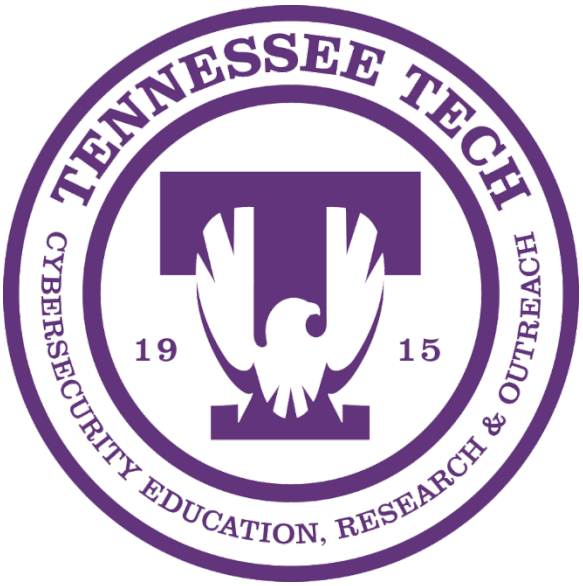

ANNUAL REPORT

Fiscal Year 2024

Abstract

This report provides details of the efforts and outcomes of CEROC, a cybersecurity workforce development and research center funded by the State of Tennessee.

Cybersecurity Education, Research and Outreach Center

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Executive Summary

Welcome to a New Era!

FY 24 (July 2023 to June 2024) was a major transition point for the Cybersecurity Education, Research, and Outreach Center (CEROC). After a two-year transitionary period under the leadership of Dr. Doug Talbert, the center prepared for a new era by onboarding a new permanent director (August 2024) and the pending opening of the Asraf Islam Engineering Building (August 2024), completing its eight-year residency in Prescott Hall.

During the center's first eight years, CEROC established a solid reputation in many areas by

- becoming the eighth largest CyberCorps Scholarship for Service program in the nation regarding successful scholar academic completion and placement.
- continuing participation efforts in the Department of Defense Cyber Service Academy.
- expanding the number of teams placed in competitions and improving placement in existing competitions.
- developing and growing the Golden Eagle Cyber Certificate dual enrollment program to include eight (8) school districts and over 50 students (11 completing the certificate program in Spring 2024).
- expanding our K12 outreach footprint via the Tennessee GenCyber on Wheels program, a first-of-its-type format within the GenCyber community.
- expanding our workforce and research footprint by supporting the establishment of a new center focused on data science and artificial intelligence (AI) (Machine Intelligence and Data Science Center, aka MInDS).
- expanding our FY 23 pilot program, the CEROC Student Ambassador program is now firmly established and has become a model locally recognized across the campus as an exemplar as well as nationally recognized for their logistical performance at conferences such as Women in Cybersecurity and NICE K12.
- expanding our research footprint with new initiatives and infrastructure development in quantum communications and computing and AI in critical infrastructure cybersecurity.

CEROC (The Next Five Years)

As discussed in the pages ahead, CEROC has begun the challenging work of moving to the next level of center presence. We are moving from a small team configuration to a distributed leadership model with team members leading groups outside the confines of center staff lines. This structural change to our business model is essential for the center to scale to new demands made of the center by internal and external entities.

In alignment with these changes, CEROC has grown the student ambassador program to help staff the growing number of requested center engagements with K12 and community colleges. These students complete a rigorous training program enabling them to conduct events without the direct supervision of CEROC staff. It allows the center to spread its wings further while providing role models who can better relate to younger populations. This leadership training program will be described later in this document.

The Golden Eagle Cyber Certificate (GECC) program is among CEROC's new projects. Piloted in FY 22, the GECC program provides early postsecondary opportunities (EPSO) to the secondary school community through a cybersecurity dual enrollment program. The certificate program allows a high school student in a participating Tennessee school district to select up to three designated courses to take as part of a dual enrollment program. Students completing the program will receive a certificate from Tennessee Tech and earn nine (9) hours of college credit while in high school. These credits will transfer to any Tennessee university.

CEROC is also changing its approach to research funding models. As described later in the document, the center has begun approaching all funding requests made to the center as a mini-grant, allowing for new accountability structures to ensure growth outcomes and not static, repeated funding requests. This model will be used for project funding and RA/GA requests.

About CEROC

The **Cybersecurity Education, Research and Outreach Center (CEROC) at Tennessee Tech University (TNTech)**, virtually established in October 2015 and physically established in January 2016, is a **Center of Academic Excellence in Cyber Defense Education (NCAE-C CD) designated by the National Security Agency (NSA)** thru 2028. The center was established by the Department of Computer Science and the College of Engineering to integrate university-wide existing activities and initiatives in cybersecurity education, research, and outreach, the emphasis of which makes it unique in the state.

The center's name outlines its primary missions: education, research, and outreach. All efforts of the center must align with one of these three (3) pillars. **A core support for all these efforts is the CEROC Cyber Range.** This automated Infrastructure as Code platform provides the basis on which all laboratory efforts are built, supporting the three pillars. The internally developed system can dynamically generate system and network architectures for large deployments in minutes, providing a safe environment to train, experiment, and learn.

Education goals focus on the informal, cybersecurity-focused educational activities of students. These supports include the CyberEagles and Women in Cybersecurity student chapter organizations, which provide bi-weekly meetings creating venues for external speakers from government and industry to discuss timely cyber topics and job opportunities with students. The center also supports cyber interest groups focused on defensive and offensive security and capture-the-flag (CTF) groups. Cyber competition teams are developed from these interest groups in cooperation with the newly created competition cyber interest group.

Research support is provided to cybersecurity faculty members, ranging from securing vehicular networks to malware reverse engineering to quantum computing/networking. In addition to a growing research assistant program, CEROC provides cyber researchers access to the CEROC Cyber Range for ad hoc structures supporting project testing and development.

Outreach efforts primarily focus on K-14 audiences, energizing interest in cybersecurity as a field of study. While lower grade-level events focus on Internet safety, hands-on exercises are used at middle, high, and community college levels. These efforts aim to develop further the cybersecurity workforce

pipeline, which will see a deficit of greater than 500,000, while also seeking to expand diversity within the field. The center also works with TN companies seeking to improve their cyber risk positioning. CEROC's standing cyber risk assessment student teams provide CMMC v1 and NIST 800-171 focused evaluations.

In FY 24, CEROC has either led or served as a collaborator to 12 activated projects with a financial impact of $2,103,158.40 and 34 submitted proposals totaling $14,374,611. CEROC faculty affiliates have published 36 articles across 12 cybersecurity research topics within the 2023 and 2024 publication cycles.

CEROC is constantly seeking government and industry partners to further its core missions. Our student-focused solutions aim to empower an agile cyber professional ready to contribute meaningfully to the cybersecurity community. Annual reports and other information about the center can be found at https://www.tntech.edu/ceroc.

FY 24 CEROC Highlights

- Dr. Muhammad Ismail and Eric Brown took 14 CyberCorps SFS students to the 2024 SFS Annual Job Fair in Washington, DC. While there, they conducted the 2nd annual NS3 (CyberCorps SFS New Scholar Seminar Series) recognition ceremony for the 2023 cohort. The participants received a certificate of completion and a challenge coin. CEROC has also served as a mentor institution to other new SFS programs over the past year, helping them to establish management frameworks for their SFS programs.
- CEROC conducted a GenCyber Day event at the 2023 NICE K12 Conference. The one-day event served 40 Phoenix-area high school students (including members of the Navajo Nation). NSA continued to complement CEROC's outreach programs and external events. CEROC also had 5 students, 4 staff members, and 2 faculty members serve as volunteers/facilitators/speakers at the conference.
- CEROC continued to expand the CEROC Student Ambassadors program. The ambassadors were trained in key areas of CEROC history, K12 engagement best practices, cyber outreach content, Minors on Campus, and Youth Protection training. The program is led by two senior ambassadors and overseen by Eric Brown, associate director for workforce development.
- CEROC members (table and speakers) participated in the regional cyber summit at Volunteer State Community College.
- Over FY 24, CEROC programs and events impacted over 12,000 participants both within the state and nationally, introducing cybersecurity content and pathways into cyber from multiple disciplines.
- CEROC has been a part of the GenCyber program since 2016, conducting summer cybersecurity camps and special events such as GenCyber Day. In FY 23, CEROC submitted a $165,000 proposal to the NSA, which was awarded for a new type of GenCyber camp. CEROC conducted Tennessee GenCyber on Wheels during FY 24 and will continue into FY 25, taking the Tennessee Tech STEMobile on the road and introducing cybersecurity across the state. The 2–3-day event will provide various programs, including hands-on activities on the STEMobile, professional development sessions for teachers and school counselors, and parent sessions. CEROC also conducted a summer camp in FY 24 and provided GenCyber content to the Governor's School for Emerging Technologies.

- CEROC presented to the state cybersecurity council, updating the group on CEROC's efforts over the past 16 months.
- CEROC has provided pre-award support for the first quantum computing grant at Tennessee Tech. Dr. Muhammad Ismail was awarded by NSF "Beginnings: Creating and Sustaining a Diverse Community of Expertise in Quantum Information Science (EQUIS) Across the Southeastern United States." This state-of-the-art network will provide cutting-edge opportunities to Tennessee Tech students at the undergraduate and graduate levels.
- The CEROC Capture the Flag (CTF) competition team took first place at the Infosec Nashville competition, winning over multiple professional cybersecurity companies.
- CEROC served as the Mid Central regional host for the Collegiate Penetration Testing Competition (CPTC) competition, hosting nine teams. The team would later win 3rd place in global competition.
- CEROC facilitated the creation of a new center focused on artificial intelligence and machine learning – Machine Intelligence and Data Science (MInDS). As part of the work, CEROC granted a workforce development award to create the AI Corps scholarship program, emulating many NSF CyberCorps Scholarship for Service program elements. This project established Tennessee Tech as a leader in the space before the final discovery report from NSF in the same area. Results from the work were submitted to multiple agencies and members of Congress.
- CEROC expanded the Golden Eagle Cyber Certificate program to four new K12 districts. The program now includes intro programming, intro to cyber, intro to sociology, and intro to American government.

Influence of Federal and State Programs

Student Impacts

Tennessee Tech was awarded the **Department of Defense Cyber Scholarship (CySP)** grant for the first time in May 2018 (Award H98230-18-1-0315) and has continued participating in the program. This puts Tennessee Tech among an elite group of universities in the nation to have both the DoD CySP and CyberCorps SFS programs, not to mention the only university in the State of Tennessee to have such a distinction. The primary focus of the program is to produce candidates with M.S. degrees. Seven scholars have completed the program to enter Department of Defense agency roles. The Department of Defense reintroduced the program as the Cyber Service Academy (CSA).

As part of this program, CEROC has contributed back to the CySP community in a variety of ways, including:

- Design and implement polos and academic stoles for CSA scholarship participants during outreach and graduation exercises.
- Creating a DoD CySP logo, submitted and used by the national program until its conversion to the CSA.
- Contributed program management best practices to the CySP/CSA community.
- Participants in our program have received outstanding reviews from their assigned agencies.

