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Re-Constructing the Campus Cyberinfrastructure of a Small, Liberal Arts HBCU to Maximize Stem Innovation and Integration

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Abstract

Texas College is dedicated to enhancing connectivity and internet bandwidth to support advanced research and collaboration among students and faculty. The Network Management Plan ensures reliable connectivity and security for immersive learning experiences. This paper explores the transformative potential of Cyberinfrastructure at Texas College to reconstruct campus cyberinfrastructure (CC*) through a planning project. This strategy is based on three different layers. The first layer becomes that of planning how to reconfigure the design of the curriculum to include more Science, Technology, Engineering, Arts, and Mathematics. The Second task for open admission liberal arts college involves planning how to advance STEM knowledge among openly admitted students so that STEM knowledge is not diluted in its integration with liberal arts subject matter. The Third part of such an effort is infrastructural for HBCU to determine how they can better serve the goal of the institution. This involves upgrading infrastructure with fiber optic and Cat6 cabling for high-performance networks. Integrating STEM with liberal arts disciplines aims to cultivate valuable skills in students like analytical thinking, problem solving, communication, a daptability innovation & creativity. Texas College CC* Planning grant emphasizes cyber networking excellence in STEM education, shaping the future of HBCUs and STEM professionals.

Subject Areas

Applications for Communication Systems

Keywords

Cyberinfrastructure, Campus Cyberinfrastructure, STEM/STEAM Education, Data Integration, Cybersecurity, Data-Driven Network, HBCUs

1. Introduction

Reconstructing cyber infrastructure is essential for every sector in educational, research, and institutional environments. It is not just a technical upgrade, it is a strategic step to better access and equity, enhanced security and threat resilience, support for modern technological demands, compliance with regulations and standards, enablement of innovation and collaboration, support for remote and hybrid learning, future-readiness, as well as increases participation in STEM (Science, Technology, Engineering, and Mathematics) environments [1]. The demand for STEM/ STEAM (STEM with the addition of Arts) skilled workforce is rising rapidly and an evolving global economy [2]. Historically, Black Colleges and Universities (HBCUs) have held the distinctive status of being the only institutions in the United States that have explicitly provided educational opportunities for Black Americans [3]. The integration of STEM and STEAM education within Historically Black Colleges and Universities (HBCUs) represents a significant opportunity to advance educational equity and excellence. As the US continues to confront the challenges of the 21st century, advanced cyberinfrastructure, computational systems, data storage capabilities, and high-speed networks have emerged as a transformative force in the realm of scientific research and education. The STEM approach with its strong emphasis on technology and engineering disciplines, offers students an interdisciplinary perspective, allows students to apply theoretical knowledge in practical settings and also ensures its implementation, so it is particularly significant in the era of information technology and communication [4]-[6]. Advanced cyberinfrastructure provides the backbone for innovative pedagogical approaches enabling hands-on experiential learning essential for mastering complex STEM concepts. STEM has contributed to many disciplines and practices that continue to develop information technology, communications, and new applications from the creative interactions between computer science and other fields [7].

In the United States, the integration of technology into education has revolutionized learning STEM subjects like Science, Technology, Engineering, and Mathematics. Cyberinfrastructure in the context of STEM education encompasses a broad spectrum of technologies and platforms designed to enhance teaching and learning experiences. From high-performance computing resources to virtual classrooms and research laboratories, CI empowers educators to transcend traditional classroom boundaries, offering students access to an unparalleled wealth of knowledge and opportunities for hands-on learning experiences. In the new era of teaching and learning, cyberinfrastructure is vital for shaping STEM/Liberal Arts education in the United States. Expanding global collaborations through cyberinfrastructure can lead to more diverse and inclusive educational experiences. By leveraging international networks, students and researchers can access a wider range of resources and expertise, fostering a more global perspective in STEM education [8]. It has an impact on curriculum development, access to resources, collaborative learning environments, and the cultivation of critical skills essential for success in

the 21st-century workforce. It has become an immediate priority to train the next generation of STEM professionals and their capabilities for professional, real-life applications, education, and research [2].

Cyberinfrastructure has emerged as a critical factor shaping America due to its significant economic, social, and national impact. Over the past twenty years, scientists across all STEM fields have experienced tremendous growth in the use of cyberinfrastructure as a research tool. Universities are increasingly integrating this infrastructure and its applications into the core of scientific education [9]. HBCUs have been pivotal in advancing STEM education among underrepresented groups, contributing significantly to the diversity of the STEM workforce. However, many of these institutions struggle with outdated technological frameworks that disrupt their ability to offer cutting-edge STEM programs. Cyberinfrastructure facilitates seamless collaboration among individuals at different institutions, including underdeveloped research institutes. These platforms empower junior scientists and students to engage as equals, irrespective of age, experience, race, or physical ability. They enrich science and engineering education by providing valuable resources, experience and expert mentorship. The expansion of broadband networks in schools enables students and teachers to utilize sophisticated multimedia resources, thereby enhancing education across all disciplines and institutions [10].

