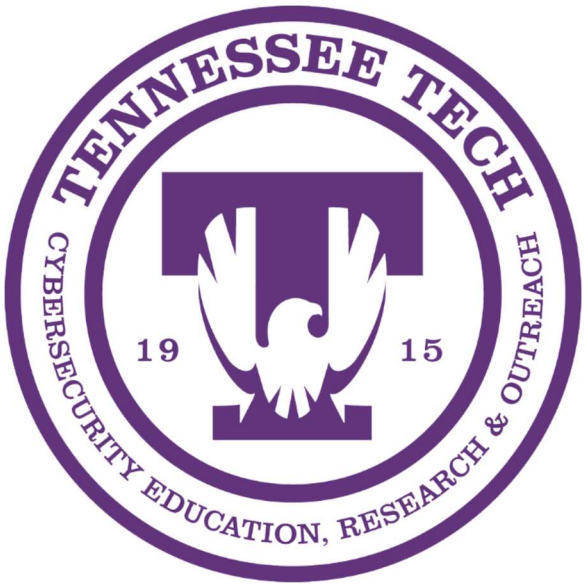

ANNUAL REPORT

Fiscal Year 2023

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

Farewell and Good Fortune

FY 23 (July 2022 to June 2023) was a growth year and a point of transition for the Cybersecurity Education, Research and Outreach Center (CEROC). After founding CEROC and serving for six years as its director, Dr. Ambareen Siraj moved to a new opportunity with the National Science Foundation. Her tenure with the center saw tremendous growth from a single focused goal to a comprehensive center with foci in all strategic areas of cybersecurity workforce pipeline development: education, research, and outreach. All efforts of the center continue to center in one of these three mission areas.

Under her leadership, CEROC developed from a university project to a nationally recognized center of academic excellence in cyber defense education by the NSA with significant contributions to the National Center of Academic Excellence – Cybersecurity (NCAE-C), NSF CyberCorps Scholarship for Service (SFS) program, and Department of Defense Cybersecurity Scholarship (CySP) program communities. Through her efforts and the CEROC staff, CEROC is a nationally recognized brand for K-16 cybersecurity workforce development efforts. Students benefiting from the center's programs have gone on to cyber defender roles in the federal government sector, state government sector, national lab infrastructure, and critical infrastructure industries.

As the center moves to a new iteration of its history, the contributions of Dr. Ambereen Siraj will long be remembered and appreciated by her co-workers and students.

CEROC (The Next Five Years)

As discussed in the pages ahead, CEROC has begun the difficult work of positioning itself for growth and expansion of services. 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 created a 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.

Modifications to the leadership structure of the center have been completed during FY 23, better enabling the center to focus on growing programs. Additionally, the center named an interim director to oversee operations while a center director search is conducted.

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. CEROC has initiated the process for the Research designation (NCAE-C R), being assigned to the January 2025 application cohort. 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.

Research support is provided to cybersecurity faculty members, ranging from securing vehicular networks to malware reverse engineering to quantum computing. 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 23, CEROC has either led or served as a collaborator to eight (8) activated projects with a financial impact of $2,292,785.95 and 11 submitted proposals totaling $4,194,285. CEROC faculty affiliates have published 58 articles across 12 cybersecurity research topics over the same period.

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.

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.

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

- Design and implementation of polos and academic stoles for CySP scholarship participants during outreach and graduation exercises.
- Creating a new DoD CySP logo, submitted and currently used by the national program.
- Contributed program management best practices to the CySP 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 38 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 a SFS scholar. 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), 54% INSuRE class, 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 be a positive influence in 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 a 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 formalized 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 76 activated proposals totaling over $11,415,993.35 on a proposal count of 119 totaling $34,354,248 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 not only helped our institution attract more 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 upon 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.

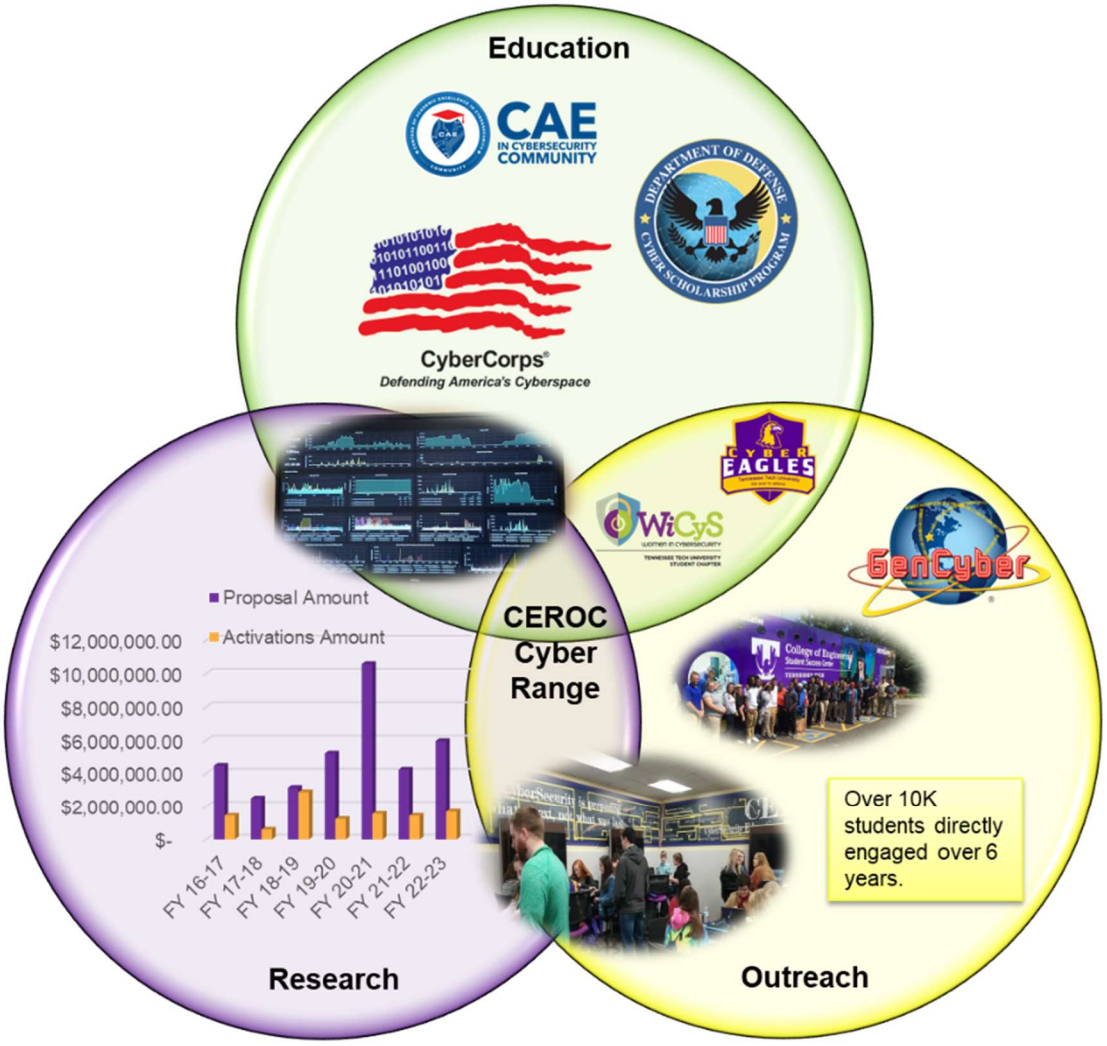
Infrastructure Strategic Goal

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

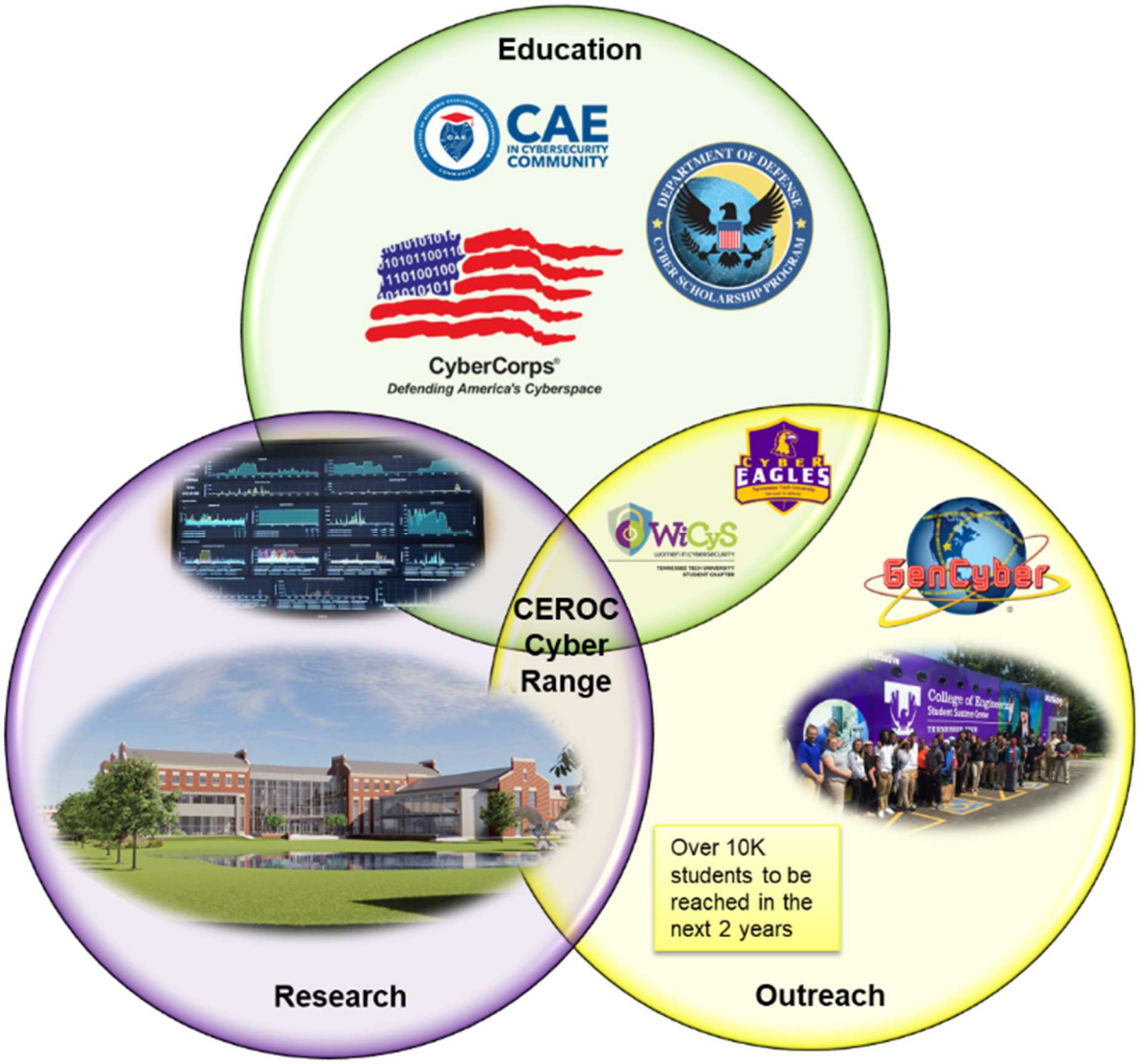
Objectives:

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 with the goals of enriching themselves and providing opportunities to enrich their peers and 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 activities such as 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 with a mission to raise computer and information security consciousness and proficiency of students in using, designing, developing and operating computing technology. The club welcomes student members interested in cybersecurity from departments across the university. Currently there are 100+ members, and membership continues to grow. 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+ members of the student organization host various professional development activities monthly 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 new cybersecurity student ambassador program. 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. The center created the CEROC Student Ambassador program for the center's FY 23 organizational expansion.

