- ***Outstanding Issues***—Listing of any additional problems, questions, concerns, or comments not addressed in the aforementioned sections.

At a physical or virtual meeting, this documentation is walked through with the research team (and usually cyberinfrastructure or IT representatives for the organization or region), and an additional discussion takes place that may range beyond the scope of the original document. At the end of the interaction with the research team, the goal is to ensure that EPOC and the associated CI/IT staff have a solid understanding of the research, data movement, who's using what pieces, dependencies, and time frames involved in the Case Study, as well as additional related cyberinfrastructure needs and concerns at the organization. This enables the teams to identify possible bottlenecks or areas that may not scale in the coming years, and to pair research teams with existing resources that can be leveraged to more effectively reach their goals.

3.3 McLennan Community College Deep Dive Background

In March of 2022 EPOC organized a Deep Dive in collaboration with LEARN and McLennan Community College to characterize the requirements for several key science drivers. The representatives from each use case were asked to communicate and document their requirements in a case-study format. These included:

- Department of Computer Science
- Department of Engineering
- Campus Information Technology

3.4 Organizations Involved

The Engagement and Performance Operations Center (EPOC) was established in 2018 as a collaborative focal point for operational expertise and analysis and is jointly led by Indiana University (IU) and the Energy Sciences Network (ESnet). EPOC provides researchers with a holistic set of tools and services needed to debug performance issues and enable reliable and robust data transfers. By considering the full end-to-end data movement pipeline, EPOC is uniquely able to support collaborative science, allowing researchers to make the most effective use of shared data, computing, and storage resources to accelerate the discovery process.

The Energy Sciences Network (ESnet) is the primary provider of network connectivity for the U.S. Department of Energy (DOE) Office of Science (SC), the single largest supporter of basic research in the physical sciences in the United States. In support of the Office of Science programs, ESnet regularly updates and refreshes its understanding of the networking requirements of the instruments, facilities, scientists, and science programs that it serves. This focus has helped ESnet to be a highly successful enabler of scientific discovery for over 25 years.

Indiana University (IU) was founded in 1820 and is one of the state's leading research and educational institutions. Indiana University includes two main research campuses and six regional (primarily teaching) campuses. The Indiana University Office of the Vice President for Information Technology (OVPIT) and University Information Technology Services (UITS) are responsible for delivery of core information technology and cyberinfrastructure services and support.

Lonestar Education And Research Network (LEARN) is a consortium of 43 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 300 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 advance 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.

McLennan Community College (MC) Located in Waco, Texas, McLennan was established in 1965 by the citizens of McLennan County. McLennan was the first junior college in Texas to incorporate the word "community" in its name. For 50 years, McLennan has been serving Waco and the surrounding areas to help community members achieve their educational goals. MCC now serves about 9,000 students and has more than 700 employees. MCC offers two-year associate degrees in arts and sciences for students who want to transfer to four-year schools. The school also has training programs, two-year associate degrees in applied science and one-year certificates, for students who want to enter the workforce. The school also offers a diverse choice of continuing education courses for all community members.

4 McLennan Community College Case Studies

McLennan Community College presented a number of use cases during this review. These are as follows:

- Department of Computer Science
- Department of Engineering
- Campus Information Technology

Each of these Case Studies provides a glance at research activities, the use of experimental methods and devices, the reliance on technology, and the scope of collaborations. It is important to note that these views are primarily limited to current needs, with only occasional views into the event horizon for specific projects and needs into the future. Estimates on data volumes, technology needs, and external drivers are discussed where relevant.

4.1 McLennan Community College Department of Computer Science

Content in this section authored by Jeremy McCormick, Department of Computer and Information Systems (CIS).

4.1.1 Use Case Summary

The Department of Computer and Information Systems operates a substantial program that addresses cybersecurity concepts, through a mixture of theory and practical hands-on experience through the construction and operation of a yearly "cyber-range" activity.