Cyberinfrastructure (CI) stands as a cornerstone in the advancement of STEM education particularly within historically black colleges and universities (HBCUs). Texas College, with its rich legacy dating back to 1894 in Tyler, Texas, embodies the spirit of educational excellence and community enrichment. Texas College offers a wide range of undergraduate programs in the arts and humanities, social sciences, natural sciences, business, and education. The college is dedicated to delivering a comprehensive education that prepares students with the skills and knowledge needed to succeed in today's rapidly changing world. In this context, the integration of cyberinfrastructure holds significant promise for elevating STEM and liberal arts education at institutions like Texas College. Recognizing this potential, Texas College has actively engaged in CI-based efforts to enhance STEM education, supported by a $100,000 planning grant from the National Science Foundation (NSF). This grant serves as a catalyst for the assessment and design of a new campus cyberinfrastructure aimed at meeting critical objectives for STEM innovation and integration. By examining the current state of cyberinfrastructure in Texas College, our NSF-funded CC* project team identifies critical gaps and proposes strategic solutions to the unique needs of this institution. Through assessment, careful selection of technical equipment, and innovative approaches, this study of the CC* project aims to provide a comprehensive framework for Texas College to develop resilient, state-of-the-art campus cyberinfrastructure to integrate STEM/STEAM education. So that Texas College as a HBCU can produce talented and diverse STEM graduates who are well-equipped to meet the demands of the nation.

Therefore, the project sets out concrete objectives to 1) upgrade the campus backbone to a resilient 10 Gbps fiber/Cat6 network with scalable pathways toward 100 Gbps to ensure long-term sustainability; 2) deploy advanced cybersecurity and network management frameworks that align with best-practice standards; 3) establish dedicated cyberinfrastructure support for integrated STEM/STEAM teaching and research. The expected deliverables include measurable improvements in network performance (≥9.5 Gbps sustained throughput, <5 ms latency across campus segments), faculty adoption of more new data-intensive research or instructional applications within a few years, and student participation benchmarks of ≥70% of STEM majors leveraging the modernized infrastructure for coursework or research activities. These outcomes will provide a foundation for expanding collaborative research, enhancing digital equity at the HBCU, and improving student learning outcomes across disciplines.

The remainder of this article is organized as follows. Section 2 describes the methodological approach used to assess current assets, identify performance gaps, and plan targeted infrastructure upgrades. Section 3 reviews the existing network environment and its limitations for supporting advanced instructional and research activities. Section 4 analyzes the alignment of the upgraded network with integrated STEM/STEAM curricula and demonstrates its instructional and research applications. Section 5 examines the role of cyberinfrastructure resources in supporting STEM and Liberal Arts curricula, with attention to enhancing teaching, experiential learning, and cross-disciplinary engagement. Section 6 discusses the importance of building a cyberinfrastructure grounded in regional connectivity, highlighting how external partnerships and shared resources extend institutional capacity. Section 7 addresses cybersecurity planning at Texas College, emphasizing resilience, data protection, and alignment with national best practices. Section 8 outlines the proposed cyberinfrastructure upgrades, with emphasis on 10 Gbps fiber/Cat6 backbones, enterprise network management, and scalability toward 100 Gbps. Section 9 presents projected impacts in terms of performance improvements, faculty adoption, and student participation. Finally, Section 10 concludes with implications for institutional growth, regional collaboration, and broader HBCU capacity building.

2. Methods

To ensure a representative and mission-driven approach, four academic Divisions at Texas College were objectively selected for this study: the Division of Natural and Computational Sciences, the Division of Education, the Division of Business and Social Sciences, and the Division of General Studies and Humanities. These units were chosen because of their established TC community service programs, which position them as the first line of teaching and research personnel employing online tools and internet resources for student learning and scholarly activity.

Within these Divisions, participants included Division Chairs, Program Coordinators, faculty members from major programs, research faculty, the Dean of

Academic Affairs, Information Technology, and library personnel. This group was selected not only for their central role in instructional delivery but also for their extensive knowledge and practice aligned with the College's community service mission, making them particularly well-suited to evaluate the needs for upgrading the campus cyberinfrastructure.