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

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 a wide variety of 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 bootcamp given such a camp did not exist for the DoD program at the time.

In 2021 with lessons learned from COVID and the award of the new CyberCorps SFS grant, 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 conducting a review of district needs, alignment of current university assets, administrative challenges, and establishment of 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 9 credit hours prior to their high school graduation will earn the certificate. Currently, the program is a "3 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 an "X pick 3" option allowing them to create course selection grouping that more aligns with their specific interest 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). 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 POLS offering for the Fall 2023 semester focusing on the policy side of cybersecurity.

CEROC has also provided sponsorship for three faculty members to complete the CITL Faculty Academy program being offered by the provost's office to accentuate online teaching skills. Beginning FY 25, all cyber dual enrollment faculty members will be required to complete the CITL Faculty Academy by the end of the first year of program participation.

Pilot Partners

Current relationships have allowed us to create pilot partnerships with Putnam County, White County, and Tullahoma City Schools. During the FY 23 year, CSC 2570 was deployed in each of these districts to gather feedback from the students. Content preparation and planning were conducted for CSC 1200 and SOC 1010 based on feedback from the CSC 2570 offerings. These schools were specifically selected due to current initiatives within the districts and a long-standing relationship that would be tolerant of the challenges encountered as part of a pilot. The school feedback was an essential part of the administrative update process.

GECC Synergistic Activities

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

- Megan Cooper has been reclassified as our Cyber Outreach Coordinator. She serves as the focal point for all K12 interactions and provides a single point of contact for all

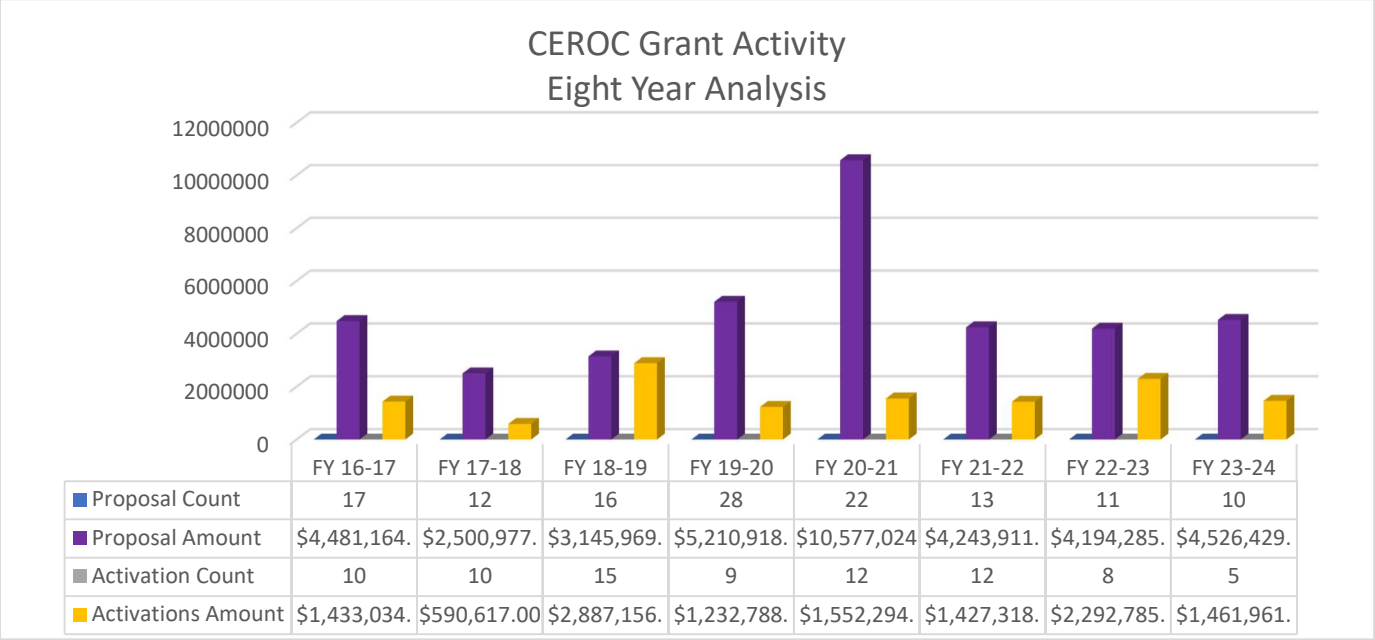
districts seeking participation in the dual enrollment program and our other curriculum offerings.

- Eric Brown has been appointed as a senior lecturer in Computer Science and serves as Associate Director of Workforce Development for CEROC. This new alignment will allow him to focus more on the dual enrollment program administration, curriculum content, and information distribution.
- Depending on the funding line, CEROC will be deploying the STEMmobile several times during FY 24 under the name CEROC on Wheels or GenCyber on Wheels. These three-day deployments will be used to
    - Introduce students to cybersecurity using 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 them with 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 is distributing 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 will include an introductory letter to the district superintendent and CTE director for the district. The number of guides per district will be prorated based on school district 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 moved up as a R2 university — a doctoral university with high research activity. This is indicative of Tennessee Tech's increased performance in research/scholarship doctoral degrees and research expenditures. With the addition of five new faculty members to Computer Science (three with a cyber focus, two with a cyber-intersecting focus) in FY 20, the center saw an increase in the number of proposals.

In Computer Science, eight faculty are active in security-related research and are working with students in 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, and 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 16-17	FY 17-18	FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24
Proposal Count	17	12	16	28	22	13	11	10
Proposal Amount	$4,481,164.	$2,500,977.	$3,145,969.	$5,210,918.	$10,577,024	$4,243,911.	$4,194,285.	$4,526,429.
Activation Count	10	10	15	9	12	12	8	5
Activations Amount	$1,433,034.	$590,617.00	$2,887,156.	$1,232,788.	$1,552,294.	$1,427,318.	$2,292,785.	$1,461,961.

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 restructuring strategy provided 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 supports to the cybersecurity research community making use of CEROC services. The faculty affiliate program provides funding in mini grant structures to encourage future investment in 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 23 Event Type	Event Count	Participant Impacts
K-12 Schools Visits	7	636
K-12,College Career Fairs	6	8200
On-Campus Group Visits	11	1246
Cyber Competitions	6	124
Webinars (sync & async)	19	193
Community College Visits	1	17
Totals	**50**	**10416**

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 for the Machine Intelligence and Data Science (MInDS) center. His primary research interests include machine learning, data minting, 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 within Computer Science.

Mr. Eric Brown serves as the Associate Director for Workforce Development at CEROC, managing daily operations of the center. 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 additionally serves as a Senior Lecturer in TNTech's Computer Science Department, teaching intro to cyber, IT security, and software engineering.

Dr. Stacy Prowell serves as 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 lifecycle in private industry and research. 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 logistics management for events. She holds a B.S. in Fashion Design and a Master of Business Administration (Information Systems Focus) both from TNTech.

Mrs. Sara Howard serves as a Project Manager for CEROC. She manages all financial transactions for the center. She also performs all pre- and post-award grant processing 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 actively collaborates with students, faculty, researchers, and external clients to deliver cybersecurity simulation solutions in complex environment. Mr. Lee also serves as an adjunct faculty member in the Computer Science Department teaching computing principles and providing support for the IT security courses. Mr. Lee holds a B.S. in Computer Science. He anticipates completion of his M.S. in Computer Science Fall 2023 with a focus area in 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, management of all cybersecurity interest groups, and liaison to the CyberEagles and WiCyS cyber student organizations. Mr. Potts holds a B.S. in Computer Science from TNTech, anticipating completing his M.S. in Computer Science May 2024 with a focus area in cybersecurity concerns in smart manufacturing.

Our Facilities

Administrative Spaces

As of August 2023, CEROC has five administrative spaces assigned to the center that includes office space for the director, two associate directors, project manager, two cyber range engineers, and a cyber outreach coordinator.