Cybersecurity is a constantly evolving field of research, and MCC tries to stay ahead of requirements to prepare students for real-world job opportunities. Through several years of experience, the construction and operation of a real-world network, that can be used to evaluate and mitigate risks, has prepared a number of students for placement after they receive their degree. In practice the students will design, construct, and then operate a network environment and allows them a number of experiences in network design, server installation and operation, software development, measurement and monitoring, and security analysis.

4.1.2 Collaboration Space

MCC will be collaborating with Baylor University on an NSF grant to further advance the opportunities for students in the field of cybersecurity via internship, and joint course work on security, networking, and systems as a part of the degree program. There will be an effort to evaluate trends from industry, to make students more desirable after they complete the program.

MCC collaborates with Scinary[3], a cybersecurity firm based in Waco, on a program that offers internships. This interaction affords them the ability to listen and use suggestions to potentially alter the trajectory of the program.

Lastly, MCC seeks advice from an 'Industrial Board' from the Waco community that features local tech companies to guide some of the coursework. It is anticipated that the Baylor and MCC grant partnership will leverage a similar advisory board.

4.1.3 Instruments & Facilities

The MCC cyber-range consists of:

- Server, rack, patch panel "pods" that student teams are able to design, build, and operate
- 20 laptops for use during cyber exercises
- 20 Raspberry Pi machines for prototyping
- Older systems (PCs, Switches) that were used for A+ certification.
- Wireless routers that can be programmed and integrated

The entire system is segregated from the MCC network via an airgap, and has a different 10Gbps WAN connection. This was done to limit the exposure of the MCC network to

[3] https://www.scinary.com

some of the potentially risky behaviors that the cyber-range operates: investigation into banned web sites, software, and risks that may come about from virus, worm, and trojan behavior. The Department of Computer and Information Systems operates this separate network connection, and it does not integrate with MCC. Students can still access the MCC network through traditional Wi-Fi approaches. Future efforts may join this infrastructure with the Baylor "BRIC" technology center.

4.1.4 Data Narrative

Most, if not all, of the data generated by the cyber-range is KB to MB in size. There are occasions where larger downloads (e.g., GB) are required when downloading software packages. The cyber-range does not generate or store large amounts of telemetry data.

4.1.4.1 Data Volume & Frequency Analysis

Over the course of a year, it is possible that nearly a TB of data may be downloaded, but in practice this is software downloads of OSs/Apps which are then deleted after use. Other tools may produce output, and there is not a lot of external sharing currently (beyond the use of email or cloud sharing). In the general case, downloads occur weekly (MB to GB scales), and there is minimal activity out of class seasons.

4.1.4.2 Data Sensitivity

Current use cases do not have data sensitivity, but there is a possibility that future industrial partnerships may require some form of protection.

4.1.4.3 Future Data Volume & Frequency Analysis

Future data volumes are not expected to grow beyond the current estimates.

4.1.5 Technology Support

The Department of Computer and Information Systems operates the cyber-range independently of the Information Systems and Services Department. Having assistance to deal with some aspects of operation would be a consideration for the future.