Data collection was conducted through multiple complementary methods. First, face-to-face semi-structured interviews were carried out with research participants to capture detailed insights into current practices and infrastructure needs. Second, surveys were distributed across divisions to obtain broader input and quantify faculty and staff perspectives. Third, institutional inventory tools and documentation were reviewed to establish a baseline of existing network assets and resources. Together, these methods provided a triangulated dataset that informed the assessment of current capacity and the formulation of recommendations for cyberinfrastructure modernization.

3. Cyberinfrastructure at Texas College

Cyberinfrastructure plays a crucial role in advancing STEM education, particularly in historically black colleges and universities. Texas College is an HBCU that has been a cornerstone of education and community enrichment since its founding in 1894 in Tyler, Texas. Texas College offers a diverse range of undergraduate programs across various disciplines, including arts and humanities, education, social sciences, business, natural and computational sciences. The college's curriculum is designed to provide students with a well-rounded education that prepares them for success in their chosen fields and equips them with the skills and knowledge needed to thrive in today's rapidly evolving society. Cyberinfrastructure holds great promise for advancing STEM/Liberal Arts education at HBCUs like Texas College, empowering students and faculty to engage in advanced research, innovation, and collaboration. Texas College has been actively engaged in CI-based efforts to improve STEM education and has been funded with $100,000 for a planning project by the National Science Foundation to enhance its campus cyberinfrastructure. This grant is used to assess and design a newer Campus Cyberinfrastructure so that a number of critical objectives can be met for STEM innovation and integration. In order to establish and accomplish this task, Texas College is now changing its Campus Cyberinfrastructure with the capacity (internet speed from 1.0 to 10.0 Gbps) to capture data on every component of our operations from the recruitment of students to the calculation of services that will be needed to prepare our students for success in STEM with inclusion of Liberal Arts courses.

In the rapidly evolving education system, having a robust and reliable cyberinfrastructure is crucial for the success of academic institutions like Texas College. Two key components of this infrastructure are fiber optic and Cat6 cabling systems for network connectivity. Currently, Texas College has single-mode fiber optic cables installed as our backbone cable that connects Main Distribution Frame

(MDF) in Martin Hall building to Independent Distribution Frame (LDF) in other buildings. Our fiber cable offers speeds that exceed 10 Gbps to 100 Gbps. Thus, fiber optic cabling offers several advantages for high-performance networks such as High Bandwidth, Low Latency and Security.

Cat5 and Cat6 Ethernet cables connect campus computers, printers and other devices to our Local Area Network (LAN). Cat5 and Cat6 Ethernet cables are also used to connect network switches to patch panels in our network closets. Currently most of the buildings on our campus still have Cat5e cables. Our current Cat5e cables offer speeds of up to 1000 Mbps, a bandwidth of 100 MHz with less noise. Cat6 cable offers speeds of up to 10 Gbps and 250 MHz of bandwidth. Currently Gilmore Hartley dormitory is the only building that has Cat6 cables. Cat6 cabling remains a popular choice for LANs due to its various benefits such as Gigabit Ethernet Support, Enhanced Performance, higher volume data transfer, higher internet speed, and Futureproofing. We need to upgrade all our Cat5e cables to Cat6 cables across the campus to have a faster internet speed. The items listed below are high priority in order to upgrade the campus infrastructure:

3.1. Internet Cable Upgrade

1) Upgrade old Cat5 Ethernet cables to Cat6 across campus for higher internet bandwidth

2) Upgrade old Cat5 Ethernet patch cables in network closets to new Cat6 cables.

3.2. Internet Bandwidth Upgrade

Texas College currently has 1 Gbps Internet bandwidth from our Internet Service Provider (ISP). Since we are adding more upgraded devices to our network that use more data, we need to increase our bandwidth from ISP in order to meet the data demand of students and faculty staff.

Recommended upgrade: Internet speed up to 10 Gbps with Max. Capacity 100 Gbps and 250 MHz of bandwidth.

3.3. Online Learning Upgrade

The Texas College's IT Office worked closely with Key Faculty, the Technology Consultant and interested students to identify the exact kinds of new hardware and software products that are available and that can best assist our students in benefiting from a better learning experience. There are many online learning tools that identify the products that best meet our needs.