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

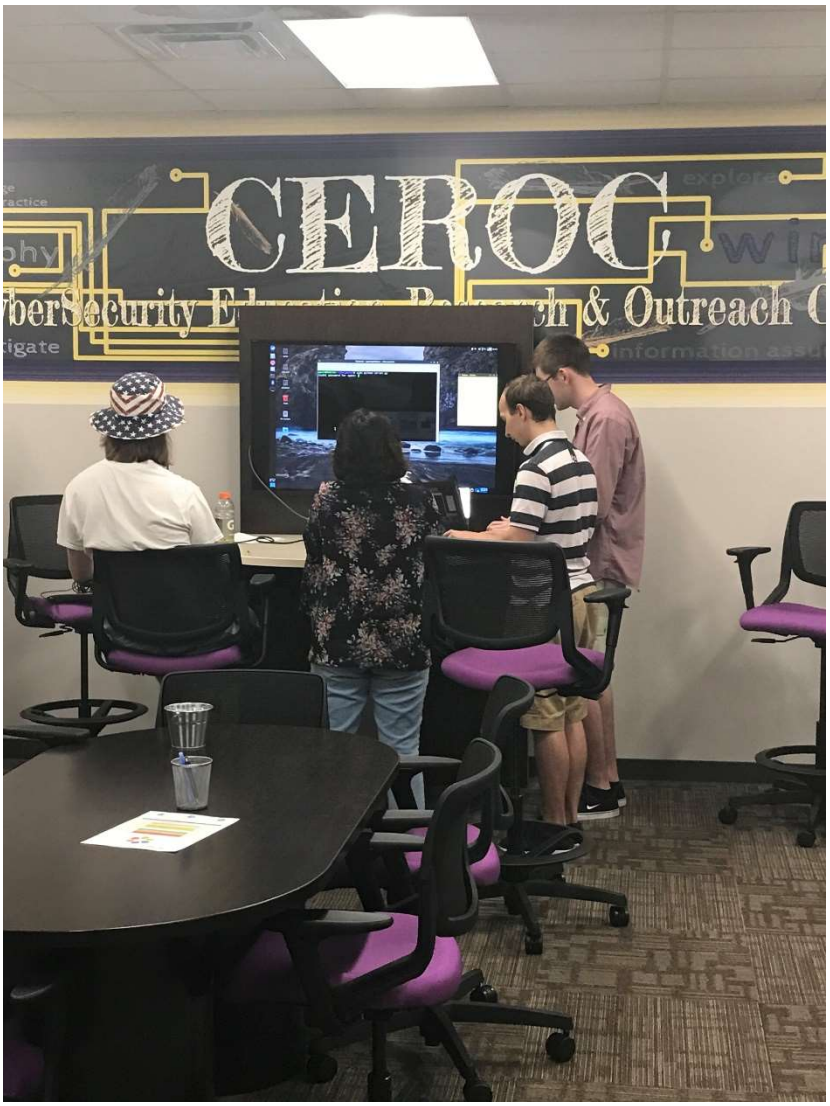
The primary goal for these spaces is to provide researching students a quiet place to work in between classes and meetings. The Student Research and Development Lab (PRSC 416) is an area providing 20 workstation areas for students participating in the CyberCorps SFS, Cybersecurity Scholar, or CEROC-funded 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.

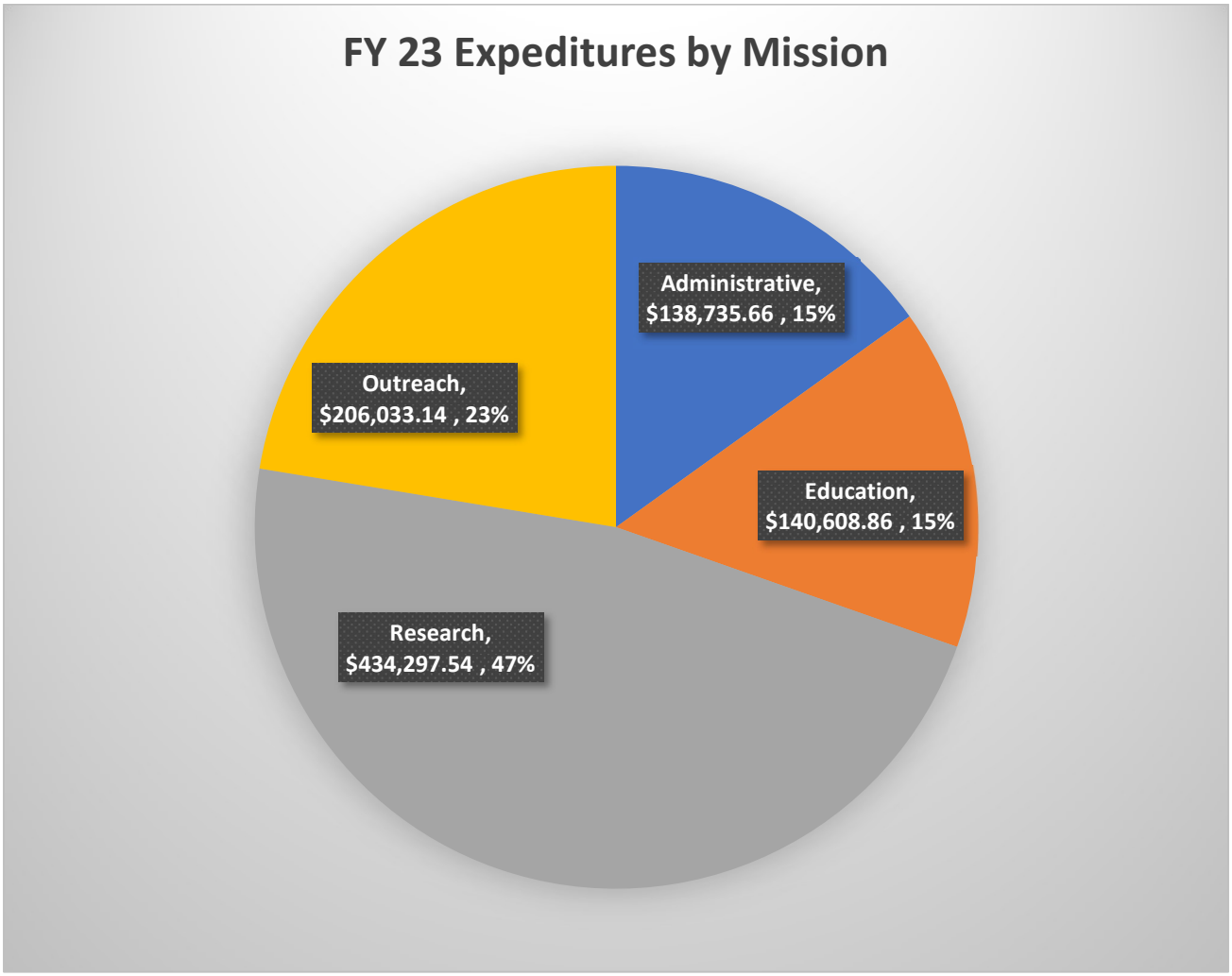
Multi-Center Video Conference Room

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.