Tennessee Tech was first awarded the **NSF CyberCorps SFS scholarship grant** in December 2015 (NSF Award 1565562), and again in 2021 (NSF Award 2043324). Tennessee Tech was the first university in the State of Tennessee to be awarded the opportunity to manage this prestigious scholarship and remains the largest of such program in the state. The program's primary focus is to produce profession-ready candidates with M.S. degrees. With current extensions to the grants, we have produced 42 workforce-ready cybersecurity professionals over seven years.

In a survey conducted among all SFS scholars who graduated or are currently in the program, all students agreed that their experiences at TNTech as an SFS Scholar have been integrated in education, research, and outreach activities, which have (or are) contributed(ing) to making them a better cyber professional as a whole and following is evidence:

- ***Education*** - Most students (96%) reported that they engaged in both "*Crowdsource Learning"* and "*Continuous Learning"*. All students agreed that the informal learning opportunities positively impacted their success as SFS scholars. All students participated in informal learning through cyber interest groups: 75% Defense, 64% Offense, and 82% CTF (Capture-The-Flag), and all participated in cybersecurity competitions and the SFS job fair. Most students (82%) had participated in one or more cybersecurity conference(s). All had participated in OPM-approved summer internships.
- ***Research*** - Most students (89%) felt that the research opportunities at CEROC positively impacted their success as SFS scholars. Most (93%) students have participated in at least one research experience so far — 79% as part of their coursework, 29% as a graduate thesis, 32% graduate project, 25% as Research Experience as Undergraduates (REU), 61% summer internship, 11% faculty-sponsored projects, and 11% Honors experience. This research has resulted in numerous research deliverables: 29% refereed papers, 18% graduate theses, 29% graduate project reports, 21% unpublished technical reports, 25% research presentations at campus events, 29% off-campus research presentations, 50% research posters, & 36% software artifacts.
- ***Outreach*** - All students reported that the outreach opportunities positively impacted their success as SFS Scholars. CEROC students are engaged in numerous outreach activities: 57% GenCyber summer camp, 43% WiCyS Conference, 36% GenCyber Day at WiCyS, 75% Cybersecurity Discovery Day, 7% CyberPatriot Mentorship, 32% Cyber Training for Tech Employees, 79% new SFS Scholar Bootcamp, 43% Cyber Reviews for Local Businesses, 54% STEMmobile visits in schools, 43% area K-12 visiting CEROC, 36% CEROC visiting local K-12, 11% Cyber Encounter Workshop for K-12 teachers and students, 25% CEROC Advisory Board Presentations, 7% College of Engineering Advisory Board Presentations, 11% VIP Professionals Presentations, 47% Other On-Campus Presentations Representing CEROC and SFS, and 32% Other Off-Campus Presentations.

CEROC students experience and contribute to a supportive and collaborative environment, and 93% reported meeting the expectation of "Paying It Forward." This is supported by 78% of students reporting that they see themselves as mentors and 59% as leaders. These students have participated in various CS on-campus student communities: 96% CyberEagles, 43% CyberEagles-W, 50% ACM, 11% ACM-W, 7% NSBE, and 7% Data Science League.

The center has also proved to positively influence the number of students entering the Computer Science program and pursuing the cybersecurity concentration. The Center's outreach efforts, such as GenCyber and related summer camps, regional school tours and visits, and K12 career fairs, have significantly contributed to this.

Institutional Impacts

TNTech was one of ten universities to participate in a pilot program conducted by the National Science Foundation's CyberCorps SFS program office to provide two-year cybersecurity program students a pathway into four-year cybersecurity programs. During this time, TNTech worked with its community college partners to identify student participants for the program. Ultimately, six students successfully completed a summer bridge program or entered an SFS Pathway program, allowing them to complete a B.S. in computer science with a cybersecurity concentration. Since the pilot program, the SFS program office has created a formal program to support community college students using the best practices learned from the pilot program. CEROC was pleased to be a successful contributor to the program. This work has uniquely positioned the center to provide mentoring for new bridge programs and new SFS programs.

The impact of the SFS program on our school is indisputably groundbreaking. As a result of the center's CAE designation and the subsequent award of the CyberCorps SFS grant, the State of Tennessee, as part of the FY 2017 state budget process, appropriated "$500,000 to Tennessee Technological University to match funds provided by the National Science Foundation for cyber security research", a total of $2,000,000 for the four years ending FY 2021. This non-recurring budget allocation was crucial in establishing CEROC and is the sole source of its logistical operations. The funds were allocated each year in alignment with the center's three pillars of operation to serve the state and region. These funds contribute to salaries for center staff, research infrastructure, mini-grants for faculty researchers, graduate and research assistantships, and support for the many community outreach activities conducted throughout the year. In FY 21, after successful reapplication for another five-year CyberCorps SFS grant, the State of Tennessee awarded CEROC a $1,000,000 non-recurring budget for operations. This budget was moved to a recurring line beginning with the FY 24 budget cycle.

Since 2015, the center has submitted and/or managed 88 activated proposals totaling over $13.5 million on a proposal count of 153 totaling over $48.7 million, with an office of four people providing research opportunities for cyber students and educational opportunities for K12 students. Secondly, CEROC has helped the CS department hire eight new faculty members active in cybersecurity over the past three years. Finally, CEROC has led or participated in several pilot programs to expand the reach of the community with the NSF community college (CC) pathway program, CAE re-designation pilot program, NSF SFS Bootcamp, NSF's CReST, Cyber Encounter, and Women in Cybersecurity (WiCyS) programs. The SFS program has helped our institution attract not only highly qualified students but also non-SFS students. Without the SFS scholarship program at Tech, fewer students in Tennessee and the region would pursue cyber careers with the government.

CEROC and TNTech are now regionally and nationally recognized for their academic, outreach, and research programs in cybersecurity. This recognition comes via a unique combination of program opportunities, innovative programming, dedicated staff, and a student group that developed amazing

deliverables. The center is now actively sought out to become a collaborator in external programs based on our past workforce development success. This is the path to the center's next growth journey.

Mission Statement

At the Cybersecurity Education, Research, and Outreach Center (CEROC) at Tennessee Tech University, we are dedicated to fostering a comprehensive understanding of cybersecurity. We commit to advancing academic excellence in cyber defense education, promoting cutting-edge research, and driving meaningful outreach initiatives. Supported by our state-of-the-art CEROC Cyber Range, our mission centers on empowering students and professionals, addressing the cybersecurity workforce gap, and fortifying the digital landscape for the future. Through education, innovation, and collaboration, we aim to nurture an agile community of cybersecurity experts ready to lead and safeguard our interconnected world.

Strategic Goals

Education Strategic Goal

Goal: We will expand the dual enrollment program to 20 school districts by the end of FY 25.

Objectives:

1. Hire a Tennessee K12 STEM teacher (one year contract) to focus on dual enrollment via the Tennessee GenCyber on Wheels program and other on-prem offerings.
2. Deliver Golden Eagle Cyber Certificate Introduction Packs to all 147 school districts including Start Engineering guides and letters of introduction to the dual enrollment program and other CEROC outreach offerings.
3. Conduct conference talks at four venues in the state and/or at national conferences.
4. Expand K12 communications via improved contact lists and regular program updates.

Research Strategic Goal

Goal: We will be nationally recognized for our cyber research efforts by FY 25.

Objectives:

1. We will achieve the NCAE-C Research designation by the end of FY 25 with the CAE-R introduction check list submitted for candidacy by the end of Fall 2023.
2. Achieve $3 million in yearly research activations by end of FY 25.
3. Create and expand the Tennessee Tech Cyber Council to 20 members with one member of each college/school by the end of FY 24.
4. Develop red team capacities for research proposal peer review implemented via the CEROC faculty affiliate program by the end of FY 24 conducting at least two meetings.

Outreach Strategic Goal

Goal: We will reach 4,000 Tennessee K12 students by the end of FY 25.

Objectives:

1. Implement the Tennessee GenCyber on Wheels program (eight locations) via the 2023 and 2024 NSA-funded GenCyber grants (performance period ending 12/31/2025).
2. Conduct eight (8) on-site, cyber events in Tennessee K12 classrooms during the 2023 - 2024 K12 academic year.
3. Participate in six (6) outreach conferences/workshops in FY 24.
4. Solidify new communication strategy for K12, CC, university, government, and industry by end of FY 24.
5. Create the Community College Cyber Collaboration and Exchange (C4E) program and conduct one workshop by the end of FY 24.

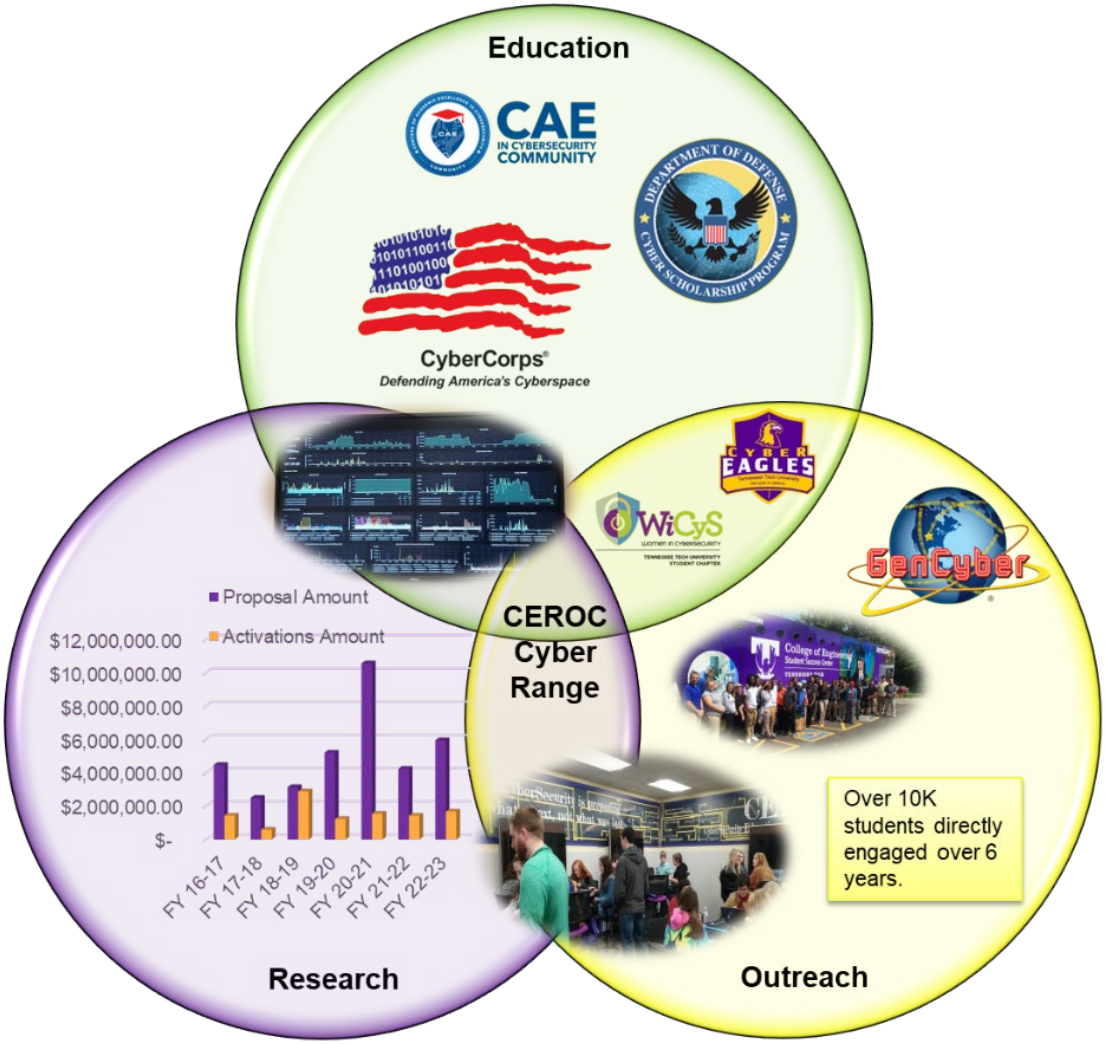
Infrastructure Strategic Goal

Goal: We will double the CEROC Cyber Range capacities by the end of FY 24.