4.1.5.1 Software Infrastructure

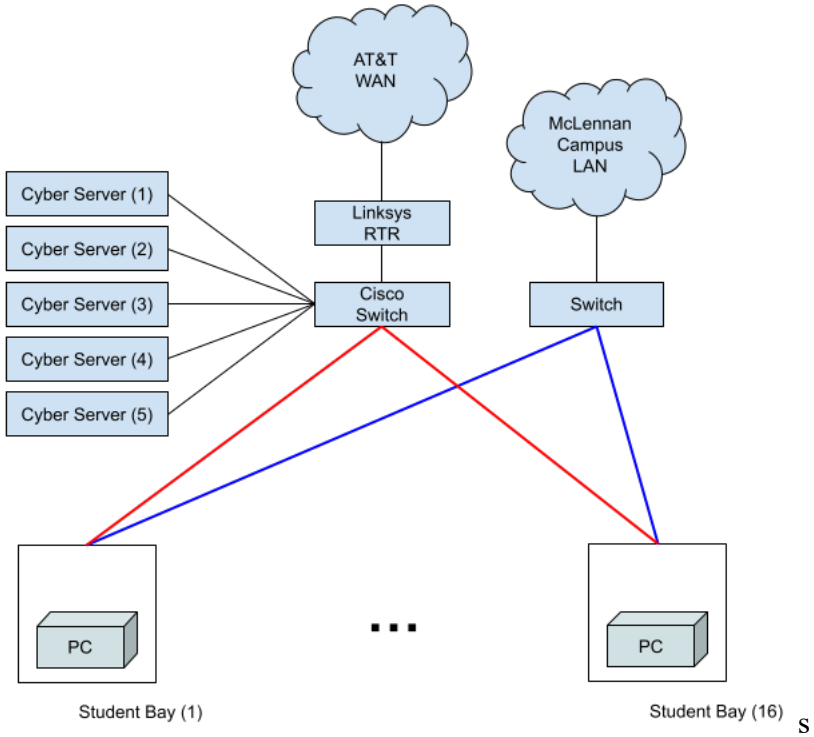
The major software requirement for the Department of Computer and Information Systems is an educational platform called "CompTIA". This is a cloud-based system that provides certification programs that are recognized by the technology industry in several fields (security, networking, and servers). The program used to use lots of independent approaches, but has adopted this as the primary way to manage certifications. In the general case, this fills the gap between theory and practice.

Additionally, the program uses:

- Linux Images
- MS Server Images
- Brightspace D2L (classroom)

The cyber-range does not have a centralized way to monitor the health of the network. They can consider use of Nagios, Solar Winds, or host-based sFlow.

4.1.5.2 Network Infrastructure



s

Figure 1 – Current McLennan Cyberange

The McLennan Cyberange consists of a rack of equipment for educational purposes, a dedicated WAN connection, and 16 student bays used during lessons and study activities:

- 5 servers used during course work
- 16 bays for education range –
- 2 internet connections (MCC and a private connection)
- Central Cisco Switch
- Linksys Router

4.1.5.3 Computation and Storage Infrastructure

There is no substantial computation or storage infrastructure in the cyber-range beyond the aforementioned servers.

4.1.5.4 Data Transfer Capabilities

This is not a critical need to explore at this time.

4.1.6 Internal & External Funding Sources

McLennan partners with Baylor University[4] on several cybersecurity related efforts.

[4] https://www.baylor.edu/mediacommunications/news.php?action=story&story=205251

4.1.7 Resource Constraints

The single greatest risk to the Department of Computer and Information Systems is the ongoing operation, and possible expansion, of the cyber-range. As this is operated by the department, it does not have many staff resources available for typically operational tasks; most of these fall on researchers, faculty, and students. As such, there is an opportunity to expand the use case:

- Measurement and monitoring infrastructure
- Unified approach to WAN connectivity
- Containerization of core functions
- Opportunities for students to work closely with professional IT staff

It is also possible that other public cyber-ranges could be considered:

- https://www.merit.edu/security/training/hubs/
- https://deter-project.org

In doing so, students will have more opportunities to learn and participate in national-scale efforts.