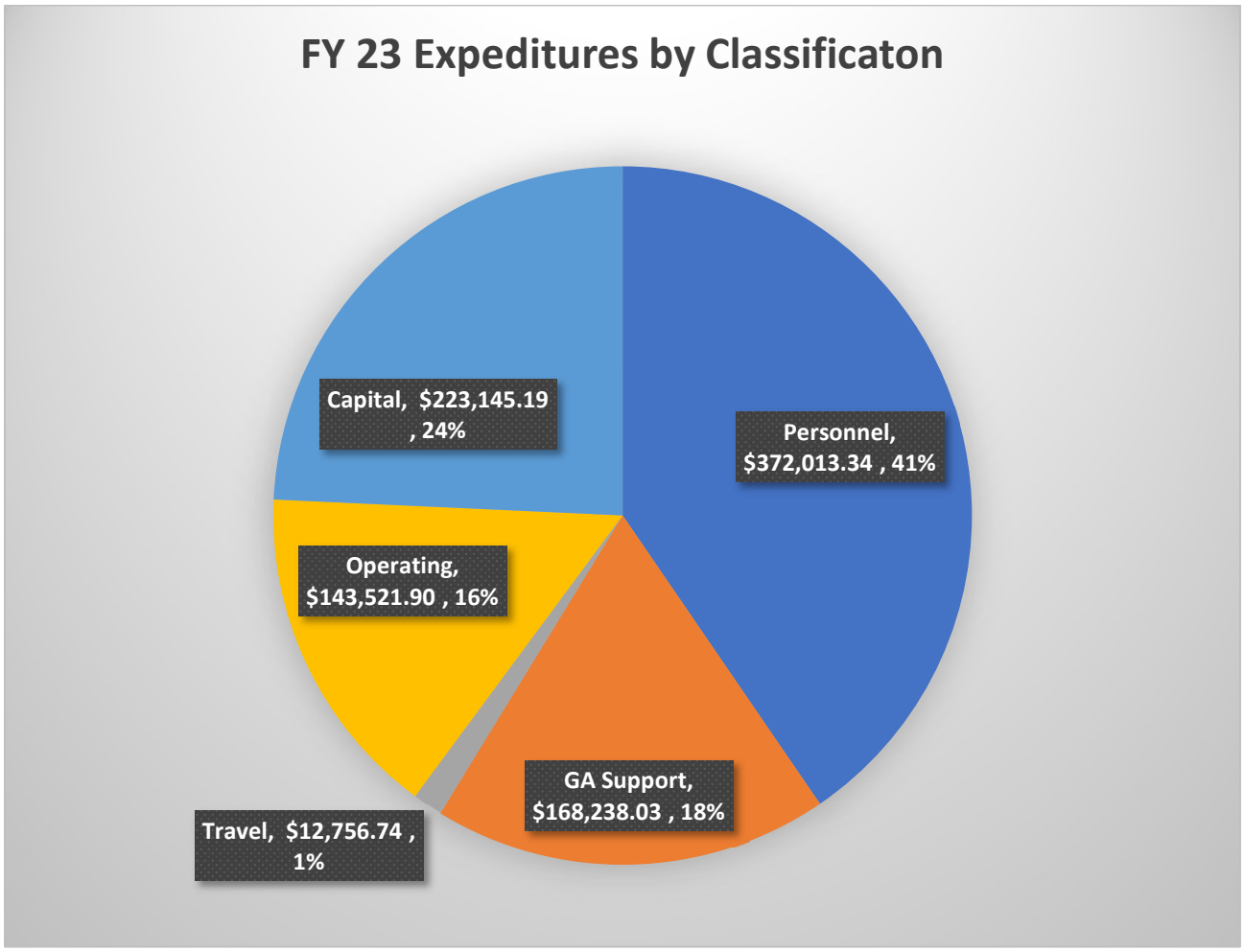


CEROC FY 23 Financials

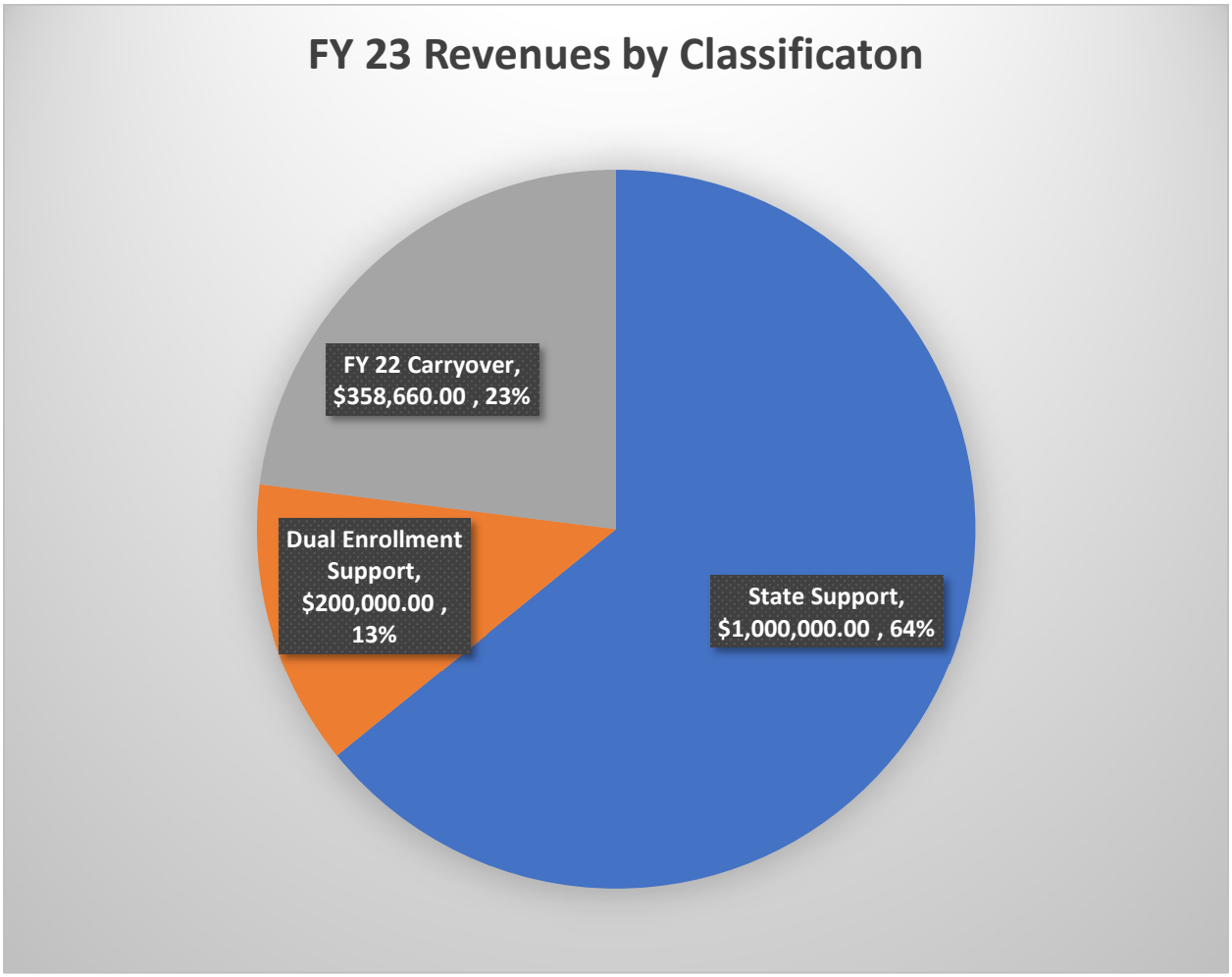
As mentioned earlier, all CEROC expenditures fall into one of the identified missions. Our research expense increase in FY 23 as a result of the expansion of the CEROC Cyber Range. Note that our administrative costs were kept to a minimum operating at 15%.



As typical for a research center, a dominant part of the operational expenditures are personnel costs. Combining CEROC staff and GA/RA supports, people costs represent over 60% of our budget. The impact was lessened by carryover from FY 22.



CEROC's primary funding source is an allocation from the State of Tennessee. Since FY 22, this has been a $1,000,000 investment. The center has also received a $200,000 allocation to develop the cybersecurity dual enrollment program. Beginning with FY 24, our primary state support will become a recurring item providing more financial stability for the center and decreasing the reliance of carryover to address yearly budget changes.



CEROC FY 24 Base Projections

FY 24 Summary Budget Plan			
Category	**Revenues Amount**	**FY 23 Carryover Expense**	**FY 24 Budget Expense**
Approved FY 23 Carryover	$ 638,985.00		
Dual Enrollment Allocation (non-recurring)	$ 200,000.00		
State Allocation (recurring)	$ 1,000,000.00		
Total Revenues	**$ 1,838,985.00**		
Salaries and Benefits Budget Pool			
Faculty Summer Pay			$ 59,940.00
Faculty & Acad Adjuncts			$ 3,750.00
Student Hourly			$ 38,400.00
Prof Support Salaries			$ 253,041.00
GA Salary			$ 142,000.00
Prof Support Longevity			$ 5,000.00
Prof Support TTU Bonus			$ 2,600.00
Benefits Budget Pool			$ 187,239.00
Director Search / Startup / Salary		$ 275,000.00	
Mobile Classroom Instructor Support		$ 90,625.00	
Faculty Startup Packages		$ 90,000.00	
Dual Enrollment (development and promotion)		$ 60,000.00	
Conference Sponsorships		$ 50,000.00	$ 15,000.00
Travel Budget Pool			$ 30,000.00
Workforce Development Budget Pool			$ 100,000.00
Research Development Budget Pool			$ 100,000.00
Outreach Material Support			$ 35,000.00
Operating Expense Budget Pool			$ 236,507.00
Total Expenses		**$ 565,625.00**	**$ 1,208,477.00**
Projected FY 24 CarryOver	**$ 64,883.00**		

Appendix 1 – Cyber Competitions Results

CPTC

On October 15, 2022, CEROC hosted the Colligate Penetration Testing Competition where teams from SMU, Tulsa, and Tennessee Tech performed penetration tests on The Cozy Croissant, a fictitious hotel chain. All three teams performed well, with Tulsa placing first and gaining a spot at the global competition, Tennessee Tech placed second, and SMU placed third. Our team consisted of Hayden Keller, Mimi Vertrees, Jacob Sweeten, Hallie Sevier, Mykola Omelchenko, and Alexander Baker. Both SMU and Tennessee Tech are waiting for the other regions to compete to see if they get picked as a wildcard to compete in the Global Competition.

Hivestorm

On October 15, 2022, Tennessee Tech had a total of 6 teams compete in Hivestorm. The competition had about 300 teams compete, and we had teams place 3rd, 31st, and 34th. Our 3rd place team was Landon Byrge, Carter Haney, Nate Whiteaker, and Daniel Fleisig. Our 31st place team was Evyn Price, Ezra Cota, Ethan Byker, and Micah Jones. Our 34th place team was Trey Burks, Mike Soare, Tate Seyler, and Nate Dunlap.

NCL – Fall 2022

During the individual game, CEROC had 14 students participate out of a total of about 3500 individual players participated and our top students placed 73rd, 331st , 340th, 374th, and 433rd. During the team game we had 5 teams participate and our top 3 teams placed 135th, 213th, and 326th.

Our overall school rating was 67th nationally with 89th team rank, 42nd individual rank, 39th participation rank. In the Eastern region, our school rating was 25th with 30th team rank, 15th individual rank, and 17th participation rank.

NCL – Spring 2023

Our overall school rating was 27th nationally with 18th in team rank, 70th in individual rank, and 72nd in participation rank. In the Eastern region, our school rating was 10th with 8th in team rank and 27th in individual and participation ranks.

CyberForce

On November 5th, Tennessee Tech had two teams compete in the DOE CyberForce Competition. One team traveled to Chicago to compete in person and placed 7th out of 170 teams. This team was Trey Burks, Mike Soare, Evyn Price, Landon Crabtree, Nate Dunlap, and Justin Presley. We had a second team compete virtually that placed 53rd out 170 teams. This team was James Massingille, Tate Seyler, Joseph Horesovsky, Micah Jones, Ryan Tomlin, and Alyssa Kitchen.

CCDC

Disqualified during main competition due to competition organizer error. Competed in the wildcard competition and placed 2nd out of 12 teams. The team was Nate Dunlap, Hayden Keller, Landon Crabtree, Landon Byrge, Mike Soare, Brett Billingsley, Evyn Price, JP Ognibene, Micah Jones, and Trey Burks.

Appendix 2 – Cyber Organization Schedules

Fall 2022

Defense Cyber Interest Group (6:00pm – 8:00pm) PRSC 411	
August 31, 2022	Intro DCIG/Linux
September 14, 2022	Documentation (MITRE, OWASP, CVEs, Policy, Standards, etc.)
September 28, 2022	Into/Intermediate Networking
October 12, 2022	Firewalls (Host/Network-Based)
October 15, 2022	**HiveStorm**
October 26, 2022	Cloud Security (AWS/Azure)
November 4 – 5, 2022	**CyberForce**
November 9, 2022	Students Choice
November 23, 2022	**Thanksgiving**
November 30, 2022	Last Chill Meeting

Offense Cyber Interest Group (6:00pm – 8:00pm) PRSC 411	
September 1, 2022	Intro
September 8, 2022	CPTC Training
September 10, 2022	**CPTC Tryout**
September 22, 2022	OSINT/Social Engineering
October 6, 2022	Reconnaissance, Scanning
October 15, 2022	**CPTC**
October 20, 2022	Web-based Exploitation
November 3, 2022	Physical (Wifi/Hotpplug)
November 4 – 5, 2022	**CyberForce Red-Team**
November 17, 2022	Post Exploitations and Maintaining Access w/ Backdoors, Rootkits
December 1, 2022	Fun Activity / Feedback

CTF Cyber Interest Group (6:00pm – 8:00pm) PRSC 411	
August 29, 2022	Intro/Environment Setup
September 12, 2022	Crypto
September 19, 2022	Wireshark/Network Traffic Analysis
September 26, 2022	Password Cracking
October 2, 2022	OSINT & Forensics
October 10 – 17, 2022	**NCL Practice Game**
October 17, 2022	Web Exploitation
October 21 – 23, 2022	**NCL Individual Game**
October 24, 2022	NCL Individual Game Review
November 4 – 6, 2022	**NCL Team Game**
November 7, 2022	NCL Team Game Review
November 14, 2022	Binary Exploitation
November 21, 2022	Nmap & Scanning
November 28, 2022	Mini CTF Comp

Cyber Eagles (11:00am – 12:00pm) PRSC 215	
August 16, 2022	Min'n'Mingle
August 25, 2022	Intro/CIG Intro/Joint WiCyS
September 8, 2022	Summer Intern Panel
September 22, 2022	Amanda Joyce, Argon National Lab
October 6, 2022	Ryan Utley, Nettitude
October 20, 2022	Speaker TBD
November 3, 2022	TVA Speaker
November 17, 2022	SoarCTF
November 22, 2022	ACM Joint