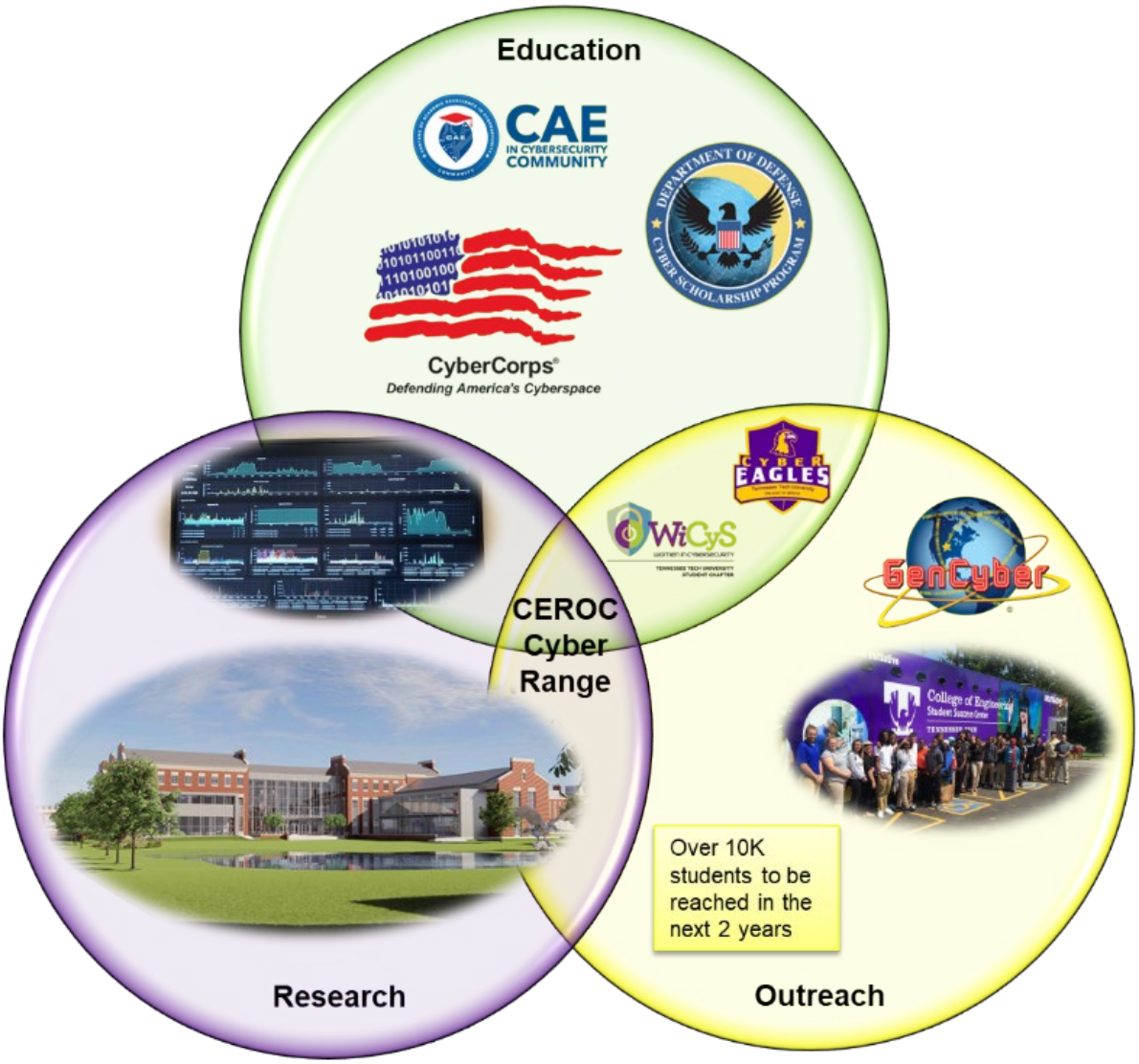
Objectives:

1. Complete implementation of C stack by the conclusion of Fall 2023.
2. Complete integration of GPU nodes into range operations by the conclusion of Fall 2023.
3. Rollout fully functional web portal to CEROC Cyber Range external clients by the end of FY 24.
4. Complete implementation of three laboratory testbeds by the end of FY 24 (including smart power grid, smart manufacturing, and 5G/6G networks).

Who We Are Now



Where We Are Going



Mission Reports

As stated in the Executive Summary, all efforts within the center are focused on the primary missions of education, research, and outreach (as displayed in the name). The following is a report of our work in each area.

Education

CEROC facilitates an integrated experience for cybersecurity students, ensuring their participation in informal education, research, and outreach activities alongside their formal cybersecurity education as part of the CS curriculum. With the mantra of ***continuous learning, crowdsource learning, and paying it forward***, students are constantly challenged to immerse themselves into their educational experiences to enrich themselves and provide opportunities to enrich their peers and the community around them.

Informal Education and Professional Development

Hands-On Skill Development

Hands-on active learning is an integral part of education. It has been found that students actively engaging with concepts from course material learn more effectively. For students to effectively contribute to the defense of our nation in cyberspace, it is crucial for them to gain experience in active hands-on offense/defense training. Most of the courses with security content already contain hands-on exercise modules for students to engage with course concepts actively. Additionally, CEROC supports and facilitates the following student skill training interest groups:

- The ***Capture the Flag (CTF) cyber interest group*** that meets to hone interest and gain active learning experiences in CTF style of activities. The group competes in online CTF competitions such as the National Cyber League, Virginia Cyber Summit, and picoCTF. Another goal for this team is to facilitate local competitions and events for K12 CTF teams, either at on-campus events or on-site at local schools.
- The ***Defensive cyber interest group*** cultivates interest and supports training in defensive skills. The primary competition for this team is the Collegiate Cyber Defense Competition. Other competitions that they participate in are the DOE CyberForce competition and Hivestorm.
- The ***Offensive cyber interest group*** (largest group among the three) meets to practice and acquire offensive proficiencies. The primary competition for this team is the Collegiate Penetration Testing Completion. Other competitions they participate in are DOE CyberForce, SFSCon etc.

DoD, NSF, and State Funded Cyber Range

With funding from DoD and NSF, CEROC has developed the CEROC Cyber Range, a virtual infrastructure supporting our education, research, and outreach activities. This space is supported by virtualization hardware in the university's data center. It is also physically and logistically air-gapped through the wired and wireless network that Information Technology Services (ITS) supports. The range is extensively used in special interest group training, competitions, cyber war games, lab support in IT Security, Reverse Engineering and Ethical Hacking courses, K12 lesson plans, outreach activities, and research projects. A more complete description of the cyber range can be found in the facilities section of this document.

Cybersecurity Student Organizations

CyberEagles

The Tennessee Tech CyberEagles is a student organization that aims to raise computer and information security consciousness and students' proficiency in using, designing, developing, and operating computing technology. The club welcomes student members interested in cybersecurity from departments across the university. Currently, there are 70+ members. It is very active and conducts bi-weekly seminars for club members, such as invited talks by external speakers from diverse walks of life, including research, industry, and government service sectors, virtual CAE NSA Tech talks, training seminars, and regional security conference attendance. The club has been a very positive influence on our students. Aside from the educational benefit of these meetings, CyberEagles is an important part of our internal recruitment strategy to get more Tennessee Tech students to consider the cybersecurity

focus area. Senior members of the club are strongly encouraged to take leadership roles to improve their organizational and management skills and provide mentorship to newcomers.

WiCyS Student Chapter

Tennessee Tech also founded the first Women in Cybersecurity (WiCyS) student chapter of the national Women in Cybersecurity Organization. The 25+ student organization members host monthly professional development activities for all students interested in attending. It includes networking events, technological activities, field trips, and guest speaker engagements. Members of this organization apply to attend the annual national conference, where they serve as student ambassadors at the event.

CEROC Student Ambassador Program

As referenced earlier, CEROC established a cybersecurity student ambassador program to help support its education and outreach missions. Before creating this group, students selected from the SFS and CySP programs would be asked to serve in ambassador roles regularly. As demand for center services grew, this became a problem for these scholarship students with a significant service load.

Using the successful model of the cybersecurity interest groups, a tiered leadership structure was established, identifying roles for senior ambassadors, junior ambassadors, and ambassadors. Each level comes with increasing responsibility for CEROC outreach events. Senior ambassadors run the program under the supervision of the associate director for workforce development. All ambassadors undergo extensive training in cyber community development, classroom management, first aid, and youth protection. Each member must complete a background check before becoming active in the group.

Service Learning with Cyber Reviews

CEROC has collaborated with the Tennessee 3-Star Industrial Assessment Center (IAC) at Tennessee Tech to provide cybersecurity risk assessments for small to mid-sized manufacturing companies in Tennessee. As part of a joint effort funded through a grant with the Department of Energy, CEROC and the 3-Star IAC deploy student assessment teams led by CEROC's associate director for workforce development to conduct cyber reviews for local and regional manufacturing companies and small businesses. The reviews involve an on-site evaluation component that allows students to exercise their team and client development skills. Once data collection activities (via survey and personal interview) are complete, the students begin processing and evaluating the collected data against a scoring rubric based on the NIST Cybersecurity Framework and other NIST SP documents. A final report is delivered by the student team with recommendations for improvement of their security posture. CEROC has also piloted a program of K-12 school district reviews with county districts. This program focuses on the unique challenges associated with school districts.

CyberCorps SFS New Scholar Bootcamp

Since 2016, TnTech has organized the annual Cybersecurity Scholar Bootcamp (funded through an extension of our original SFS grant) every summer. This first-of-its-kind camp provided cybersecurity scholars from across the country an opportunity to attend a day-and-a-half workshop covering various essential soft skills for their future academic and professional careers. Topics covered during the camp included financial planning, communications, diversity awareness, resume development, and research ethics and methodologies. The TnTech cohort had an additional half day of training conducted in the Volpe Library to become further acquainted with university research resources. CEROC also included TnTech students participating in the Department of Defense Cyber Scholarship program in this boot camp, given that such a camp did not exist for the DoD program then.