4. Transformative Cyberinfrastructure-Based Strategy in STEM/Liberal Arts

Cyberinfrastructure-based strategy in STEM has the potential to revolutionize research, education, and innovation by utilizing the power of digital technologies to accelerate scientific discovery, facilitate collaboration, and empower the next generation of STEM professionals. Some divisions of Texas College strive to train and

prepare its STEM students to pursue graduate studies or professional careers in STEM. Texas College is committed to nurturing and preparing its STEM students for advanced studies or professional endeavors in STEM disciplines. Through a variety of initiatives and projects, Texas College aims to enhance STEM education, support students' academic performance, and increase graduation rates. One key project is *Re-Constructing the Campus Cyberinfrastructure of a Small, Liberal Arts HBCU In Order to Maximize STEM Innovation and Integration* awarded by National Science Foundation in 2022 (Award No. 2201474). This planning project endeavors to reconstruct the campus cyberinfrastructure with the goal of incorporating STEM/Liberal Arts education. Throughout this planning period, Texas College has focused on enhancing its curriculum by incorporating more Science, Technology, Engineering, Arts, and Mathematics (STEAM) elements.

Our methodological efforts involved extensive consultations, including interviews and meetings with academic department heads, faculty members, and researchers, to find their technological needs for both traditional duties and research endeavors. Through these discussions, we identified specific requirements for integrating STEM content across the curriculum and conducted a comprehensive inventory to assess existing technological assets and explore opportunities for enhancement. Texas College conducted thorough analyses to evaluate equipment and explore new technologies that could improve computer processes, data storage, and output systems.

Our planning team meticulously compiled lists of necessary support equipment, specialized software, and hardware, prioritized factors such as performance, scalability, security, and cost-effectiveness. Furthermore, we addressed various aspects of technology management, including inventory records, hardware refresh and disposal, software license renewal, licensing compliance, procurement, infrastructure upgrades, record-keeping, server redundancy, cybersecurity, disaster recovery, end-user training, privacy protection, audits, employee evaluations and hiring, business continuity planning, and user manuals.

In addition to these efforts, Texas College also developed an IT strategy roadmap, governance framework, communication plan, firewall migration strategy, technical solution manual, and network management plan. These initiatives aim to enhance the campus cyberinfrastructure to facilitate the integration of STEM and liberal arts disciplines.

5. CI- Resources in STEM/Liberal Arts Curriculum

In order to prepare students for future challenges involving complex knowledge, advanced reasoning, and problem-solving with multidimensional data and sophisticated representations, it is essential that they develop new types of knowledge and refine their thinking skills beyond what has been traditionally emphasized [11]. In the modern era, there's a growing demand for individuals possessing 21st-century competencies such as critical thinking, entrepreneurship, communication, collaboration, decision-making, leadership, problem-solving, responsibility,

and creativity. One educational paradigm that cultivates these attributes is the STEM approach [12] [13] which was first mentioned by The National Science Foundation Director J. A. Ramaley in 2001 and spread rapidly after this date [14].

While STEM is focusing on the core disciplines in education such as science, technology, engineering, and mathematics, recent scholarly works have introduced the integration of the arts which is leading to the emergence of a new approach known as STEAM, denoting STEM with the added inclusion of 'A' for art. As per Land (2013), while the traditional STEM approach prioritizes the development of analytical thinking skills, the STEM+A meaning STEAM educational approach emphasizes both analytical and creative thinking skills [15]. The Principal Investigator of CC* planning project at Texas College organized meetings with faculty members who were already actively engaged in research and those who were interested in involving future research. Together, they pinpointed research-specific requirements across disciplinary, intra-disciplinary, and interdisciplinary contexts. Additionally, they explored the development of new courses and syllabi aimed at integrating STEM and Liberal Arts disciplines.

6. Creating a Cyberinfrastructure Based on Regional Connectivity

In modern education, Science, Technology, Engineering, and Mathematics fields are essential for preparing students to excel in the job market and awareness in society dynamically. Acknowledging the significance of nurturing STEM education, regional endeavors utilizing cyberinfrastructure have emerged as an impactful resource in overcoming educational disparities. By leveraging advanced technologies and collaborative networks, these initiatives enable students and educators to transcend geographical boundaries, access cutting-edge resources and engage in immersive learning experiences. Cyberinfrastructure facilitates online collaborative platforms where students, educators and researchers can connect, share resources and collaborate on STEM projects in real-time. These platforms promote interdisciplinary learning, peer-to-peer interaction, knowledge exchange, foster a vibrant STEM community, and nurture the next generation of innovators and problem-solvers.