4.1.8 Ideal Data Architecture

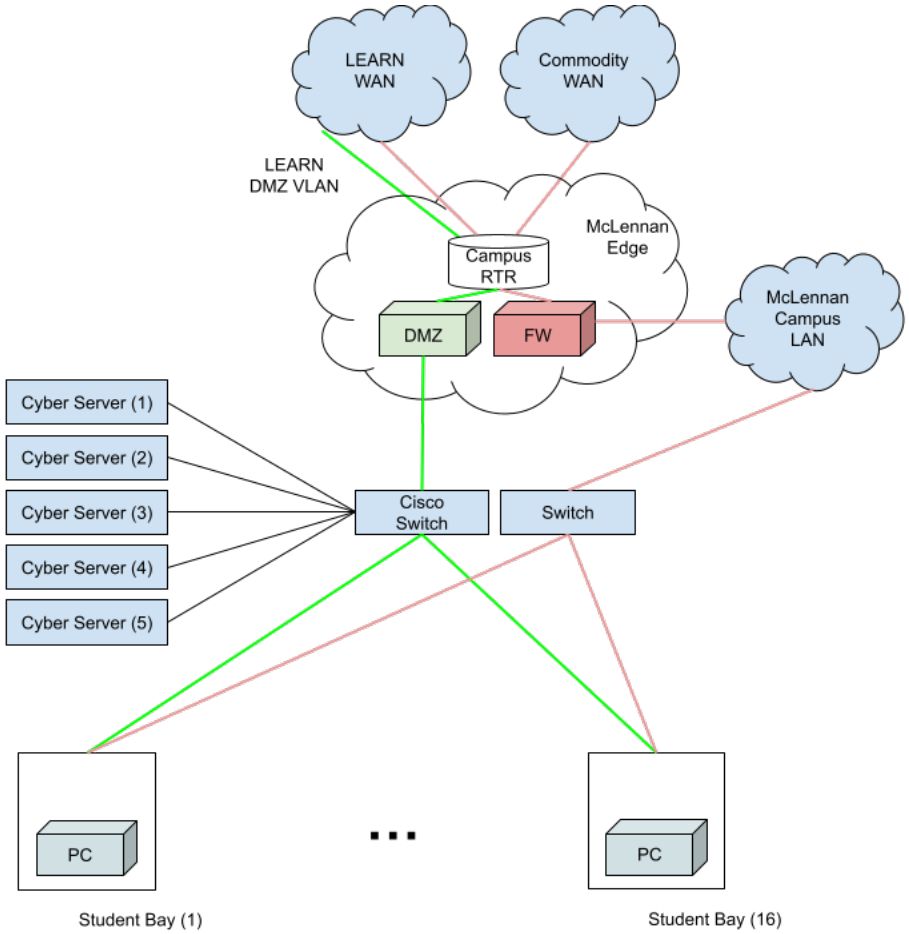


Figure 2 – Current McLennan Cyberange

To improve the overall operation of the McLennan Cyberange, it is recommended that a unified network architecture be designed that can leverage the capability of LEARN, while still allowing a flexible environment that facilitates education and research in concepts that may not fit the general risk profile of the campus. Figure 2 describes the proposed changes:

- Working with LEARN to enable access to the Science DMZ virtual network
- Splitting the LEARN connection at the McLennan border to handle the Science DMZ VLAN around the enterprise infrastructure's protections. It is noted that this step must be done with care, and additional security mitigations (e.g., an intrusion detection system, logging, and ACL filtering) are recommended.
- Ceasing to use the private WAN provider, but instead swapping in the use of the LEARN Science DMZ
- All other internal connectivity to student bays will be preserved.

4.1.9 Outstanding Issues

Forming a closer relationship with the Information Systems and Services Department will allow scalability of resources (physical and people-based). Currently an area of friction, and one of the reasons the cyber-range operates independently, is a mismatch of security risk and mitigation strategies for the enterprise versus the research use case. For example, the cyber-range often must access things that are blocked by the MCC enterprise risk profile (e.g., web sites, downloads that are a risk to the campus). Instead of requesting whitelisting, it was decided that a different network connection to outside world would better allow the use case to flourish. It is time to consider if this can be merged back, with sensible security considerations for both use cases.

4.2 McLennan Community College Department of Engineering

Content in this section authored by April Andreas and Paulina Sidwell from the Department of Engineering.