In 2021, with lessons learned from COVID and the new CyberCorps SFS grant award, CEROC created the CyberCorps SFS New Scholar Seminar Series (NS3). This eight (8) week online program brings new SFS students from across the nation to a virtual venue to conduct the same valuable lessons delivered during the in-person campus. The advantage of the new program is in the delivery. Creating a virtual event allowed more students to participate by removing the travel barrier. Additionally, the new virtual venue allows for a new style of collaboration featuring two-hour sessions across eight weeks. Each week features speakers from government agencies and subject matter experts who are needed to teach specific soft skill areas.

Formal Education

Golden Eagle Cyber Certificate Program

CEROC was tasked with developing a dual enrollment plan focusing on cybersecurity in FY 22. The plan focused on reviewing district needs, alignment of current university assets, administrative challenges, and establishing pilot partners. This work was conducted during FY 22 and FY 23, making use of funds allocated by the state of Tennessee. Each area of work will be detailed below. The program was named the Golden Eagle Cyber Certificate program.

High school students completing nine (9) credit hours before graduation will earn the certificate. Currently, the program is a "4 pick 3" program in that three courses of three credit hours each are available. We are working on additional courses so that students will have a "5 pick 3" option, allowing them to create a course selection grouping that more aligns with their specific interests, such as computer science or cyber law.

Current GECC Efforts

Making use of current work in Computer Science and content development resulting from the CyberCorps SFS grant funding the Cyber Law minor in Sociology, a plan was developed to offer three courses: CSC 1200 – Computing Principles (coding), CSC 2570 – Intro to Cyber and Privacy (cyber foundations), and SOC 1010 – CYBER (cyber social studies). POLS 1030 (American Government) was added to the portfolio in FY 24. These courses had the following characteristics:

- No prerequisites
- Introductory in each respective space
- Transferrable to any state of Tennessee post-secondary school
- Capable of being delivered in an asynchronous online format

Work is being conducted to have a CSC 2220 offering for the Spring 2025 semester, which introduces how data science and artificial intelligence are used in industry and academia. Students will be introduced to what data science is all about: how statistics, machine learning, and software engineering play a role in data science, and be introduced to some of the terms and tools used by data scientists. Students will learn about the structure of a data science project, what makes for successful and unsuccessful projects, and participate in a data science project. Students will also be introduced to artificial intelligence and its application to real-world problems.

GECC Enrollment

During the 2024 academic year, the GECC dual enrollment program had 17 students enrolled in the Fall semester and 21 students in the spring semester. During the AY 24, the GECC dual enrollment program students represented 9 schools and 6 districts. By Spring 2024, 11 students completed the 3 courses needed to earn the Golden Eagle Cyber Certificate.

GECC Synergistic Activities

As mentioned earlier, CEROC conducts several K12 outreach activities throughout the year. The center has made some strategic changes to improve the overall delivery of the dual enrollment program and become a primary service point for districts looking to address computing and cybersecurity curricula. Among the efforts made:

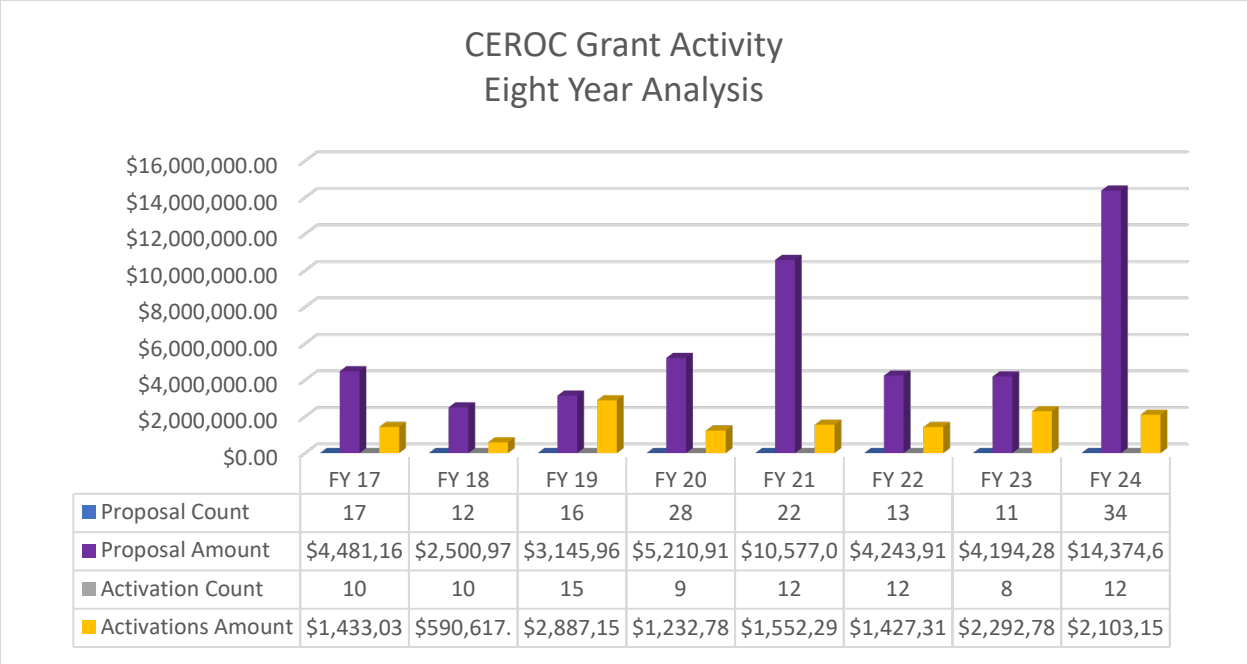
- Using multiple funding lines, CEROC deployed the STEMobile 14 times during FY 24 under the name GenCyber on Wheels. These three-day deployments will be used to
    - Introduce students to cybersecurity using the curriculum created for our GenCyber camps.
    - Introduce students to the 502 Project (Tennessee Tech is a coalition member in a group led by the University of South Florida)

    - Provide teachers with sample cybersecurity lesson plans that can be used as individual elements rather than full modules (allowing teachers to provide a glimpse of cybersecurity in ELA, mathematics, and science courses)
    - Provide professional development sessions for teachers in the region discussing methods to introduce cyber across all curriculum divisions.
    - Provide professional development sessions for school counselors, providing additional information about cyber careers and post-secondary training opportunities.
- An initial email announcement (and related website content) has been given to all 147 school district superintendents and CTE directors. Additional communications will be sent throughout the year, providing updates and encouraging participation.
- CEROC distributed 10,000 Start Engineering guides across the 141 school districts across the state. Aside from providing a wealth of information about cybersecurity areas of study and pathways, these guides will be customized for CEROC, specifically advertising the Golden Eagle Cyber Certificate program. These shipments included an introductory letter to the district superintendent and CTE director for the district. The number of guides per district will be prorated based on the school district's population size.

Research

With healthy Ph.D. production and financial commitment to research, in 2019, Tennessee Tech bolstered its position in the Carnegie Classification and became an R2 university — a doctoral university with high research activity. This indicates Tennessee Tech's increased performance in research/scholarship doctoral degrees and research expenditures. With the addition of eight (8) new faculty members to Computer Science, the center saw an increase in the number of proposals.

In Computer Science, eight faculty members are active in security-related research and work with students on cybersecurity-related research projects as mentors. Research areas in security include (but are not limited to) cyber-physical systems security, Internet of Things (IoT) security, vehicular ad-hoc network security, network and 5G security, Darknet, healthcare security, web application security, machine learning-assisted security, and quantum computing. Students have multiple opportunities to conduct research under the guidance of CS faculty mentors through sponsored projects, courses in curriculum, thesis, and project requirements.



	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24
Proposal Count	17	12	16	28	22	13	11	34
Proposal Amount	$4,481,16	$2,500,97	$3,145,96	$5,210,91	$10,577,0	$4,243,91	$4,194,28	$14,374,6
Activation Count	10	10	15	9	12	12	8	12
Activations Amount	$1,433,03	$590,617.	$2,887,15	$1,232,78	$1,552,29	$1,427,31	$2,292,78	$2,103,15

In FY 22, CEROC welcomed Dr. Stacy Prowell to the team. Dr. Prowell serves CEROC as the Associate Director for Research while on a joint appointment at Oak Ridge National Laboratory as a Distinguished Scientist. Dr. Prowell's appointment was a key part of the center's restructuring strategy, providing key leadership focus on research and workforce development independently. As part of his efforts, the TNTech Cyber Council was established as a catalyst and conference for all academic and research cybersecurity efforts to unite all colleges and schools regarding cybersecurity efforts. Working with Dr. Doug Talbert, Interim Center Director, the CEROC Faculty Associate program was relaunched, providing more direct research support to the cybersecurity research community using CEROC services. The faculty affiliate program provides mini-grant funding to encourage investment in future research activity. This model will be extended to include future GA/RA requests.

Outreach

Both locally and nationally, CEROC has a track record of various outreach activities in CS and cybersecurity for both secondary and post-secondary education, including public and private industry sectors. Since the center's inception, CEROC has worked with thousands of K-12 and CC students through state and federally funded programs. Our outreach programming especially provides opportunities for students in Tennessee's rural regions to be aware of cybersecurity careers and prospects, encouraging consideration of cybersecurity as a field of study, sparking interest in cybersecurity education and competitions, and fostering participation of under-represented populations in STEM areas. Along with other students, CEROC Student Ambassadors actively participate in various outreach activities such as (but not limited to) the following:

- Women in CyberSecurity conference
- Faculty development workshops (onsite and offsite)
- GenCyber summer camps
- GenCyber on Wheels deployments to area schools
- FAB Fridays at the Tennessee Tech STEM Center (elementary and middle school)
- Cybersecurity awareness workshops
- Cybersecurity risk assessments and workshops for small to mid-sized businesses
- Middle and high school career fairs
- Community college career fairs

FY 24 Event Type	Event Count	Participant Impacts
K-12 Schools Visits	29	5705
K-12, College Career Fairs	5	3500
On-Campus Group Visits	11	985
Cyber Competitions	8	104
Webinars (sync & async)	2	100
Community College Visits	2	600
Totals	**57**	**10994**

Note: These counts include major events executed throughout the year. Other small events, such as minor competitions, occur year round.

NSA and NSF Funded GenCyber Program

Tennessee Tech has been awarded funds from NSA and NSF to conduct GenCyber camps since 2016. In the past, CEROC organized a one-week camp focused on cybersecurity hands-on exercises with and without the use of technology. CEROC camps have focused on high school students (rising 9th– 12th grade). Over the last four years, we have directly interacted with 750 students (250 in the state and 500 students in four other states through GenCyber Day WiCyS events). Additionally, we have directly interacted with 30 teachers and 18 school counselors in the Middle and East Tennessee regions. These specific contacts have indirectly influenced thousands of students over the past seven (7) years.