Our main investigation is to connect several regional alignment networks and academic partnership platforms designed for collaboration and course-sharing consortia. We need to co-register with suitable vendors to set up back-up platform and connectivity. These initiatives aim to link students in STEM/STEAM, HBCUs, and other minority-serving institutions with a broader array of online courses which will facilitate their ability to still be on track for timely graduation. For enabling seamless information exchange and collaboration among regional stakeholders, Texas College under NSF CC* planning project has devised a strategy to establish high-speed internet connectivity, advanced communication networks, improve data storage capacity, enhance data security, and integrity. Key campus servers including Jenzabar Internet Campus Solution (Jics), Powerfaids, have been

identified as top priorities for managing academic and administrative functions, enhancing communication, and fostering a cohesive learning environment within Texas College. These systems facilitate efficient data management, student engagement and support services, contributing significantly to the effectiveness and functionality of campus cyberinfrastructure. To address the need for extensive data storage, the team has formulated plans for high-availability server redundancy and explored alternative technologies for computer processes. Additionally, CC* IT team has identified software and hardware tools for managing database systems and conducting big data analytics.

7. Cybersecurity at Texas College

Educational institutions increasingly rely on cyberinfrastructure to support STEM education initiatives [1]. The need for robust cybersecurity measures becomes paramount due to significant cyber threats that pose risks to the integrity, confidentiality, and availability of sensitive data and resources within campus cyberinfrastructure networks [16]. A comprehensive cybersecurity plan design is essential to safeguarding intellectual property, research data, and student information for STEM education. The IT planning team at Texas College has formulated a comprehensive strategy for cybersecurity, data protection and preventive measures as well as incident response protocols.

During emergencies, a series of essential preventive protocols will be implemented, including Isolation and Containment, Invocation of Incident Response Plan, Communication Plan Activation, Engagement of Cyber Security Response Team, Backup Restoration Procedures, Involvement of Law Enforcement, and Reporting, Enhanced Monitoring, Patching and Remediation, User Account Management, Forensic Analysis, Post-Incident Review, Public Relations Initiatives, Vendor and Partner Communication, Legal and Compliance Actions, and Continuous Monitoring and learning. Recognizing the importance of collaboration with local entities, the Texas College planning team has identified the integration of Smith County, the City of Tyler and the State of Texas as crucial for overall success. Accordingly, our CC* project team communicated with Smith County for a cybersecurity and management plan, received recommendations for the utilization of vendors, tools and staff training to enhance cybersecurity readiness.

Consequently, Texas College has initiated the development of an Annex for Cybersecurity within the College. To safeguard data for disaster recovery purposes, the IT team developed a plan to support multiple copies of data stored in various locations to mitigate the risk of data loss due to server or storage device failures, adverse weather conditions or malicious activities. Also, Texas College is implementing a comprehensive cybersecurity strategy to reinforce its infrastructure against potential threats. The firewall, serving as a critical defense barrier between the campus network and the internet, has undergone rigorous examination to ensure its robustness. Regular assessments and updates of both software and hardware components are being conducted to address security vulnerabilities

proactively. Measures are being taken to keep all operating systems and applications updated and patched, reducing the risks associated with outdated software and blocking potential exploitation. Recognizing the threat of ransomware attacks, proactive steps are being taken to prevent data encryption and mitigate risks.

Our efforts to enhance network security and set up robust data protection protocols, physical access to technology equipment is being restricted to bolster security, with rigid controls in place for sensitive hardware and data storage areas. The integration of security cameras and ongoing monitoring serves to fortify measures aimed at protecting resources within the critical infrastructure framework for STEM education. Additionally, a meticulous firewall migration plan has been devised, focusing on evaluation and careful selection of firewall solution, implementation, change management, and tracking processes. By adhering to this CC* project plan and emphasizing change tracking accordingly, Texas College aims to effectively manage and document firewall changes, ensuring a secure and compliant network environment conducive to uninterrupted educational activities.

However, effective training is essential to enhance proficiency in our software applications. Users lacking proficiency in software utilization may experience reduced productivity and may inadvertently commit errors when handling sensitive data [17]. To address this, Texas College CC* planning team members have undergone SecureX cybersecurity training from Cisco to develop cybersecurity skills, while the College has procured 70 licenses for cybersecurity awareness training for faculty and staff. All faculty, staff and students at Texas College prior to the commencement of each semester are getting software-based training like Jics, and internet security through in-house sessions. Additionally, Texas College provides other software training like PowerFAIDS and other requested on-demand software training as well as vendor-provided training.

8. Network Management at Texas College

Optimal network management is essential for a campus cyberinfrastructure seeking to integrate STEM education seamlessly. The network serves as the backbone of the technological ecosystem, facilitating access to vital resources, collaboration platforms, and innovative tools essential for STEM learning experiences. A well-managed network ensures reliable connectivity, high-speed data transfer, and robust security measures, laying the foundation for immersive virtual labs, real-time collaboration, and data-intensive research projects.