4.2.1 Use Case Summary

The MCC Department of Engineering serves as the starting point for 6 majors:

- Mechanical
- Electrical
- Civil
- Industrial
- Chemical
- Bio-Medical

The coursework is focused on delivering the core requirements for the first two years of these programs, and then facilitates a transfer to a 4-year university to complete the educational process. As a part of this, core components of the curriculum (basics of engineering, mathematics, sciences, etc.) are offered before students move on to other universities. MCC closely collaborates with other programs to ensure coursework is a useful stepping stone to prepare for degree completion. There are 10 core classes offered that adhere to the Texas state higher education board:

- Circuit Design & Laboratory
- Statics & Dynamics
- Introduction to Engineering
- Surveying
- Programming
- Digital systems
- Engineering Economics
- Mechanics of Materials
- Discrete Mathematics
- Differential Equations

4.2.2 Collaboration Space

The department itself does not collaborate closely with other entities. Beyond coursework, students routinely collaborate on research projects that are outside of the course structure, often with members of the Waco community. These projects are student-driven and temporary in nature. Many involve use of software and hardware resources to solve engineering problems. For example:

- A student participated in land survey work with the City of Waco to construct a parking lot, and learned to utilize GIS software
- A student worked to design components of an inter-planetary science mission in the Arizona desert

- A student partnered with the City of Waco to learn to use the NIST Augmented Reality Testing of Equipment in Multiple Immersive Simulations (ARTEMIS) environment for first responders.

In these cases, MCC serves as a conduit to make relationships and provides support if needed.

4.2.3 Instruments & Facilities

MCC Department of Engineering has access to several campus facilities:

- Maker Space (e.g., 3D printers)
- Laptop cart with 10 laptops (running engineering software)
- Digilent Analog Tool (e.g., Oscilloscope, logical analyzer).
- Campus Computer Labs

4.2.4 Data Narrative

The major data component for the MCC Department of Engineering is student created files from certain software packages. Some outputs (e.g., CAD files from SOLIDWORKS) can grow to large MB to small GB in size. Exchanging these between students can be challenging. Email has a limit on file sizes (e.g., less than 10MB), which means other exchange methods to share must be used.

Students have historically had access to on-campus resources (e.g., the 'Z' Drive, or 'L' Drive for faculty), but access was restricted to those on campus and storage space was limited. Most rely on cloud storage (personal Dropbox accounts, or institutional access to Microsoft OneDrive), which can be slow depending on how things are accessed.

4.2.4.1 Data Volume & Frequency Analysis

File sizes for student work, or videos of lectures, can be large MB to small GB in size. Due to the number of students and faculty, a frequency of weekly is the best way to describe sharing and posting activity.

4.2.4.2 Data Sensitivity

There are no sensitive aspects to the data.

4.2.4.3 Future Data Volume & Frequency Analysis

Future files and video output should not grow beyond the estimates of large MB to small GB in size. Frequency could increase.

4.2.5 Technology Support

The MCC Department of Engineering relies heavily on technology support from the campus. Software is a critical issue for coursework and research projects, as well as the campus hardware that supports the packages for students who do not have their own computers.

4.2.5.1 Software Infrastructure

There are several critical software packages within the MCC Department of Engineering:

- MATLAB - course work. Uses a limited seat (35) academic license.
- SOLIDWORKS - course work. Uses a limited seat (40-60) academic license and has to be renewed yearly.
    - This software is also used as a dual credit class in collaboration with local high school classes.
- AUTODESK CIVIL (3D) - course work. Typically used on campus, but can also be extended to student computers if needed. Limited use per term.
- PSPICE (for circuits design) - course work. Uses a freeware version.
    - This software package is legacy, and there are some challenges in making it compatible with Windows 10
- VHDL Language – course work. Uses a freeware version
- ARCGIS – research projects. Uses a limited seat (5) academic license.

The MCC Department of Engineering is also considering LabView for a number of use cases, but the cost may be a factor.