Our Team

Dr. Doug Talbert serves as the interim director for CEROC and the co-director of the Machine Intelligence and Data Science (MInDS) center. His primary research interests include machine learning, data mining, medical informatics, and usability. Dr. Talbert also serves as the Associate Chair for the Computer Science Department at TNTech. Dr. Talbert teaches a variety of data science courses in computer science.

Mr. Eric Brown serves as the Associate Director for Workforce Development at CEROC, managing the center's daily operations. He holds a B.S. and M.S. in computer science from Tennessee Tech. He served 20 years in the Computer Science Department at Tennessee Tech as an information and instructional technology specialist and adjunct faculty teaching portions of the information technology curriculum. He also has extensive experience in K12 education administration through his work on the Putnam County School Board and Tennessee Department of Education.

Eric is a Certified ScrumMaster, Certified Scrum Product Owner, ICAgile Certified Professional, and holds the DevOps Foundation certification from the DevOps Institute. He also serves as a senior lecturer in TNTech's computer science department, teaching Intro to Cyber, IT Security, and Software Engineering.

Dr. Stacy Prowell is the Associate Director for Research at CEROC, managing research operations. He also has a joint appointment with Oak Ridge National Laboratory, where he serves as a Distinguished Researcher. He is a software and systems engineering generalist with experience throughout the private industry and research lifecycle. He has managed successful products, evaluated technologies for acquisition, directed research teams, consulted and coached, and co-owned a small business. He has led teams in developing technologies to support automated reverse engineering of compiled software, physics-based intrusion detection, quantum-based encryption and authentication, large-scale analysis of cyber artifacts, and the analysis of microelectronics.

Mrs. Megan Cooper serves as the Cyber Outreach Coordinator for CEROC. She is the primary contact for all CEROC clients (K12, CC, university, industry, government). Mrs. Cooper is responsible for communications and marketing of the center's programs and event logistics management. She holds a B.S. in Human Ecology and a Master of Business Administration (Information Systems Focus) from TNTech.

Mrs. Sara Howard serves as a Project Manager for CEROC. She manages all financial transactions for the center. She also processes all pre- and post-award grants for CEROC researchers. She has an extensive background in collaborative grant development, working with funding agencies, including the National Science Foundation, the Department of Defense, and the Department of Energy.

Mr. Travis Lee serves as a Cyber Range Engineer for CEROC. In his role, Mr. Lee architects and deploys virtual infrastructure on the CEROC Cyber Range. He collaborates with students, faculty, researchers, and external clients to deliver cybersecurity simulation solutions in complex environments. Mr. Lee also serves as an adjunct faculty member in the Computer Science Department, teaching computing principles and supporting the IT security courses. Mr. Lee holds a B.S. in Computer Science. He anticipates completion of his M.S. in Computer Science in Fall 2023 with a focus on quantum applications in cyber.

Mr. Jeremy Potts serves as a Cyber Range Engineer for CEROC. In his role, Mr. Potts is responsible for the cybersecurity laboratory testbeds, managing all cybersecurity interest groups, and liaising with the CyberEagles and WiCyS cyber student organizations. Mr. Potts holds a B.S. and M.S. in Computer Science, focusing on cybersecurity concerns in smart manufacturing.

Our Facilities

Administrative Spaces

As of July 2024, CEROC has five administrative spaces assigned to the center that include office space for the director, two associate directors, a project manager, two cyber range engineers, and a cyber outreach coordinator.

Mobile Classroom Support

Tennessee GenCyber on Wheels (TGoW) Mobile Classroom

The TGoW program is the next generation of GenCyber outreach programs by CEROC. This program takes the best practices and content from the center's years of experience with the GenCyber summer program and turns it into a year-round mobile classroom event. Using mobile classroom-optimized GenCyber lesson plans, our dedicated mobile classroom instructor conducts week-long events at participating schools. The TGoW can take two forms: mobile classroom or library takeover.

In the mobile classroom model, the STEMobile from the Millard Oakley STEM Center is transformed into a cyber mobile classroom. Lessons are conducted in 30-minute blocks with up to 25 students participating in a single session. In the library takeover model, the school provides a classroom (or library space) where equipment will be set up for 30-minute lessons with up to 25 students participating in a single session. In addition to the lesson, the CEROC team will also provide teacher/counselor professional development, parent engagement meetings, and ready-to-use lesson plans to the school. Host schools are encouraged to contact neighboring schools to ensure the resources are consistently used throughout the week-long engagement.

Cyber (Eagles) Range

Team Room

The CEROC Cyber (Eagles) Range – Team Room is a laboratory space consisting of six, four-person team workstations. This space is supported by virtualization hardware located in the university's datacenter.

In addition to the virtual air-gapping provided by the virtualization software, the room is also physically and logistically air-gapped through the wired and wireless network supported by Information Technology Services (ITS). Design was based on an immersive, collaborative concept, and the stand-up stations provide a 49-inch display allowing students to plug in their own laptops (or center-owned equipment) to collaboratively work within the group. The room has a collection of portable whiteboards which can be configured to facilitate the needs of working teams at any given time. Aside from the team workstations, the room also has a regular four-person conference table in the center of the room to facilitate small group conferences where only whiteboards may be needed. The space has been designed to support multiple use cases including:

- Cybersecurity course support active learning
- Competition team training
- Workshop training
- R&D (using actual hardware or virtualized hardware)

Infrastructure- Hardware

The CEROC Cyber Ranges consists of two (2) sets of three (3) VMware ESXi 7.0 servers arranged in a highly coupled network via 10Gb connections using separate channels for control and data. Each system is configured as follows:

- 2 AMD EPYC 7501 2.0GHz/2.6GHz processors
- 32 physical cores / 64 hyper threads per processor
- 1 TB RDIMM 26666MT/s dual rank memory
- 84 TB of shared storage via VSAN

In FY 23, CEROC expanded the range to include GPU offerings in support of AI-informed cybersecurity research. The additional system included:

- 2x Intel Xeon Gold 5320 26-Core Processors

- 1TB RAM
- 4x NVIDIA A100 80GB GPUs

The addition of GPUs was needed to facilitate machine learning on live malware on an active "victim" machine. These GPUs can be utilized for local cybersecurity experiments that involve malware or any niche problem that is more feasible on the Cyber Range than the on-campus HPC. CEROC has the ability to slice the GPUs into smaller GPUs so that more research can be done at once.

Since the installment of the new GPU node, testing has been on-going to determine the research capacity of the current configuration. Testing has been conducted with machine learning stress tests and quantum computing simulation. These tests have been very positive as we could simulate a 24-qubit quantum computer using a GPU-enabled library. Current calculations suggest that around 10 - 15 GPU-heavy research projects can occur on the new GPU node. This number can change depending on each environment's memory and GPU requirements as the node is limited to 1TB of RAM, with 64GB being the minimum requirement per GPU-enabled machine deployed.

Infrastructure- Software

The addition of new hardware and the requirements of our students, faculty, and staff being ever-changing, software development has been in full swing. Starting in 2019, CEROC produced an in-house automation platform that facilitates our virtual infrastructure deployments.

PTerraDactSL is a **P**seudo-**T**erraform **D**omain **S**pecific **L**anguage to automate virtual infrastructure for cybersecurity education. It functions as a shorthand syntax for building cybersecurity training infrastructure. Since its creation, this project has been ongoing. Built with Hashicorp's Terraform as the base, expansions have been made to keep up with the changes made to Terraform. These changes started with the addition of the NVIDIA A100 GPUs to facilitate the automated deployment of GPU-enabled research environments.

Other software expansions include creating and using a central SaltStack "grandmaster" on the Cyber Range. This was implemented in FY23 to control the configuration of all machines from one location. Previously, each project had its controller, which is unchanged, but we have welcomed the addition of central configuration management now.

Lab Expansion

The field of cybersecurity is constantly evolving, so educators need to be able to keep up with demand. Developed as part of the C2E grant in FY22, "Foyer University" is an automated lab environment for students to have a realistic training environment for configuration, implementing security policies, monitoring attacks, and more! This project was deployed in FY23.

In this pilot project, we developed specialized training infrastructure mimicking four real world environments: finance, healthcare, education, and industrial control systems. This allowed trainees to experience what it is like to work as a security professional in these real-world job sectors. To simulate all these areas in a single, cohesive environment, "Foyer University" was born. This fictional university has an onsite bank, hospital, factory, and educational spaces. This setup allows for students to participate in

any of the areas that interest them, as well as allowing them to practice general security concepts and applications. While most of these areas might be self-explanatory, the addition of the factory was to facilitate sensor networks and SCADA systems in a location that made sense. This project encourages practical application in these interest areas and allows compliance and regulation standards to be learned in a matching environment. Some of these standards include:

- PCI
- HIPAA
- FERPA
- CISA (ICS) best practices

This environment was a pilot to the C2E project and was introduced to a group of six veterans for a 3-month starter program into cybersecurity in the fall of 2022. This project was then transformed into a workshop at the 2023 WiCyS conference.

Current expansions as of 2023 include more "user" automation that give the environment a realistic feel, better modularity of environment states for module lessons, and the addition of more area specific software.

Software Systems Expansions

A CEROC web portal is in progress, but it is still in the early stages of development. This portal will allow educators to more easily request environments that will then be automatically deployed after being reviewed by a Cyber Range Engineer. The portal will allow students to access environments via the Guacamole application and keep track of work while in the portal. This portal will facilitate outreach by allowing non-university students to access the Cyber Range more easily.

Other expansions include further development to the automation platform "PTerraDactSL" and the addition of a new cluster. This cluster will be a cyclical upgrade to replace the initially added cluster. While this is a replacement, the older cluster will remain, but not under a maintenance agreement.

Programs Supported by Cyber Range

The cyber range supports the work of multiple classes and programs within the Center and Department of Computer Science. These supports include:

Direct Class Support

The Cyber Range is used heavily in the cybersecurity courses at Tennessee Tech. Some of these courses include CSC 3570 (IT Security) and CSC 6575 (Internet Security). These courses are the heaviest course load on our systems with CSC 3570 using almost an entire node. The Cyber Range is also leveraged in other courses where pre-configured development virtual machines are required, but the students don't have the proper hardware to run them. Some of these courses include CSC 3300 and CSC 3410. Other courses such as CSC 7570 utilize the sandbox nature of our systems for machine learning labs with malware. A list of courses that have requested labs/machines on the Cyber Range are:

- CSC 2570
- CSC 3570

- CSC 3300
- CSC 3410
- CSC 4615
- CSC 4575
- CSC 6575
- CSC 7570

Informal Education

Informal education is handled by the TN Tech CyberEagles cyber interest groups (CIGs). There are two CIGs that use the Cyber Range for informal labs, development, and competition practice. These groups are the offense cyber interest group (OCIG) and the defense cyber interest group (DCIG). Every semester the CIG leaders will work with the Cyber Range Engineers to develop a large lab environment that will encompass their labs and competition practice. These groups meet bi-weekly and can have an attendance of 20 – 30 students (depending on exam schedules). These groups will train for competitions such as DoE CyberForce, Hivestorm, Collegiate Cyber Defense Competition (CCDC), Collegiate Penetration Testing Competition (CPTC), and National Cyber League (NCL). These competitions occur yearly and are trained for on the Cyber Range year-round.