Moreover, efficient network management enables fair access to resources, supports interdisciplinary collaboration, and fosters a culture of innovation essential for preparing students to thrive in the digital age. By prioritizing network management, Texas College aims to enhance the quality and effectiveness of STEM education, empowering students and faculty to explore, innovate, and excel in their respective fields. The Network Management Plan at Texas College serves as a comprehensive framework that outlines strategies, policies, and procedures to

efficiently manage the institution's network infrastructure. With a primary focus on ensuring the availability, reliability, and security of network resources, the plan aims to meet the diverse needs of academic, administrative, and research endeavors. Key objectives include optimizing network uptime and performance, enhancing security measures to counter unauthorized access, providing dependable and scalable connectivity for all stakeholders, supporting the integration of emerging technologies, and establishing proactive monitoring and maintenance practices.

To achieve these objectives, careful attention is given to various components of the network infrastructure, such as the campus LAN, Wide Area Network (WAN), network equipment, and cabling. The backbone of this network consists of multiple High-Density switch stacks deployed in key buildings and locations. Each building is equipped with one or more of these switch stacks, enabling efficient data distribution and network management. The main server room contains houses critical network components such as the proposed next-generation firewall, VMware hypervisor servers, and LAN storage for production servers. This server room also includes a WLAN controller stack and additional switch stacks to support the core network functions. The system is connected to a Gigabit fiber switch provided by Suddenlink, ensuring high-speed internet access and redundant pathways for data transmission. The network is designed to manage significant data throughput with high capacities across various segments, ensuring minimal latency and high performance.

To enhance data security and disaster recovery capabilities, the infrastructure includes a Veeam backup primary repository and provisions for a proposed backup ISP to provide added resilience. Two key components of this infrastructure are fiber optic and Cat6 cabling systems, which form the backbone of the network connectivity. Texas College employs single-mode fiber optic cables for high-speed, high-bandwidth, low-latency, security, and currently only uses Cat5e Ethernet cables in most campus buildings, offering speeds up to 1 Gbps (**Figure 1**). The integration of fiber optic and Cat6 cabling is carefully planned to create a cohesive, high-performance network infrastructure with Proposed New Firewall Sophos XGS 4300 that can adapt to future technological advancements (**Figure 2**). Implementing 10 Gbps/100 Gbps backbones for cyber infrastructure ensures sufficient over-provisioning to handle peak traffic growth in line with core network capacity planning best practices [18]-[20], while selecting the Sophos XGS 4300 provides hardware-accelerated deep packet inspection and scalability aligned with enterprise firewall sizing guidelines [21].

Additionally, network architecture considerations prioritize scalability, redundancy and security through practices like segmentation, redundancy implementation, bandwidth management and the provision of reliable wireless coverage across the campus. Security measures, including firewalls, Intrusion Detection/Prevention Systems (IDS/IPS), access control mechanisms, network monitoring and regular audits are crucial in safeguarding network resources. Furthermore, proactive monitoring and maintenance practices with clear network governance