WiCyS (11:00am – 12:00pm) PRSC 225	
August 25, 2022	Intro
September 20, 2022	Speaker
October 25, 2022	Lightning Talks
November 15, 2022	Speaker/Intern Panel
November 29, 2022	Game Night

Spring 2023

Defensive Cyber Interest Group (6:00pm – 8:00pm) Bruner 228	
January 19, 2023	Aptitude Test
February 2, 2023	Everything Linux and Windows Hardening
February 16, 2023	Everything Firewalls
March 2, 2023	System Monitoring
March 16, 2023	**Spring Break**
March 28, 2023	DoE CyberForce Competition Tryouts
March 30, 2023	Scripting and Automation
April 13, 2023	Digital Forensics

Offensive Cyber Interest Group (6:00pm – 8:00pm) Bruner 228	
January 26, 2023	Red Team Fundamentals, Setting Up/Social
February 9, 2023	Recon/Nmap/Vulnerability Research
February 23, 2023	Phishing Attack/OSINT
March 9, 2023	Windows Hacking
March 16, 2023	**Spring Break**
March 23, 2023	Website Hacking
April 4, 2023	Tools Night: Flipper Zero
April 20, 2023	Speaker & Demo: Dee Zhao & Pentesting Team

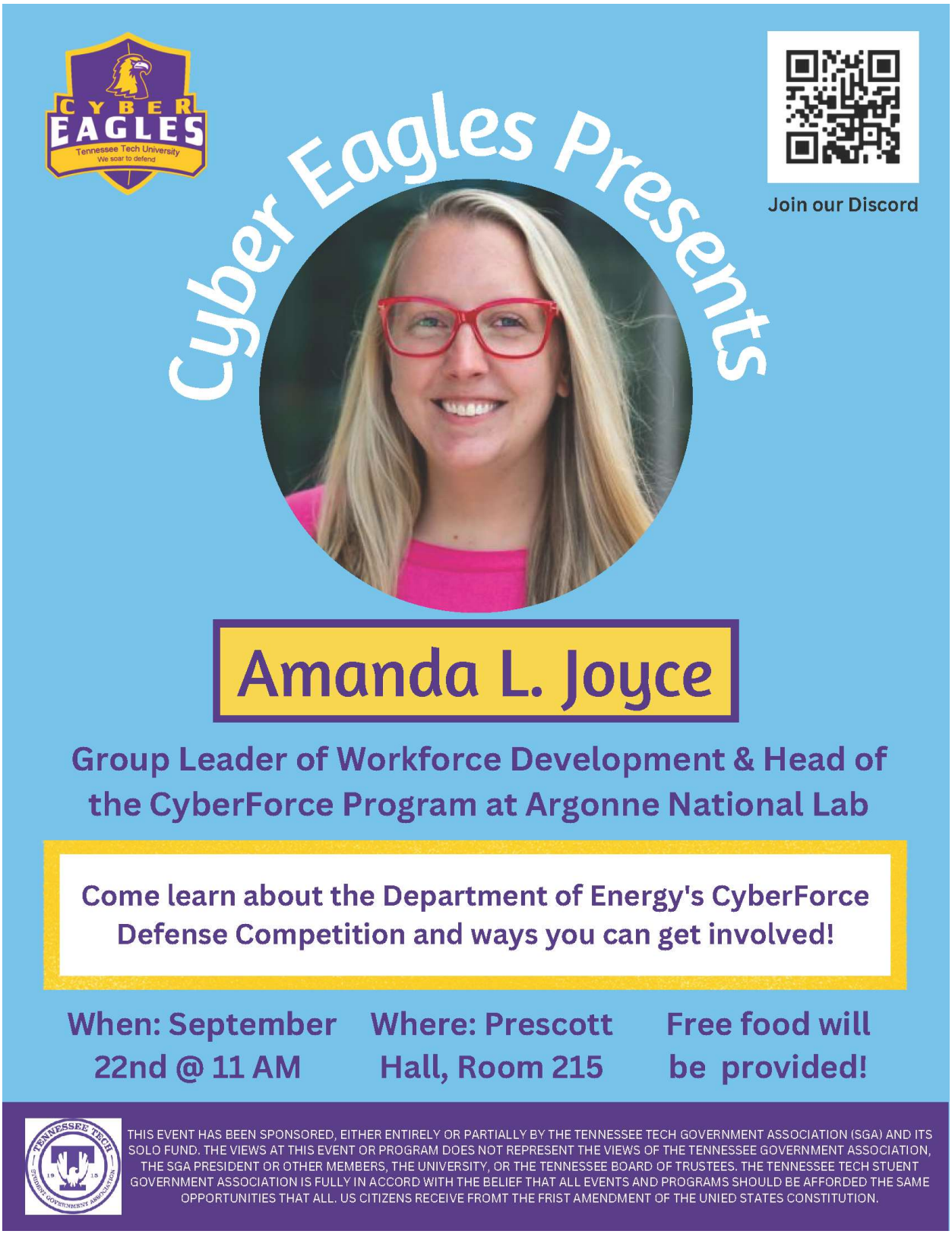
CTF Cyber Interest Group (6:00pm – 8:00pm) PRSC 411	
January 23, 2023	Back to CTF
January 30, 2023	Web Exploitation Intro
February 6, 2023	Web Exploitation Challenges/Advanced
February 13, 2023	Network Analysis Intro
February 20, 2023	Network Analysis Challenges/Advanced
February 27, 2023	Reverse Engineering Intro
March 6, 2023	Reverse Engineering Challenges/Advanced
March 13, 2023	**Spring Break**
March 20, 2023	Binary Exploitation Intro
March 27, 2023	Binary Exploitation Challenges/Advanced
April 3, 2023	Cryptography Intro
April 10, 2023	Cryptography Challenges/Advanced
April 17, 2023	Info Meeting for CTF Comp Team
April 24-28, 2023	Tryouts for CTF Comp Team

CyberEagles (11:00am – 12:00pm) PRSC 215	
February 2, 2023	Alum Panel
February 16, 2023	Dr. Stacy Prowell
March 2, 2023	Research Day
March 16, 2023	**Spring Break**
March 23, 2023	WiCyS Recap
April 13, 2023	Ryan Adamson, HPC Security
April 20, 2023	Elections

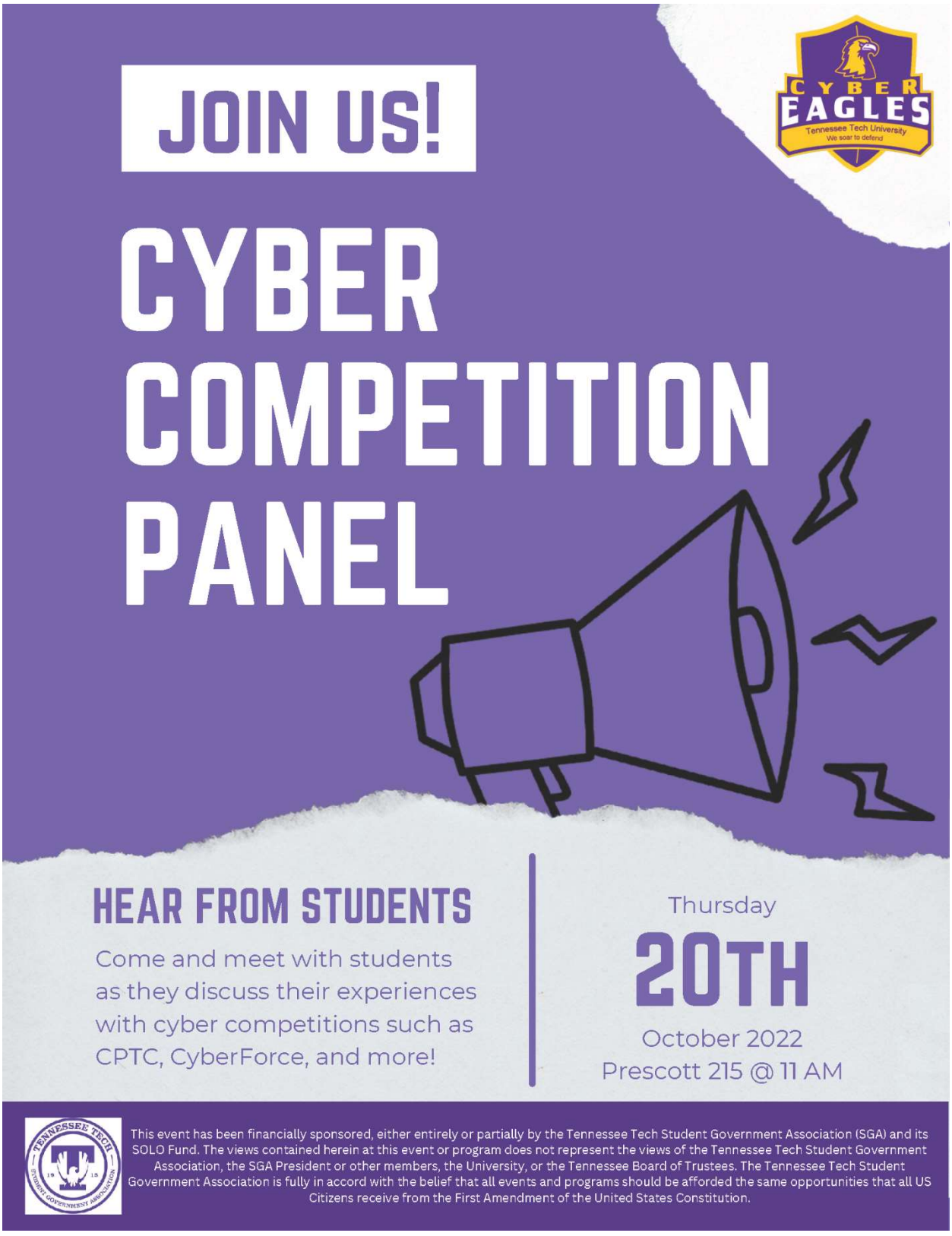
WiCyS (11:00am – 12:00pm) BRUN 410	
January 26, 2023	Careers and Coffee
February 14, 2023	Galentine's Day: Imposter Syndrome Workshop
March 14, 2023	**Spring Break**
March 21, 2023	WiCyS Conference Recap Panel
April 18, 2023 @ 6:00PM	Paint Night Party