Student Research and Development Labs

The primary goal for these spaces is to provide researching students a quiet place to work in between classes and meetings. The Student Research and Development Lab (PRSC 416) is an area providing 20 workstation areas for students participating in the CyberCorps SFS, Cybersecurity Scholar, or CEROC-funded research programs. Each workstation provides a work surface with two hard-wired network connections, university wireless connections, and a storage cabinet. The area also provides a general office work counter and a high-performance B/W copier. A large message board display provides rotating information slides about upcoming deadlines and events. Like the Cyber (Eagles) Range, the area has multiple, rolling whiteboards to create ad-hoc collaboration spaces for students working on common projects. The area is built upon an open-concept model with half-wall workstations encouraging peer collaboration.

CEROC added a second R&D Laboratory (PRSC 413) space during the Spring 2021 semester. The space is identical to the existing 20-student space. This space addresses growth in both the CyberCorps SFS and DoD CySP programs and our growing graduate/research assistant group.

Multi-Center Video Conference Room

The SIP-enabled conference room (PRSC 227) can natively host Skype and Zoom conferences. Aside from group meetings, this video-capable room can support remote training.

Other Tennessee Tech Computing Facilities

Tennessee Tech's shared high-performance computing (HPC) facility includes the Impulse cluster, launched in 2017, and the Warp 1 cluster (NSF award 2127188), launched in 2023. Both clusters are managed by Information Technology Services (ITS) and are available to all campus researchers and classes.

The Impulse cluster includes:

1. 42 CPU compute nodes, each with 28 CPU cores (Intel Xeon E5-2680v4, 2.4 GHz) and 64–896 GB RAM
2. 2 GPU compute nodes, each with 28 CPU cores (Intel Xeon E5-2680v4, 2.4 GHz), 384 GB RAM, and two NVIDIA K80 GPUs (presented as four GPU devices).
3. 56 Gb non-blocking InfiniBand network

The Warp 1 cluster includes:

1. 10 GPU compute nodes, each with 128 CPU cores (AMD Epyc 7713, 2.0 GHZ), 512 GB RAM, and two NVIDIA A100 GPUs
2. 100 Gb non-blocking InfiniBand network

Both clusters share 175 TB NFS file storage connected to Impulse's InfiniBand network. Both clusters include a variety of open-source and commercial software applications supporting research and education for areas including artificial intelligence/machine learning, bioinformatics, computational fluid dynamics, finite element analysis, and molecular dynamics, plus support for secure container-based applications promoting reproducible research, computational mobility, and increased compatibility.

After a brief consultation, all HPC resources are available to all Tennessee Tech researchers. Researchers can get help with software installation and licensing, working with the queueing system, developing workflows, and necessary end-user training.

ITS' HPC Systems Administrator, Dr. Mike Renfro, served as an NSF XSEDE Campus Champion for Tennessee Tech and continues to work with the NSF ACCESS program, facilitating the use of several NSF-funded supercomputing centers around the country, helping researchers find appropriate external resources as needed. Sharon Colson and Jim Moroney work as Student Research Computing and Data Facilitators, assisting with cluster management and working with researchers to adapt their workflows to the local HPC environment and other facilities, including NSF ACCESS resource providers.

Other Matter

The Cybersecurity Education, Research, and Outreach Center (CEROC) at Tennessee Tech University is a leading hub for innovation and collaboration in cybersecurity and related disciplines. From cutting-edge testbeds for drones, quantum key distribution, and smart manufacturing to high-performance computing facilities, CEROC empowers students, researchers, and industry partners to tackle real-world challenges.

A cornerstone of CEROC's success is its shared governance model, particularly with Tennessee Tech's Information Technology Services (ITS). This partnership enables effective management of key resources like the CEROC Cyber Range, which leverages ITS-supported hardware for secure, dynamic environments crucial for education, outreach, and research. Additionally, CEROC benefits from ITS's high-performance computing clusters, including the Impulse and Warp 1 systems. These clusters provide robust

infrastructure for advanced computational research in areas such as artificial intelligence, bioinformatics, and cybersecurity.

By fostering collaborations with ITS, Oak Ridge National Laboratory, and other key stakeholders, CEROC ensures its resources are utilized effectively to deliver transformative education and research experiences. With its state-of-the-art infrastructure and emphasis on shared governance, CEROC continues to lead the way in safeguarding critical systems, advancing cybersecurity knowledge, and equipping future leaders to address the evolving challenges of the digital landscape.

CEROC FY 24 Financials

CEROC 2024 Summary Sheet				
Budget Pools	**Budget**	**Spent**	**Committed**	**Available Balance**
Personnel	$ 757,740.00	$ 503,613.01		$ 254,126.99
Benefits	$ 212,597.00	$ 148,650.53		$ 63,946.47
Travel	$ 80,000.00	$ 74,188.66		$ 5,811.34
Operating	$ 758,352.00	$ 158,816.23		$ 599,535.77
Equipment	$ 184,121.00	$ 184,120.65		$ 0.35
Total				**$ 923,420.92**

CEROC ended FY 24 with several pending projects extending into and expenditures not being realized until FY 25. Among these projects:

- $220,000 – New compute/storage stack for the CEROC Cyber Range and extending maintenance agreements on existing hardware through November 2027.
- $100,000 – New cyber faculty startup package support
- $220,000 – Support for MInDS establishment mini-grant (2 years)
- $150,000 – Support for the expanded mini-grant program to promote new research initiatives

CEROC FY 25 Base Projections

FY 25 Summary Budget Plan

Category	Revenues Amount	FY 24 Carryover Expense	FY 25 Budget Expense
Approved FY 24 Carryover	$893,244.00		
Dual Enrollment Allocation (non-recurring)	$-		
State Allocation (recurring)	$1,000,000.00		
Total Revenues	**$1,893,244.00**		
Salaries and Benefits Budget Pool			
Faculty Salaries			$109,969.39
Faculty Release			$7,500.00
Faculty Summer Pay			$51,632.50
Faculty & Acad Adjuncts		$13,900.00	
Student Hourly		$60,000.00	$90,000.00
Prof Support Salaries			$198,116.00
Engineering Research Office			$45,874.82
Post Doctorate		$241,400.00	
GA Salary			$67,900.00
Prof Support Longevity			$5,000.00
Benefits Budget Pool		$26,250.00	$153,058.62
Mobile Classroom Instructor Support		$62,500.00	
Faculty Startup Packages		$90,000.00	
Employee Loan Agreement - Prowell			$145,302.00
Dual Enrollment (development and promotion)		$70,000.00	
Conference Sponsorships		$5,000.00	
Travel Budget Pool		$10,000.00	$35,750.00
Workforce Development Budget Pool			
STEMobile		$22,000.00	
Research Development Budget Pool			
Outreach Material Support			
CyberRange			$25,000.00
Operating Expense Budget Pool			$50,000.00
Ashraf Islam Engineering Building Maintenance / Moving Expenses		$58,709.83	
Total Expenses		**$601,050.00**	**$985,103.33**
Projected FY 25 CarryOver	**$307,090.67**		

Appendix 1 – Cyber Competitions Results

CPTC

On October 15, 2023, CEROC hosted the Colligate Penetration Testing Competition where teams from BYU, DSU, ETSU, KSU, Liberty University, Tulsa, UNG, UTSA, and Tennessee Tech performed penetration tests on Robert A. Kalka, a fictitious metropolitan sky port. All nine teams performed well, with UTSA placing first, DSU, Liberty University, and Tulsa winning wildcards and all four teams gaining a spot at the global competition. Our team consisted of Nick Omelchenko, Jake Keenan, Lance Young, Grant Palasak, Brendan Jackson, and Landon Crabtree.

Hivestorm

On October 15, 2023, Tennessee Tech had a total of 6 teams compete in Hivestorm. The competition had about 250 teams competing, and we had teams placed 10th, 15th, and 82nd. Our 10th place team was Joey Milton, Nate Dunlap, Grayson Mosley, and Mitchell Kiriazes. Our 15th place team was captain Chandler Cook, Gabriel Adams, JP Ognibene, and Landon Foister. Our 82nd place team was captain Laurae Thaete, Danny Vela Hernandez, Julian Trujillo, and Vincent Pestilli.

MITRE eCTF

During the spring semester we had a team participate in the MITRE eCTF competition for the first time. This team was cross-disciplinary between Computer Science and Electrical Engineering. They were tasked with securing a medical device that had insecure hardware. Our team placed 9th out of 90 teams that competed. The team was Landon Crabtree, Lance Young, Johnny Mac Brettlinger, Anna Timmcke, Jaxson Billings, and Lewis Bates.

InfoSec Nashville CTF

On September 26th, the InfoSec Nashville conference hosted a CTF event with any attendees. We sent a team of students to compete in the Hack-the-box style CTF. Our team placed 1st of a total of 10 other teams representing a mix of industry members and other colleges. The team was Landon Crabtree, Anna Timmcke, Landon Byrge, Nate Dunlap, and Micah Jones.

NCL – Fall 2023

During the individual game, CEROC had 11 students participate out of a total of about 3500 individual players participated and our top student placed 24th. During the team game we had 2 teams participate and our top team placed 226th. Our overall school rating was 44th out of 802 schools nationally with 74th team rank, 19th individual rank, 81st participation rank.

NCL – Spring 2024

During the individual game, CEROC had 7 students participate with the top student placing 44th. During the team game we had 1 team participate and they placed 143rd. Our overall school rating was 88th out of 737 schools nationally with 126th in team rank, 31st in individual rank, and 78th in participation rank.

CyberForce

On November 4th, Tennessee Tech had a team compete in the DOE CyberForce Competition. Our team placed 2nd from a total of 95 teams from across the nation. The team was captain Evyn Price, Nate Dunlap, Landon Byrge, Landon Crabtree, Micah Jones, and Grant Tarver.

CCDC

This year's regional competition was hosted by the Florida Institute of Technology. Our team placed second in the virtual qualifiers, competing with 36 other teams from the southeast region. The team's performance pushed them through to the regional competition which was hosted at the Kennedy Space Center. Our team placed 4th out of the top 8 in the region. The team was captain Nate Dunlap, co-captain Landon Byrge, Landon Crabtree, Brett Billingsley, JP Ognibene, Joey Milton, Micah Jones, and Johnny Mac Brentlinger.