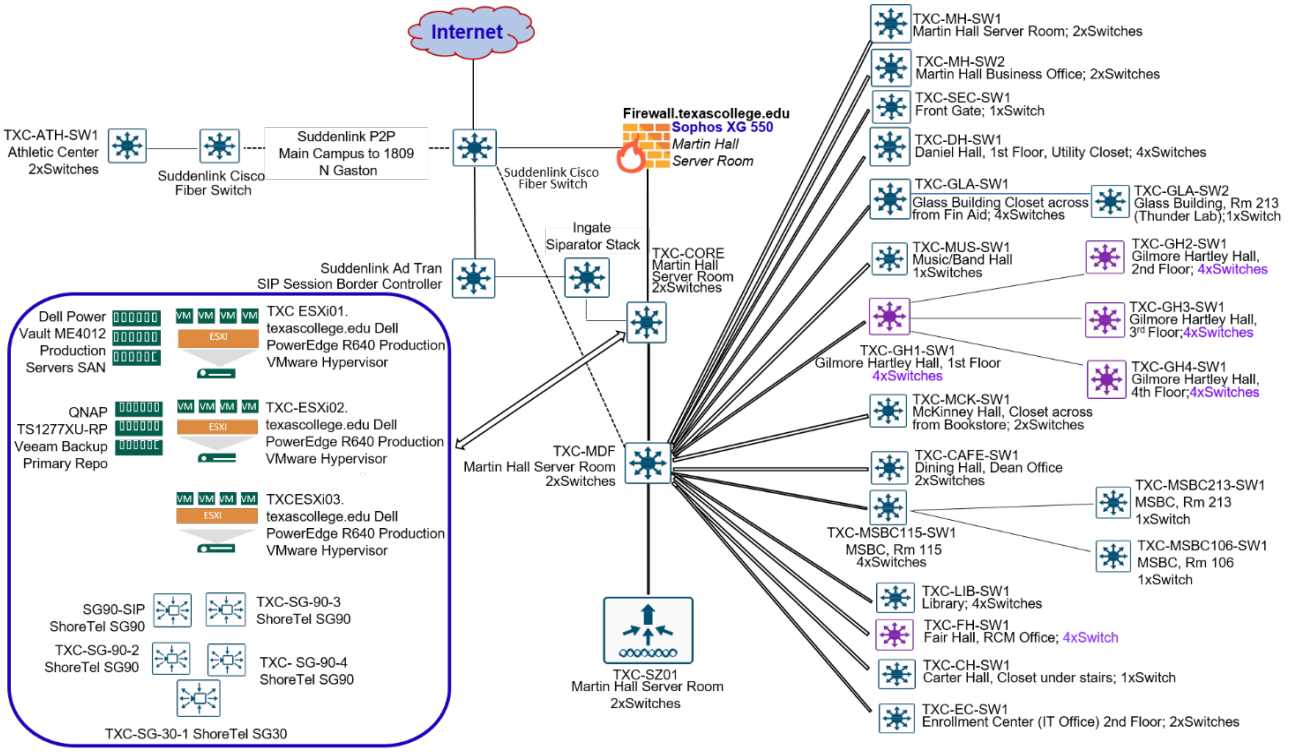

Figure 1. Texas College current campus cyberinfrastructure diagram. Current feature: (a) Firewall Sophos XG 550, (b) Cat5 and Cat5e Cabling.