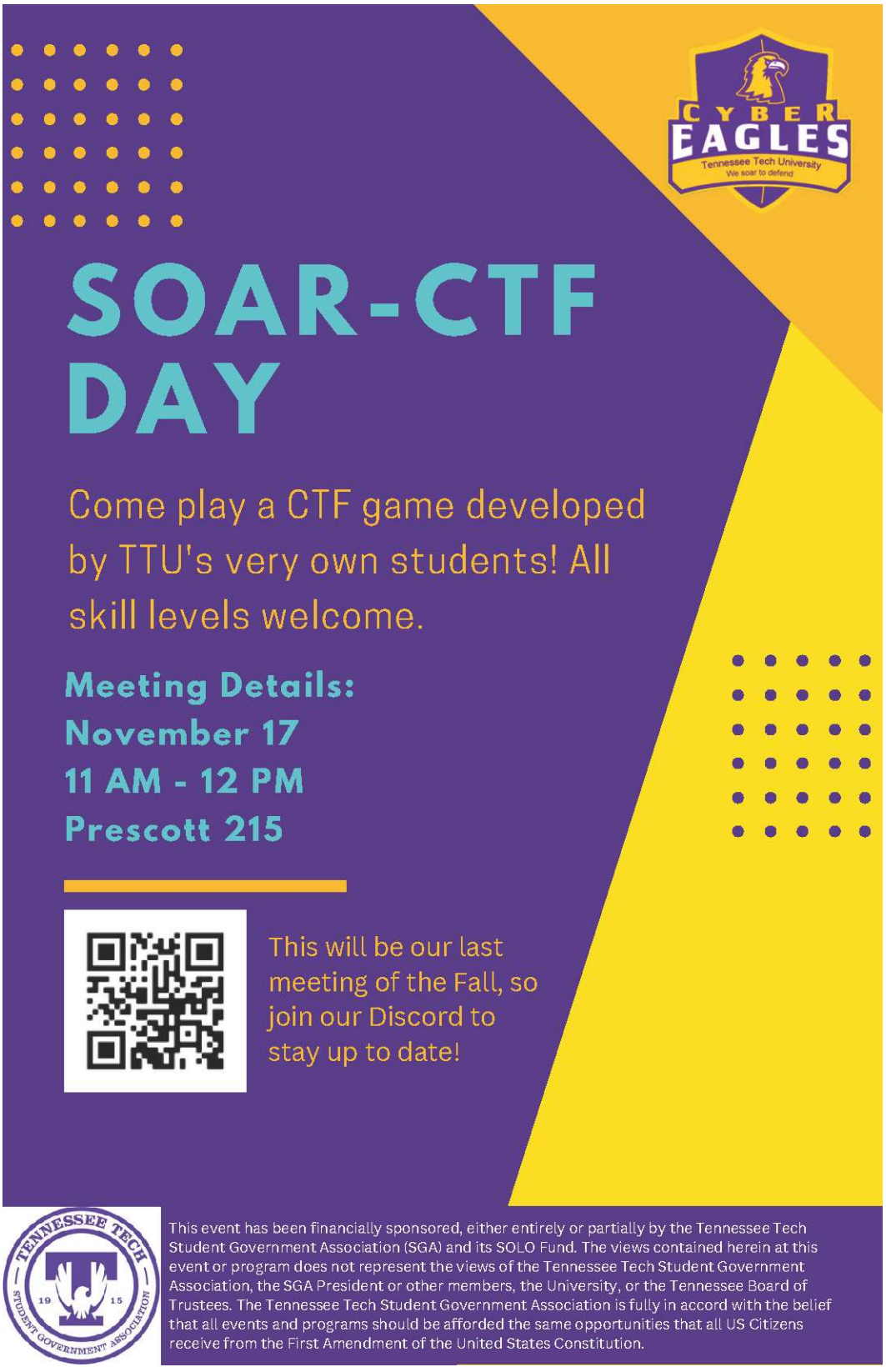
Flyer Examples Follow

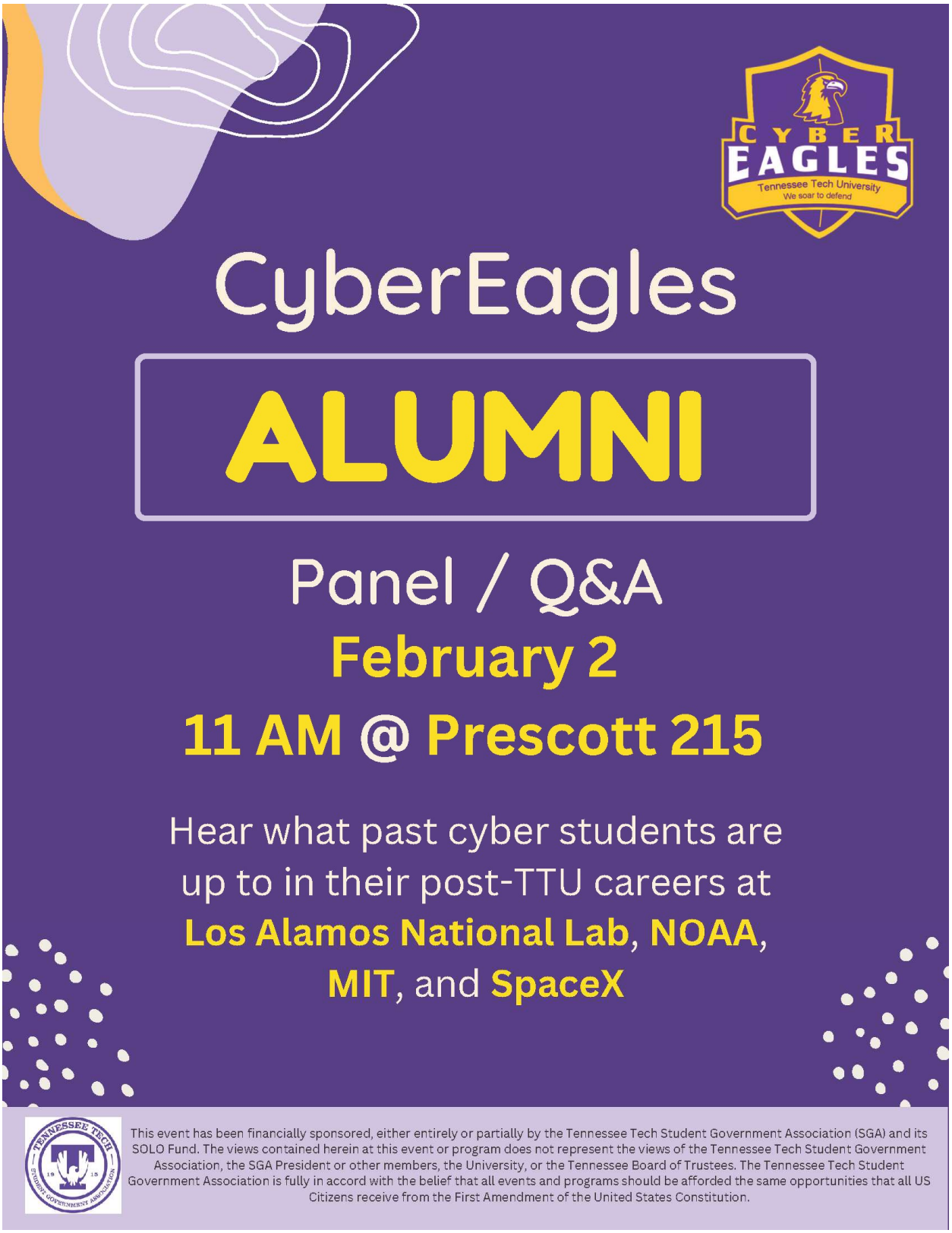
WELCOME TO CYBER EAGLES
Join the home of cybersecurity at Tennessee Tech!
Meeting Details:
August 25
11 AM - 12 PM
Prescott 215
Learn more about our offensive, defensive, and capture the flag focused interest groups as well as Women in Cybersecurity
Discord
CYBER EAGLES
Tennessee Tech University
We soar to defend


Cyber Eagles
Tennessee Tech University
We soar to defend
Cyber Eagles Presents
Join our Discord
Amanda L. Joyce
Group Leader of Workforce Development & Head of the CyberForce Program at Argonne National Lab
Come learn about the Department of Energy's CyberForce Defense Competition and ways you can get involved!
When: September 22nd @ 11 AM
Where: Prescott Hall, Room 215
Free food will be provided!
THIS EVENT HAS BEEN SPONSORED, EITHER ENTIRELY OR PARTIALLY BY THE TENNESSEE TECH GOVERNMENT ASSOCIATION (SGA) AND ITS SOLO FUND. THE VIEWS AT THIS EVENT OR PROGRAM DOES NOT REPRESENT THE VIEWS OF THE TENNESSEE GOVERNMENT ASSOCIATION, THE SGA PRESIDENT OR OTHER MEMBERS, THE UNIVERSITY, OR THE TENNESSEE BOARD OF TRUSTEES. THE TENNESSEE TECH STUENT 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 FROMT THE FRIST AMENDMENT OF THE UNIED STATES CONSTITUTION.

Cyber Eagles
Tennessee Tech University
We soar to defend
Join our Discord
Cyber Eagles Presents
Ryan Utley
Security Consultant at Nettitude
Come hear from Ryan Utley as he speaks about his experience as a security consultant in the industry, as well as opportunities at Nettitude!
When: October 6th @ 11 AM
Where: Prescott Hall, Room 215
Free food will be provided!
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.


JOIN US!
CYBER EAGLES
Tennessee Tech University
We soar to defend
CYBER COMPETITION PANEL
HEAR FROM STUDENTS
Come and meet with students as they discuss their experiences with cyber competitions such as CPTC, CyberForce, and more!
Thursday
20TH
October 2022
Prescott 215 @ 11 AM
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.


CYBER EAGLES
Tennessee Tech University
We soar to defend
SOAR-CTF DAY
Come play a CTF game developed by TTU's very own students! All skill levels welcome.
Meeting Details:
November 17
11 AM - 12 PM
Prescott 215
This will be our last meeting of the Fall, so join our Discord to stay up to date!
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.


CYBER EAGLES
Tennessee Tech University
We soar to defend
CyberEagles
ALUMNI
Panel / Q&A
February 2
11 AM @ Prescott 215
Hear what past cyber students are up to in their post-TTU careers at
Los Alamos National Lab, NOAA, MIT, and SpaceX
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
with Dr. Stacy Prowell
CYBER EAGLES
Tennessee Tech University
We soar to defend
February 16
Prescott 215
11:00 AM
Dr. Prowell is a security researcher from ORNL and cyber-security faculty member. Come hear him share a bit about his research!
Free food provided!
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.