Appendix 2 – Cyber Organization Schedules

Fall 2023

Defense Cyber Interest Group (6:00pm – 8:00pm) BRUN 228	
August 24, 2023	Intro DCIG/Linux
September 7, 2023	Scripting
September 21, 2023	Networking
October 5, 2023	OPSec
October 19, 2023	Hivestorm Prep
November 2, 2023	Firewalls
November 16, 2023	Digital Forensics
November 30, 2023	Last Chill Meeting

Offense Cyber Interest Group (6:00pm – 8:00pm) BRUN 228	
August 31, 2023	Intro & Tools
September 14, 2023	OSINT/Social Engineering
September 28, 2023	Recon & Scanning
October 12, 2023	Web-based Exploitation
October 26, 2023	Physical Attacks
November 9, 2023	Post Exploitations

CTF Cyber Interest Group (6:00pm – 8:00pm) PRSC 411	
August 28, 2023	Intro/Environment Setup
September 11, 2023	Cryptography
September 25, 2023	Web Exploitation
October 16, 2023	Network Analysis/ Log Analysis
October 30, 2023	Forensics
November 13, 2023	Open-Source Intelligence
November 27, 2023	Binary Exploitation

Cyber Eagles (11:00am – 12:00pm) PRSC 215	
August 24, 2023	Intro/CIG Intro/Joint WiCyS
September 7, 2023	Summer Intern Panel
September 21, 2023	Employees from Sandia (Alumni, CTF)
October 5, 2023	Manager from Sandia Speaker
October 19, 2023	TBD
November 2, 2023	Manager from TVA Speaker
November 16, 2023	TBD

WiCyS (11:00am – 12:00pm) PRSC 425	
August 29, 2023	Intro
September 12, 2023	Job Fair Preparation
October 24, 2023	Speaker TBD
November 21, 2023	Lightning Talks
December 1, 2023	Game Night

Spring 2023

Defense Cyber Interest Group (6:00pm – 8:00pm) BRUN 228	
February 1, 2024	Intro meeting & aptitude
February 15, 2024	Windows Tooling
February 29, 2024	Ransomware
April 11, 2024	Forensics
April 18, 2024	Joint OCIG Meeting
April 25, 2024	Detection and Response

Offense Cyber Interest Group (6:00pm – 8:00pm) BRUN 228	
January 25, 2024	Recon & Target Acquisition
February 8, 2024	Phishing & Reverse Shells
February 22, 2024	Scanning & Metasploit
March 7, 2024	Windows Hacking
March 21, 2024	Everything “Flipper Zero”
April 4, 2024	Post-Hack Procedures
April 18, 2024	DCIG Joint Meeting

CTF Cyber Interest Group (6:00pm – 8:00pm) PRSC 425	
January 22, 2024	Welcome back to CTF
February 5, 2024	Introduction to Linux Commands
February 26, 2024	Web Exploitation
March 18, 2024	OSINT
April 1, 2024	Reverse Engineering & Binary Exploitation (featuring Austin Tice)
April 15, 2024	Cryptography (or Log Analysis)

Cyber Eagles (11:00am – 12:00pm) PRSC 215	
February 1, 2024	Introduction to Cyber Opportunities
February 15, 2024	SoarCTF
February 29, 2024	Speaker
March 21, 2024	ETSU Joint Meeting/Workshop
April 4, 2024	Competition Recap
April 18, 2024	WiCyS Recap

WiCyS (11:00am – 12:00pm) PRSC 208	
February 8, 2024	Semester Kick Off
February 27, 2024	Workshop
March 19, 2024	Speaker TBD
April 9, 2024	Conference Prep
April 25, 2024	Finals Study Break

Flyer Examples Follow

CyberEagles Presents
CYBER EAGLES
Tennessee Tech University
We soar to defend
Join our Discord
Dr. Kelley Misata
Founder/CEO, Sightline Security
Hear from 2021 Cybersecurity Woman of the Year finalist, nonprofit founder, and cyber safety, privacy, and freedom of speech advocate.
When: September 21st @ 11 AM
Where: Prescott Hall, Room 215
Free food will be provided!

Sandia National Laboratories
Lunch & LEARN
with Tiawna Cayton, Sandia National Laboratories
October 5
Prescott 215
11:00 AM
Tiawna will be giving an intro to Sandia Labs, discussing the Center for Cyber Defenders (CCD) program at Sandia, as well as how to land internship opportunities!
Free food provided!
CYBER EAGLES
Tennessee Tech University
We soar to defend
Join our Discord
This event has been financially sponsored, either entirely or partially by the Tennessee Tech Student Government Association (SGA) and its SOLO Fund. The views contained herein at this event or program does not represent the views of the Tennessee Tech Student Government Association, the SGA President or other members, the University, or the Tennessee Board of Trustees. The Tennessee Tech Student Government Association is fully in accord with the belief that all events and programs should be afforded the same opportunities that all US Citizens receive from the First Amendment of the United States Constitution.

Lunch
& LEARN
OAK RIDGE
National Laboratory
with Jordan Johnson, Oak Ridge National Laboratory
October 19th
Prescott 215
11:00 AM
Jordan is a TN Tech and CyberEagles alum working as a Cyber Security Technical Professional at ORNL. Hear about his time with the club and what he's been up to at the lab!
Free food provided!
CYBER EAGLES
Tennessee Tech University
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women in CYBERSECURITY
WiCyS

TENNESSEE TECH
STUDENT CHAPTER

COME HEAR FROM SPEAKER

TORI ROBINSON

HPC CYBER SECURITY ENGINEER AT ORNL

- EXPERIENCE WORKING AT ORNL
- MAKING THE MOST OF A MALE-DOMINATED WORKPLACE

DISCORD

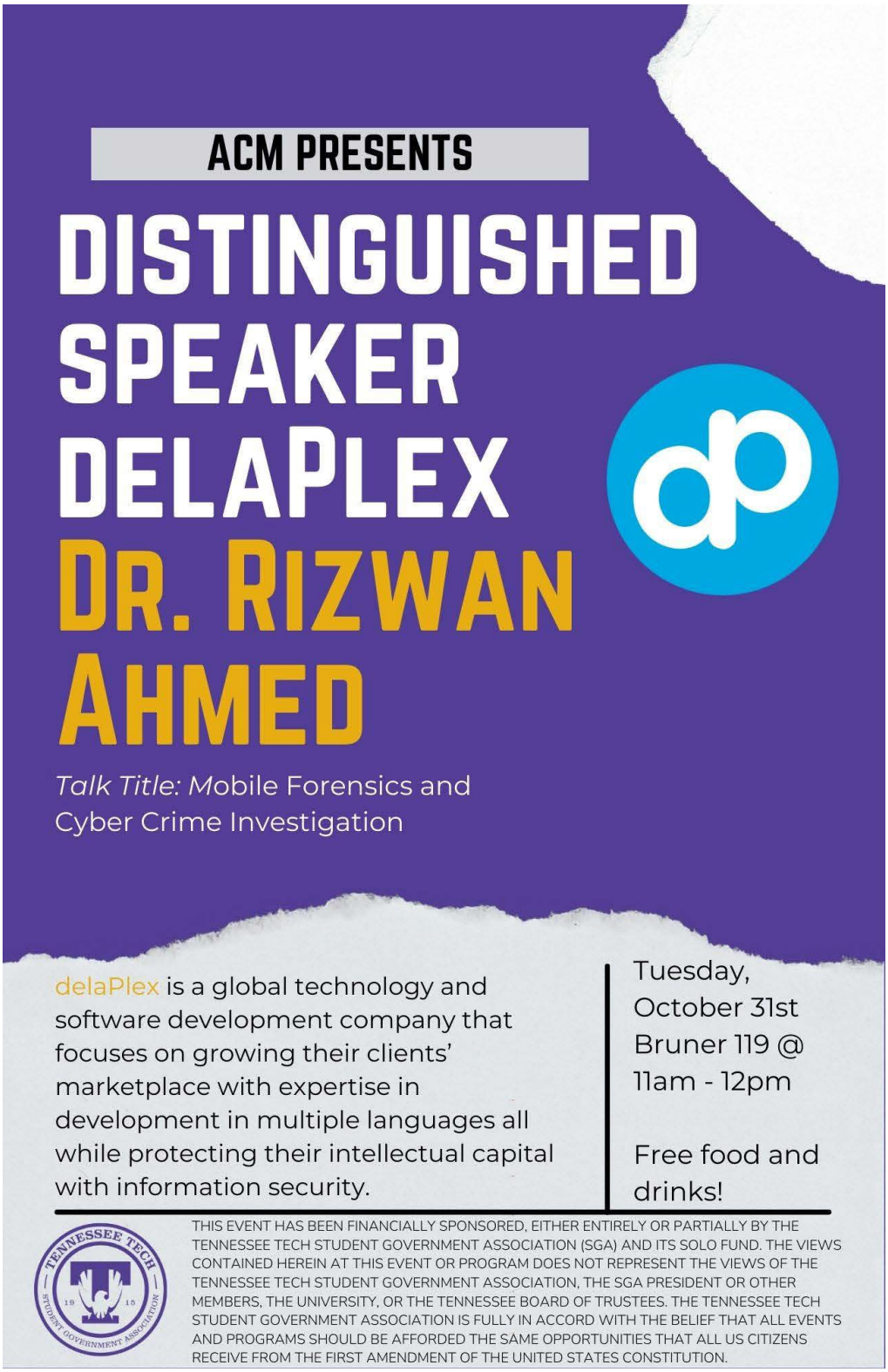
OAK RIDGE
National Laboratory

FREE FOOD AND DRINKS PROVIDED!

TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION

"THIS EVENT HAS BEEN FINANCIALLY SPONSORED, EITHER ENTIRELY OR PARTIALLY BY THE TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION (SGA) AND ITS SOLO FUND. THE VIEWS CONTAINED HEREIN AT THIS EVENT OR PROGRAM DOES NOT REPRESENT THE VIEWS OF THE TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION, THE SGA PRESIDENT OR OTHER MEMBERS, THE UNIVERSITY, OR THE TENNESSEE BOARD OF TRUSTEES. THE TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION IS FULLY IN ACCORD WITH THE BELIEF THAT ALL EVENTS AND PROGRAMS SHOULD BE AFFORDED THE SAME OPPORTUNITIES CITIZENS RECEIVE FROM THE FIRST AMENDMENT OF THE UNITED STATES CONSTITUTION."

TUESDAY, OCTOBER 24TH @ 11:00 AM, PRESCOTT 425


ACM PRESENTS
DISTINGUISHED SPEAKER DELAPLEX
DR. RIZWAN AHMED
Talk Title: Mobile Forensics and Cyber Crime Investigation
delaPlex is a global technology and software development company that focuses on growing their clients' marketplace with expertise in development in multiple languages all while protecting their intellectual capital with information security.
Tuesday, October 31st Bruner 119 @ 11am - 12pm
Free food and drinks!
THIS EVENT HAS BEEN FINANCIALLY SPONSORED, EITHER ENTIRELY OR PARTIALLY BY THE TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION (SGA) AND ITS SOLO FUND. THE VIEWS CONTAINED HEREIN AT THIS EVENT OR PROGRAM DOES NOT REPRESENT THE VIEWS OF THE TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION, THE SGA PRESIDENT OR OTHER MEMBERS, THE UNIVERSITY, OR THE TENNESSEE BOARD OF TRUSTEES. THE TENNESSEE TECH STUDENT GOVERNMENT ASSOCIATION IS FULLY IN ACCORD WITH THE BELIEF THAT ALL EVENTS AND PROGRAMS SHOULD BE AFFORDED THE SAME OPPORTUNITIES THAT ALL US CITIZENS RECEIVE FROM THE FIRST AMENDMENT OF THE UNITED STATES CONSTITUTION.