Faculty use several other packages:

- Camtasia (a screen recorder) for lesson recording
- Office 365 suite of tools. Specifically, migration to OneDrive, which will replace an aging SharePoint installation.
- There is a desire to have a better scheduling software for calendar management, Appointy or similar may help to better manage faculty time for office hours
- There is a desire to have chat software, either Slack or Teams (which may be available through Office 365 integration)

A last issue surrounding software is the desire to have access (through APIs) to student records. This would assist in creating custom reports per-student to guide the education and accreditation process.

4.2.5.2 Network Infrastructure

There are no special network infrastructure components to support this use case.

4.2.5.3 Computation and Storage Infrastructure

Beyond the use of campus computer labs and storage, there are no special computation or storage components to this use case.

4.2.5.4 Data Transfer Capabilities

A dominating issue for the campus is the use of cloud-provided storage, and performance that may be sub-optimal for some students. During busy parts of the day, uploads and downloads may suffer due to congestion. As the campus moves to off-prem storage, there will be communications published on the BCP surrounding how to share data effectively to facilitate collaboration.

4.2.6 Internal & External Funding Sources

The MCC Department of Engineering is base funded by MCC, and does not have external grants at this time.

4.2.7 Resource Constraints

The MCC Department of Engineering does require funding to be successful, as many of the course requirements hinge on software licenses, or hardware resources (computers, instruments, etc.). The department is working on a longer-term plan for faculty retention, hiring, equipment refresh, and work-study arrangements for students. The lack of funding to support coursework is not always a problem, but it does manifest in different ways. For example, the college was able to acquire a "Total Station" (tool used for survey and mapping) at a yard sale for a fraction of the cost of a new unit. Similarly, the relationship with the City of Waco often means that equipment can be passed down after it reaches the end of its usable operational life.

The department wants to invest in planning resources, and work closely with IT, to map out capital purchases for the coming years. It is suggested that MCC ISS form a committee with faculty representatives to better understand requirements and synergies for IT purchases.

4.2.8 Ideal Data Architecture

Beyond understanding how to better share data, and acquire different software packages, there are no additional data architecture components to discuss.

4.1.9 Outstanding Issues

Faculty have noted issues in accessing MCC resources (mail, records, etc.) when traveling internationally, even when trying to use a VPN. It was discovered that security policy blocked international locations from accessing the internal network. MCC faculty and staff are working out a mitigation to this to prevent the problem from occurring in the future by reviewing the security policy, and potentially offering off-prem solutions for access to some resources such as mail.

Some software packages are becoming older/unsupportable for new operating systems: PSPICE is the major concern due to its age and usefulness in the curricula. MCC ISS staff will work with MCC Department of Engineering to evaluate alternatives.

MCC staff will be working to update documentation to recommend the best tools for certain tasks as services are upgraded and retired. For instance, when Sharepoint is retired and OneDrive is the primary method to share/store files, there will be many communications offered on how to migrate and use the new resources effectively.

The MCC Department of Engineering does appreciate IT's commitment to help with software and hardware purchases, and looks forward to future interactions. Pandemic use of cameras, microphones, and laptops has been successful.

4.3 McLennan Community College Information Technology

Content in this section authored by Mario Leal, MCC Department of Information Systems and Services

4.3.1 Use Case Summary

The MCC Department of Information Systems and Services provides technology support to campus. There are approximately 75 forms of service offerings, which cover everything from printing to projecting to networking. The group is responsible for a centralized delivery of all technology support to all campus faculty, staff, and students.

4.3.2 Collaboration Space

MCC ISS collaborates heavily with LEARN, as well as with other entities within the Waco area (Baylor, City of Waco). There is also a relationship with the UT system, which provides backup DNS services, and could also serve as a DR backup facility.

4.3.3 Capabilities & Special Facilities

MCC has two satellite facilities that they support with certain aspects of the technology stack:

- Highlander Ranch, the location of the Veterinary Program. MCC ISS provides networking to this facility.
- Emergency Prep (e.g., Police, Fire, and Emergency Services Education Center [ESEC]). MCC ISS does run the network, but they are considered 'tenants' of the greater MCC infrastructure.