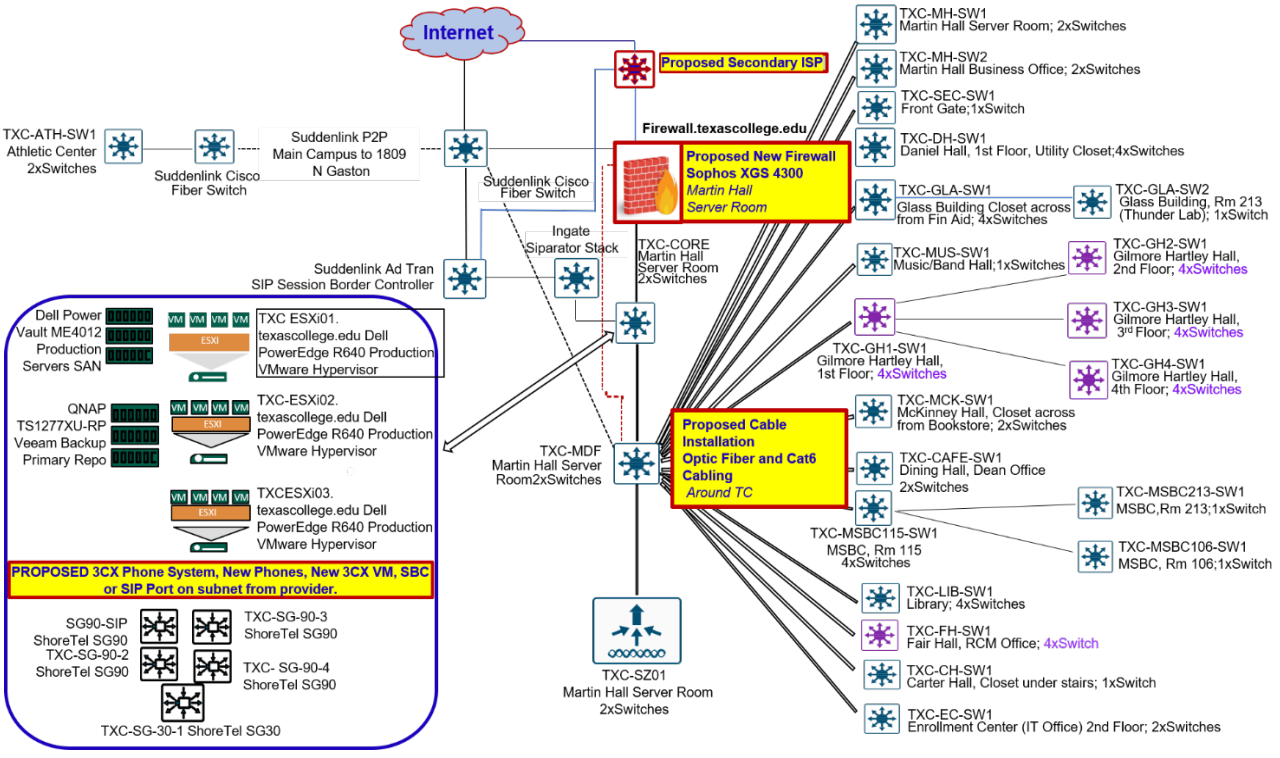

Figure 2. Texas College proposed campus cyberinfrastructure diagram. New proposed feature: (a) Secondary ISP, (b) New Firewall Sophos XGS 4300, (c) Optic Fiber and Cat6 Cabling and (d) 3CX Phone System, New Phones, New 3CX VM, SBC or SIP Port on subnet.

and policies ensure the ongoing reliability and security of the network. Moreover, the network at Texas College is driven by scientific research endeavors, necessitating high-speed connectivity, ample bandwidth, and reliable infrastructure to support data-intensive applications and ease collaboration among researchers. Overall, the Texas College network infrastructure is meticulously planned to support the institution's educational technology needs, providing a high-performance, reliable and secure environment for academic activities.

9. Projected Impact

At present, Texas College's cyberinfrastructure is limited to a 1 Gbps campus cyber infrastructure backbone with mixed legacy Cat5/Cat6 cabling, which constrains both instructional delivery and data-intensive research. The proposed upgrade to a 10 Gbps fiber/Cat6 backbone with scalable pathways to 100 Gbps which represents a tenfold increase in throughput and a reduction in latency from higher ms to <5 ms across campus segments. This expansion will directly support instructional use cases such as real-time video streaming for virtual laboratories, cloud-hosted STEM learning platforms, and simultaneous access to multimedia-rich STEAM curricula without service degradation. For research, the upgraded network will enable high-speed transfer of genomic, environmental, and imaging datasets (>100 GB) that are currently impractical on the 1 Gbps system, while also supporting collaboration with regional partners through seamless integration with high-performance computing facilities. Enhanced cybersecurity and centralized network management will further safeguard sensitive research and student data, allowing faculty to adopt data-driven projects with greater confidence. Overall, the modernized infrastructure is projected to support several new faculty-led research applications within a few years and engage ≥ 70% of STEM majors in data-intensive coursework or projects, thus expanding the College's instructional and research capacity.

10. Conclusions

In conclusion, re-constructing the campus cyberinfrastructure of a small, liberal arts HBCU is essential to maximizing STEM innovation and integration. This initiative not only upgrades the technological framework of the institution but also creates an enriched educational environment that supports advanced learning and research. The comprehensive efforts to reconstruct the campus cyberinfrastructure, as evidenced by the planning project funded by the National Science Foundation, underscore Texas College's commitment to innovation and excellence in education. By upgrading network connectivity, increasing internet bandwidth, and implementing state-of-the-art cybersecurity measures, the college is laying a robust foundation for cutting-edge research, collaboration, and immersive learning experiences. By strategically investing in modernized technology and infrastructure, Texas College can significantly enhance educational experience for its students and faculty members.

Moreover, the meticulous attention to cybersecurity and network management ensures the integrity, confidentiality, and availability of sensitive data and resources within the Texas College campus cyberinfrastructure. Through proactive measures, training, and collaboration with local entities, Texas College is fortifying its defenses against cyber threats and ensuring a secure and resilient network environment conducive to uninterrupted educational activities. This reconstruction effort not only addresses existing disparities in access to resources but also cultivates an environment conducive to innovation, collaboration, and academic excellence. Furthermore, by embracing emerging technologies and leveraging digital platforms, Texas College is effectively preparing its undergraduate students for tomorrow's increasingly technology-driven workforce. This reconstruction demonstrates a commitment to achieving educational excellence and empowering a diverse student, thereby establishing Texas College as a leader in STEM education and innovation.

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Conflicts of Interest

The author declares no conflicts of interest.

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Abbreviations

The following abbreviations are used in this manuscript:

CI	Cyberinfrastructure
CC*	Campus Cyberinfrastructure
Gbps	Giga Bit Per Second
HBCUs	Historically Black Colleges and Universities
ISP	Internet Service Provider
JICS	Jenzabar Internet Campus Solution
LAN	Local Area Network
MHz	Mega Hertz
NSF	National Science Foundation
STEM	Science, Technology, Engineering, and Mathematics
STEAM	Science, Technology, Engineering, Arts, and Mathematics
WAN	Wide Area Network