Lunch
& LEARN
TVA
with Michael Wooten, Tennessee Valley Authority
November 2
Prescott 215
11:00 AM
Michael is a manager in Configuration Management & Security in TVA Transmission. Come learn about IT/OT, security of OT devices, and more!
Free food provided!
CYBER EAGLES
Tennessee Tech University
We soar to defend
Join our Discord
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ORNL SPEAKER
FALL 2024
CYBER EAGLES
Tennessee Tech University
We soar to defend
SCAN ME
CYBER EAGLES
FREE LUNCH FOR ATTENDEES
Join Cyber Eagles as we introduce Matt Buffo, our first guest speaker of the semester! Learn about Matt's career as a Cyber-Physical Security Technical Professional with a focus on Energy Systems and Project Management!
Thursday
12TH
SEPTEMBER
11:00 A.M. - 12:00 P.M.
PRESCOTT 215
This event has been financially sponsored, either entirely or partially by the Tennessee Tech Student Government Association (SGA) and its SOLO Fund. The views contained herein at this event or program does not represent the views of the Tennessee Tech Student Government Association, the SGA President or other members, the University, or the Tennessee Board of Trustees. The Tennessee Tech Student Government Association is fully in accord with the belief that all events or programs should be afforded the same opportunities that all US Citizens receive from the First Amendment of the United States Constitution.

Appendix 3 – Publications

1. G. Nansamba, **A. Altarawneh**, and **A. Skjellum**, "A Fault-Model-Relevant Classification of Consensus Mechanisms for MPI and HPC," International Journal of Parallel Programming, vol. 51, no. 2-3, pp. 128-149, 2023.
2. M. Al Amin, **A. Altarawneh**, and I. Ray, "Informed Consent as Patient Driven Policy for Clinical Diagnosis and Treatment: A Smart Contract Based Approach," in Proceedings of the 20th International Conference on Security and Cryptography (SECRYPT 2023), pp. 159-170, 2023.
3. M. Al Amin, **A. Altarawneh**, and I. Ray, "Blockchain Smart Contracts for Policy Compliance: A Healthcare Perspective," Conference Paper, 2023.
4. **A. Altarawneh** and **A. Skjellum**, "The need for Lightweight Consensus algorithms in IoT environment," in Proceedings of the 13th International Conference on the Internet of Things (IoT '23), Article 29, 2023.
5. M. Al Amin, **A. Altarawneh**, and I. Ray, "Study on the Role of Adaptive Power Control in Jamming Mitigation for Remote Keyless Entry Systems," in IEEE Asia-Pacific Conference on Communications (APCC), 2024.
6. **J. Potts** and **M. Ismail**, "Hybrid Cyber-Physical Intrusion Detection System for Smart Manufacturing," The International FLAIRS Conference Proceedings, vol. 37, no. 1, pp. 1-6, 2024.
7. R. Atat, **M. Ismail**, and E. Serpedin, "Joint Cascade Vulnerability Assessment of Interdependent Power--Water Infrastructures," IEEE Systems Journal, vol. 17, no. 2, pp. 1025-1036, 2023.
8. S. C. Hassler, U. A. Mughal, and **M. Ismail**, "Cyber-Physical Intrusion Detection System for Unmanned Aerial Vehicles," IEEE Transactions on Intelligent Transportation Systems, vol. 24, no. 1, pp. 1-12, 2023.
9. M. M. Badr, **M. I. Ibrahem**, H. A. Kholidy, M. M. Fouda, and M. Ismail, "Review of the Data-Driven Methods for Electricity Fraud Detection in Smart Metering Systems," Energies, vol. 16, no. 6, p. 2852, 2023.
10. **M. Abouyoussef**, **M. Ismail**, and S. S. Refaat, "Secure and Privacy-Preserving Networking Strategy for Dynamic Wireless Charging of EVs," in 2023 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm), pp. 1-6, 2023.
11. **M. Gado**, **M. Ismail**, and W. O. Krawec, "Upgrading the Cyber Layer of Power Systems to Support Semi-Quantum Key Distribution," in 2024 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), pp. 1-5, 2024.
12. S. Poudel, **J. E. Baugh**, A. Takiddin, **M. Ismail**, and S. S. Refaat, "Injection Attacks and Detection Strategy in Front-End Vehicle-to-Grid Communication," in 2023 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm), pp. 1-6, 2023.

13. **B. Williams**, G. Ciocarlie, K. Saleeby, **M. Ismail**, and C. Mulkey, "Digital Twin of Cyber-Physical CNC for Smart Manufacturing," in 2023 IEEE 3rd International Conference on Digital Twins and Parallel Intelligence (DTPI), pp. 1-6, 2023.
14. **E. Mahalal** et al., "Robust Deep Learning-Based Secret Key Generation in Dynamic LiFi Networks Against Concept Drift," in 2024 IEEE 21st Consumer Communications & Networking Conference (CCNC), pp. 899-904, 2024.
15. M. Shaban and **M. Ismail**, "Secured Quantum Identity Authentication Protocol for Quantum Networks," arXiv preprint arXiv:2312.05774, pp. 1-8, 2023.
16. **M. J. Abdulaal** et al., "Privacy-Preserving Detection of Power Theft in Smart Grid Change and Transmit (CAT) Advanced Metering Infrastructure," IEEE Access, vol. 11, pp. 68569-68587, 2023.
17. M. Miller, H. Habbak, M. Badr, M. Baza, **M. Mahmoud**, and M. M. Fouda, "Electricity Theft Detection Approach Using One-Class Classification for AMI," in 2024 IEEE 21st Consumer Communications & Networking Conference (CCNC), pp. 260-265, 2024.
18. S. Abdelfattah et al., "Efficient and Privacy-Preserving Cloud-Based Medical Diagnosis Using an Ensemble Classifier With Inherent Access Control and Micro-Payment," IEEE Internet of Things Journal, vol. 10, no. 20, pp. 22080-22091, 2023.
19. A. H. Bondok, **M. Mahmoud**, M. M. Badr, M. M. Fouda, and M. Alsabaan, "A Distillation-Based Attack Against Adversarial Training Defense for Smart Grid Federated Learning," in 2024 IEEE 21st Consumer Communications & Networking Conference (CCNC), pp. 963-968, 2024.
20. **A. T. El-Toukhy**, **M. Mahmoud**, A. H. Bondok, M. M. Fouda, and M. Alsabaan, "Evasion Attacks in Smart Power Grids: A Deep Reinforcement Learning Approach," in 2024 IEEE 21st Consumer Communications & Networking Conference (CCNC), pp. 708-713, 2024.
21. **A. T. El-Toukhy** et al., "Securing Smart Grids: Deep Reinforcement Learning Approach for Detecting Cyber-Attacks," in 2024 International Conference on Smart Applications, Communications and Networking (SmartNets), pp. 1-6, 2024.
22. H. Habbak, **M. Mahmoud**, K. Metwally, M. M. Fouda, and **M. I. Ibrahem**, "Load Forecasting Techniques and Their Applications in Smart Grids," Energies, vol. 16, no. 3, p. 1480, 2023.
23. H. Habbak et al., "Efficient One-Class False Data Detector Based on Deep SVDD for Smart Grids," Energies, vol. 16, no. 20, p. 7069, 2023.
24. **P. B. Lamichhane** and **W. Eberle**, "Anomaly Detection in Graph Structured Data: A Survey," arXiv preprint arXiv:2405.06172, pp. 1-20, 2024.
25. A. A. Adeyemo, J. J. Sanderson, T. A. Odetola, F. Khalid, and **S. R. Hasan**, "StAIn: Stealthy Avenues of Attacks on Horizontally Collaborated Convolutional Neural Network Inference and Their Mitigation," IEEE Access, vol. 11, pp. 10520-10534, 2023.
26. **Z. Threet**, **M. Jones**, and **S. Shannigrahi**, "Siivn: A Framework for Enhanced Security and Interoperability in Next-Generation In-Vehicle Networks," Available at SSRN 4756104, pp. 101-108, 2023.

27. **K. Aryal**, **M. Gupta**, and **M. Abdelsalam**, "Exploiting Windows PE Structure for Adversarial Malware Evasion Attacks," in Proceedings of the Thirteenth ACM Conference on Data and Application Security and Privacy, pp. 279-281, 2023.
28. H. Manthena, J. C. Kimmel, **M. Abdelsalam**, and **M. Gupta**, "Analyzing and Explaining Black-Box Models for Online Malware Detection," IEEE Access, vol. 11, pp. 25237-25252, 2023.
29. **M. Gupta**, C. Akiri, **K. Aryal**, E. Parker, and **L. Praharaj**, "From ChatGPT to ThreatGPT: Impact of Generative AI in Cybersecurity and Privacy," IEEE Access, vol. 11, pp. 80218-80245, 2023.
30. **K. Aryal**, **M. Gupta**, **M. Abdelsalam**, and M. Saleh, "Intra-Section Code Cave Injection for Adversarial Evasion Attacks on Windows PE Malware File," arXiv preprint arXiv:2403.06428, pp. 1-12, 2024.
31. M. P. Singh, A. Anand, L. A. P. Janaswamy, S. Sundarrajan, and **M. Gupta**, "Trusted Federated Learning Framework for Attack Detection in Edge Industrial Internet of Things," in 2023 Eighth International Conference on Fog and Mobile Edge Computing (FMEC), pp. 64-71, 2023.
32. **T. Mawla**, **M. Gupta**, S. Ameer, and R. Sandhu, "The ACAC_D Model for Mutable Activity Control and Chain of Dependencies in Smart and Collaborative Systems," arXiv preprint arXiv:2308.01783, pp. 1-28, 2023.
33. **E. Becker**, **M. Gupta**, and F. M. Awaysheh, "Analyzing Edge IoT Digital Forensics Tools: Cyber Attacks Reconstruction and Anti-Forensics Enhancements," in 2023 IEEE International Conference on Dependable, Autonomic and Secure Computing, International Conference on Pervasive Intelligence and Computing, International Conference on Cloud and Big Data Computing, International Conference on Cyber Science and Technology Congress (DASC/PiCom/CBDCom/CyberSciTech), pp. 991-998, 2023.
34. A. M. Shibli, M. **M. A. Pritom**, and **M. Gupta**, "AbuseGPT: Abuse of Generative AI ChatBots to Create Smishing Campaigns," in 2024 12th International Symposium on Digital Forensics and Security (ISDFS), pp. 1-6, 2024.
35. **Q. Card**, **D. Simpson**, **K. Aryal**, **M. Gupta**, and **S. R. Islam**, "Explainable Deep Learning Models for Dynamic and Online Malware Classification," arXiv preprint arXiv:2404.12473, pp. 1-9, 2024.
36. **Q. Card**, **K. Aryal**, and **M. Gupta**, "Explainability-Informed Targeted Malware Misclassification," arXiv preprint arXiv:2405.04010, pp. 1-9, 2024.