There are 37 computer labs around campus, each with approximately 50 machines. MCC ISS supports approximately 2600 devices total (including faculty resources). A major part of the budget goes to cycling through hardware, supporting software, and an effort to consolidate and improve services

4.3.4 Technology Narrative

MCC ISS provides all technology support for campus.

4.3.4.1 Network Infrastructure

MCC ISS maintains a 10Gbps connection to LEARN that is delivered via the LEARN PoP located in Waco at the Baylor University campus. This connection delivers several LEARN services:

- R&E Connection
- Commodity Internet
- Science DMZ
- DDoS Protection

The campus also maintains a 2Gbps commodity connection to the Grande/Astound Broadband provider. These connections are managed on a single Juniper MX104 (with 2 BGP peering relationships), dual Palo Alto 5220s as core firewalls, and a Cisco Catalyst 6500 as a core switch to distribute wired and wireless networking infrastructure. MCC

ISS does not maintain the AT&T connection that supports the Cyberange mentioned in Section 4.1.

4.3.4.2 Computation and Storage Infrastructure

MCC ISS maintains a VMWare ESxi installation that supports 120 VMs across 19 servers. This infrastructure features 4TB of RAM and 40TB of storage.

4.3.4.3 Network & Information Security

MCC ISS runs dual Palo Alto 5220s as core firewalls for the campus infrastructure. There have been discussions about ways that operation of these (or other related devices, e.g., IDSs) can be a part of lesson planning for the use case mentioned in Section 4.1.

4.3.4.4 Monitoring Infrastructure

MCC ISS runs Solarwinds, and has experimented with a perfSONAR installation. MCC would like to work more closely with LEARN to understand how perfSONAR can be integrated into campus operations.

4.3.4.5 Software Infrastructure

The campus has historically run a SharePoint installation, but is going to migrate to cloud services provided my Microsoft in the future.

Beyond the packages mentioned in Sections 4.1 and 4.2, there are no large-scale software projects beyond standard productivity tools on campus resources.

4.3.5 Organizational Structures & Engagement Strategies

MCC ISS is the sole technology provider, and is involved in discussions with all departments to ensure technology needs are being met.

4.3.5.1 Organizational Structure

The group consists of approximately 25 employees, and currently employees a model of specialty in specific areas. This has hurt scalability if an employee is unavailable (or departs the organization). A focus for the 2022 and beyond timeframe is to reduce silos within the organization, and move to a more "cross training" model.

4.3.5.2 Engagement Strategies

There are three primary mechanisms for engagement:

- Helpdesk: ticketing for any technology service from any student, staff, or faculty member
- CIO Advisement: The CIO offers advice on technology policy to campus leadership
- Faculty Councils: MCC ISS discusses budgets and needs with faculty representatives.

4.3.6 Internal & External Funding Sources

MCC ISS is base funded, but works closely with LEARN on projects and grant activities, such as the NSF funded "CC* Regional: Accelerating Research and Education at Small

Colleges in Texas via an Advanced Networking Ecosystem Using a Virtual LEARN Science DMZ"[5].

4.3.7 Resource Constraints

The primary constraint to MCC is economic, there is a fixed budget for technology support and a near constant need to keep things up to date.

A secondary concern is the size of the MCC ISS team to ensure coverage for operational needs, as well as future research requirements. The team will be looking for ways to reduce specialization and become more generally focused and sustainable.

4.3.8 Outstanding Issues

None to report, beyond what was mentioned in Sections 4.1 and 4.2.

[5] https://www.nsf.gov/awardsearch/showAward?AWD_ID=1925553

Appendix A – The Lonestar Education And Research Network (LEARN)

Introduction

The Lonestar Education And Research Network (LEARN) is a consortium of 43 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 300 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 advance 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.