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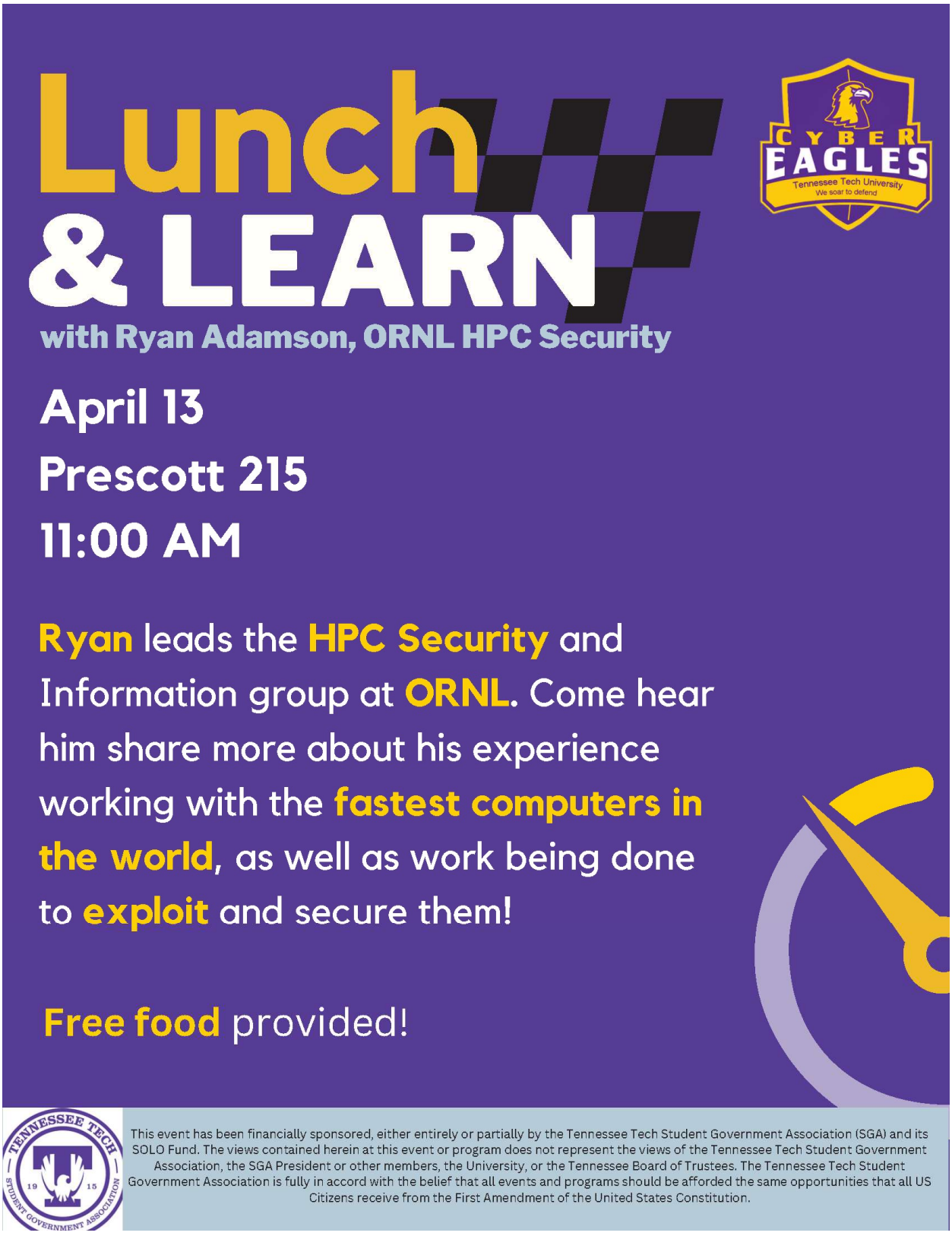
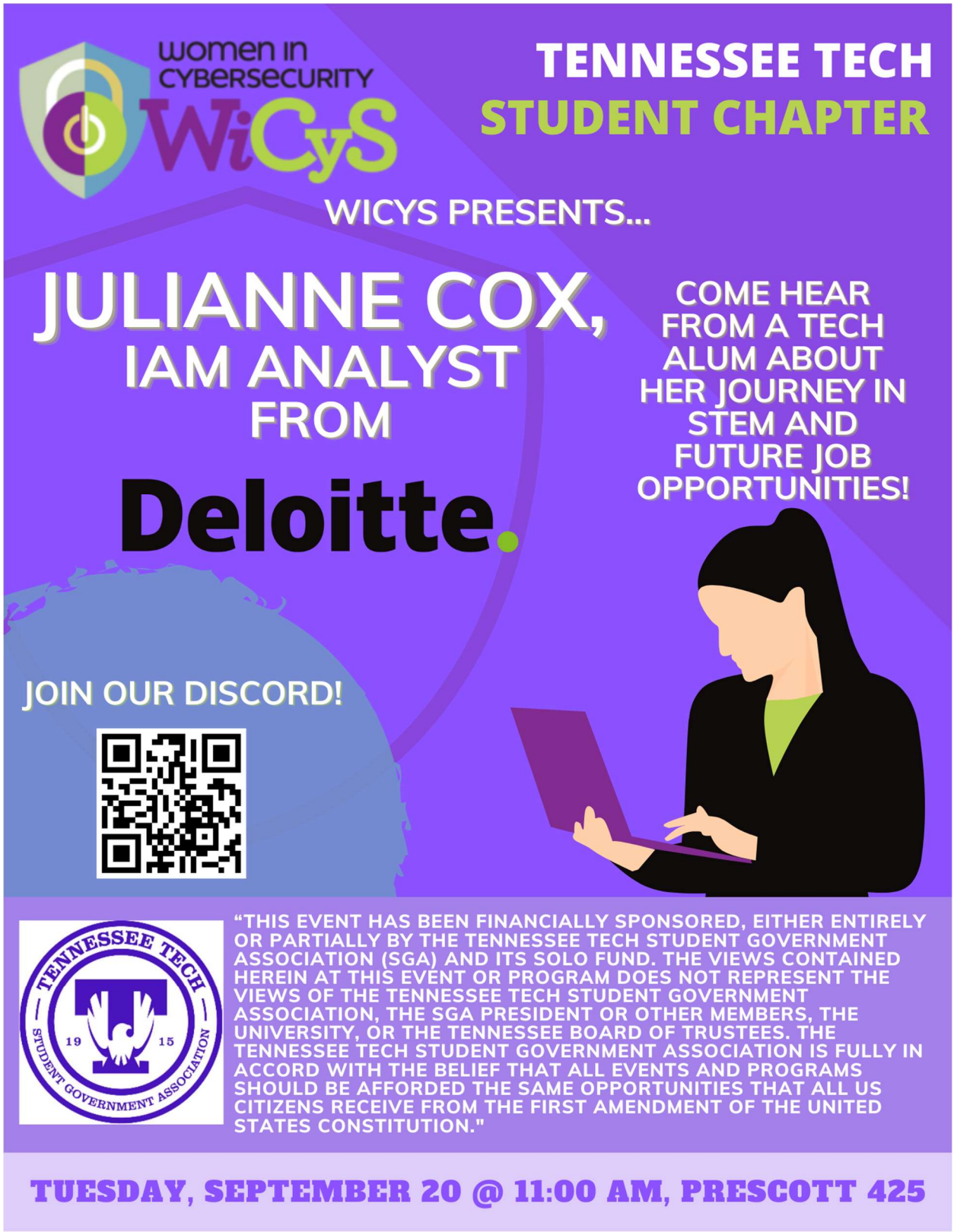
CYBEREAGLES AND WICYS PRESENT
CYBER EAGLES
Tennessee Tech University
We soar to defend
WICYS 2023
CONFERENCE RECAP PANEL
Denver 2023
women in cybersecurity
COME HEAR STUDENT EXPERIENCES!
FREE CONFERENCE SWAG!
LEARN HOW YOU CAN GO NEXT YEAR!
FOOD WILL BE PROVIDED
THURSDAY, MARCH 23RD @ 11 AM, PRESCOTT 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 and programs should be afforded the same opportunities that all US Citizens receive from the First Amendment of the United States Constitution."


Lunch
& LEARN
with Ryan Adamson, ORNL HPC Security
CYBER EAGLES
Tennessee Tech University
We soar to defend
April 13
Prescott 215
11:00 AM
Ryan leads the HPC Security and Information group at ORNL. Come hear him share more about his experience working with the fastest computers in the world, as well as work being done to exploit and secure them!
Free food provided!
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.

women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
INTRODUCTION TO WOMEN IN CYBERSECURITY
Join us to learn more about WiCyS and create a wallpaper for your desktop!
THURSDAY, AUGUST 25 @ 6:00 PM, PRESCOTT 225

Denver 2023
Women in Cybersecurity
WiCyS
March
16-18
2023
Student Scholarship applications open
NOW - Oct. 31
Call for Participation and Poster
Sessions NOW - Oct. 31
FREE SWAG
NETWORKING
VOLUNTEERING
WORKSHOPS
CAREER FAIR
KEYNOTE SPEAKERS
To apply, you must be a member
Apply to be a member here!
Use code CEROC22-23
for a free membership