LEARN's Mission

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

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.

Network Services

Members are entitled to appoint an individual to the Board of Directors and to acquire network services from LEARN at member rates. 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,
- Service Level Agreement (SLA) based Layer 2 connections to Cloud Service Providers (AWS, Google, & Azure),
- Routed Layer 3 IP Services,
- Connection Gateways to the National Research and Education Networks (Internet2 and Energy Sciences Network, and on 100G ramps to reach Pacific Wave International Exchanges),
- Seamless access to on-net data centers,

- Inter-POP Port aggregation & Co-location Services
- 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 healthcare 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, research institutions, healthcare, city and county governments, libraries and museums, and not-for-profits and public service entities. LEARN is a trusted partner and convener in these communities.

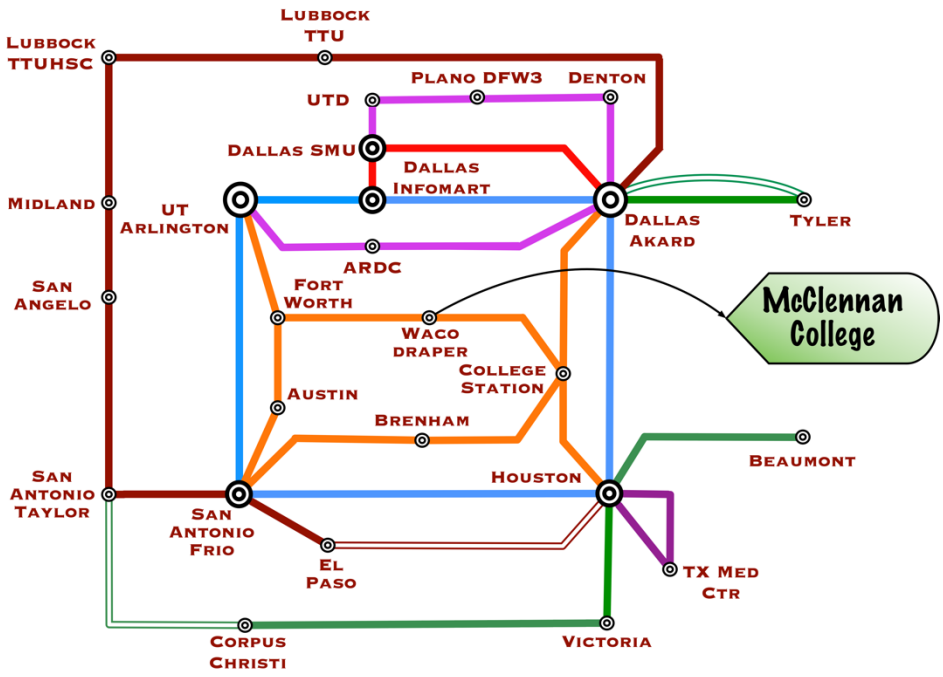


Figure 3: LEARN Connectivity Serving McClennan College

CC* Funding

In 2019, LEARN was awarded NSF Awards #1925553: "CC* Regional: Accelerating Research and Education at Small Colleges in Texas via an Advanced Networking Ecosystem Using a Virtual LEARN Science DMZ".

LEARN is partnering with national organizations in the implementation of this project. Projected impacts include increased opportunities for students to learn about and gain experience in advanced aspects of science, technology, engineering and mathematics (STEM) for which they might not otherwise have had an opportunity, for extension of the project to students and faculty at other campuses in Texas, and for the extension of the LEARN model to other regional networks and smaller campuses throughout the United States.

Objectives:

- Establish a small college collaborative environment within the LEARN community
- Improve network connectivity/services at each college campus for research and education
- Establish a network performance monitoring infrastructure
- Establish a means to facilitate the transfer of large data sets
- Deliver technical training to personnel at each campus
- Develop and implement an outreach program for informing/educating faculty, staff, and students at each college, and develop and disseminate project results