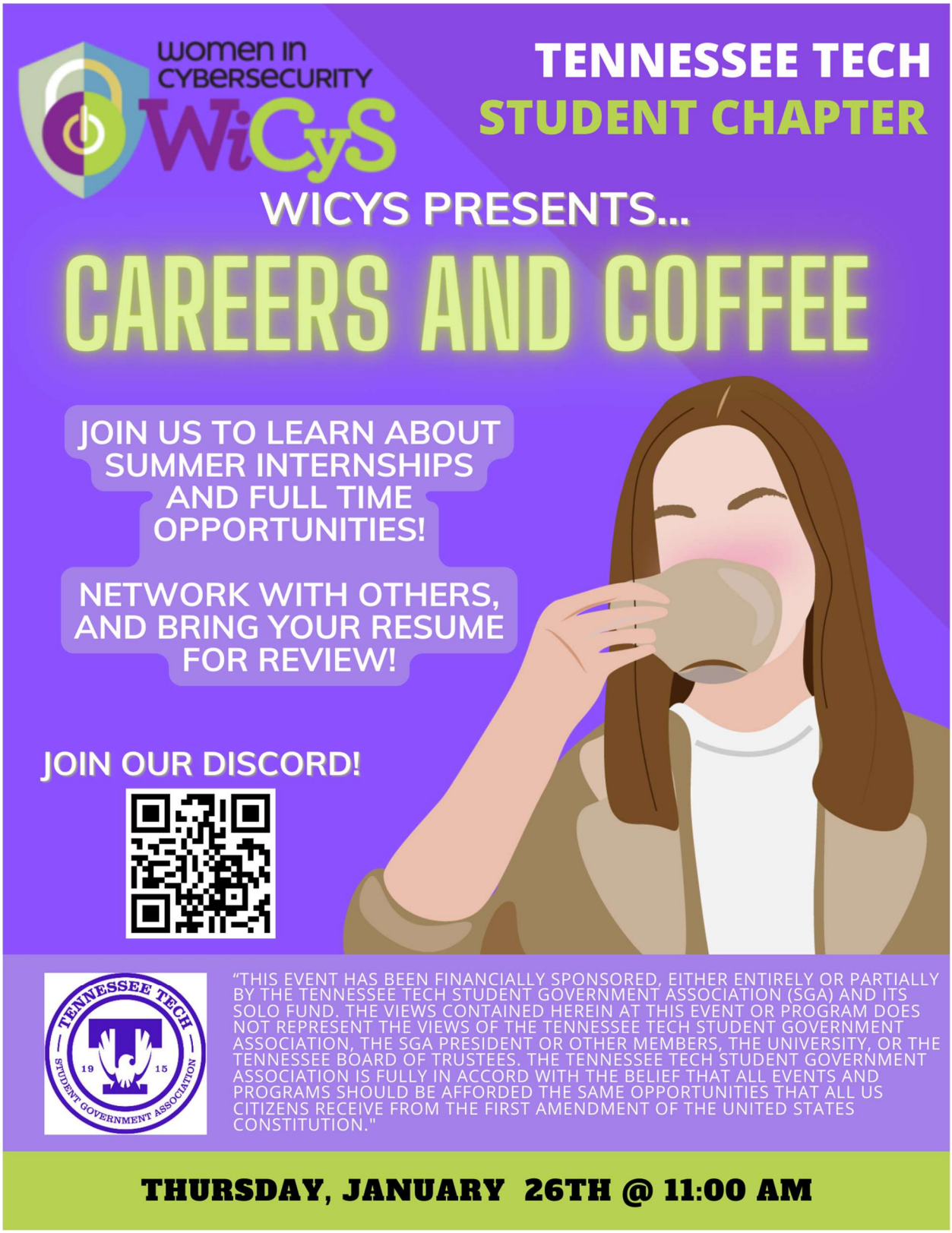

women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
WICYS PRESENTS...
JULIANNE COX,
IAM ANALYST
FROM
Deloitte.
COME HEAR FROM A TECH ALUM ABOUT HER JOURNEY IN STEM AND FUTURE JOB OPPORTUNITIES!
JOIN OUR DISCORD!
"THIS EVENT HAS BEEN FINANCIALLY SPONSORED, EITHER ENTIRELY OR PARTIALLY BY THE TENNESSEE 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."
TUESDAY, SEPTEMBER 20 @ 11:00 AM, PRESCOTT 425

SUBMIT A LIGHTNING TALK!!!
Some ideas:
• share your wicys conference experience
• cyber tool crash course
• cyber tips & tricks
• halloween themed cyber talk
• best coding practices
• talk about your research!

women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
WICYS PRESENTS...
ETHICAL HACKING 101
Come celebrate Cybersecurity Awareness Month with us and learn spooky tips & tricks about ethical hacking
JOIN OUR DISCORD!
Food & Drinks
Will be Provided!
"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."
TUESDAY, OCTOBER 25 @ 11:00 AM, PRESCOTT 425

women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
CYBERSECURITY TRIVIA
JOIN US FOR FUN, FRIENDS, AND FOOD!
ANSWER TRIVIA QUESTIONS!
WIN PRIZES!
TENNESSEE TECH
STUDENT GOVERNMENT ASSOCIATION
19 15
"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."
TUESDAY, NOVEMBER 15TH @ 11:00 AM, PRESCOTT 425

WiCyS
acm-w
JOINT
GAME
NIGHT
JACKBOX GAMES!
NINTENDO SWITCH!
BOARD GAMES!
FUN!
Feel free to bring your own switch or boardgames!
with free pizza!
"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."
MONDAY, NOVEMBER 28TH @ 6 PM, PRESCOTT 411


women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
WICYS PRESENTS...
CAREERS AND COFFEE
JOIN US TO LEARN ABOUT SUMMER INTERNSHIPS AND FULL TIME OPPORTUNITIES!
NETWORK WITH OTHERS, AND BRING YOUR RESUME FOR REVIEW!
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."
THURSDAY, JANUARY 26TH @ 11:00 AM

women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
WICYS PRESENTS...
GALENTINE'S DAY
JOIN US TO LEARN ABOUT IMPOSTER SYNDROME AND DO SOME FUN GALENTINE'S DAY ACTIVITIES!
PIZZA AND DRINKS WILL BE PROVIDED
cyber rules
i <3 wicys
JOIN OUR DISCORD!
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 THAT ALL US CITIZENS RECEIVE FROM THE FIRST AMENDMENT OF THE UNITED STATES CONSTITUTION."
TUESDAY, FEBRUARY 14TH @ 11:00 AM PRESCOTT 425

women in CYBERSECURITY
WiCyS
TENNESSEE TECH
STUDENT CHAPTER
WICYS PRESENTS...
PAINT NIGHT
END OF SEMESTER PARTY
JOIN US TO UNWIND AND RELAX BEFORE FINALS BY CREATING YOUR OWN PAINTING! ALL PAINTING SUPPLIES PROVIDED!
AND FREE PIZZA!
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."
TUESDAY, APRIL 18TH @ 6:00 PM

Appendix 3 – Publications

[1] M. I. Ibrahem, **M. M. E. A. Mahmoud**, F. Alsolami, W. Alasmary, A. S. A. M. Al-Ghamdi, and X. Shen, "Electricity-Theft Detection for Change-and-Transmit Advanced Metering Infrastructure," *IEEE Internet Things J.*, vol. 9, no. 24, pp. 25565–25580, Dec. 2022, doi: 10.1109/JIOT.2022.3197805.

[2] M. Nabil, A. Sherif, **M. Mahmoud**, W. Alsmary, and M. Alsabaan, "Accurate and Privacy-Preserving Person Localization Using Federated-Learning and the Camera Surveillance Systems of Public Places," *IEEE Access*, vol. 10, pp. 109894–109907, 2022, doi: 10.1109/ACCESS.2022.3214227.

[3] M. I. Ibrahem, **M. Mahmoud**, M. M. Fouda, B. M. Elhalawany, and W. Alasmary, "Privacy-preserving and Efficient Decentralized Federated Learning-based Energy Theft Detector," *2022 IEEE Glob. Commun. Conf. GLOBECOM 2022 - Proc.*, pp. 287–292, 2022, doi: 10.1109/GLOBECOM48099.2022.10000881.

[4] H. Habbak, M. Baza, **M. M. E. A. Mahmoud**, K. Metwally, A. Mattar, and G. I. Salama, "Privacy-Preserving Charging Coordination Scheme for Smart Power Grids Using a Blockchain," *Energies 2022, Vol. 15, Page 8996*, vol. 15, no. 23, p. 8996, Nov. 2022, doi: 10.3390/EN15238996.

[5] M. M. Badr *et al.*, "Privacy-Preserving and Communication-Efficient Energy Prediction Scheme Based on Federated Learning for Smart Grids," *IEEE Internet Things J.*, vol. 10, no. 9, pp. 7719–7736, May 2023, doi: 10.1109/JIOT.2022.3230586.

[6] M. M. Badr, **M. M. E. A. Mahmoud**, M. Abdulaal, A. J. Aljohani, F. Alsolami, and A. Balamsh, "A Novel Evasion Attack Against Global Electricity Theft Detectors and a Countermeasure," *IEEE Internet Things J.*, vol. 10, no. 12, pp. 11038–11053, Jun. 2023, doi: 10.1109/JIOT.2023.3243086.

[7] O. Elnakib, E. Shaaban, **M. Mahmoud**, and K. Emara, "EIDM: deep learning model for IoT intrusion detection systems," *J. Supercomput.*, vol. 79, no. 12, pp. 13241–13261, Aug. 2023, doi: 10.1007/S11227-023-05197-0/TABLES/4.

[8] A. T. El-Toukhy, M. M. Badr, **M. M. E. A. Mahmoud**, G. Srivastava, M. M. Fouda, and M. Alsabaan, "Electricity Theft Detection Using Deep Reinforcement Learning in Smart Power Grids," *IEEE Access*, vol. 11, pp. 59558–59574, 2023, doi: 10.1109/ACCESS.2023.3284681.

[9] 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, doi: 10.1109/ACCESS.2023.3291217.

[10] A. A. Shafee, **M. M. E. A. Mahmoud**, G. Srivastava, M. M. Fouda, M. Alsabaan, and M. I. Ibrahem, "Detection of Distributed Denial of Charge (DDoC) Attacks Using Deep Neural Networks With Vector Embedding," *IEEE Access*, vol. 11, pp. 75381–75397, 2023, doi: 10.1109/ACCESS.2023.3296562.

[11] A. Shafee, **M. Mahmoud**, J. W. Bruce, G. Srivastava, A. Balamsh, and A. J. Aljohani, "False Data Detector for Electrical Vehicles Temporal-Spatial Charging Coordination Secure Against Evasion and Privacy Adversarial Attacks," *IEEE Trans. Dependable Secur. Comput.*, 2023, doi: 10.1109/TDSC.2023.3299522.

[12] S. Abdelfattah, M. M. Badr, **M. Mahmoud**, K. Abualsaud, E. Yaacoub, and M. Guizani, "Efficient and Privacy-Preserving Cloud-Based Medical Diagnosis Using an Ensemble Classifier With Inherent Access Control and Micro-Payment," *IEEE Internet Things J.*, 2023, doi: 10.1109/JIOT.2023.3303429.

[13] A. T. El-Toukhy, **M. M. E. A. Mahmoud**, A. H. Bondok, M. M. Fouda, and M. Alsabaan, "Countering Evasion Attacks for Smart Grid Reinforcement Learning-Based Detectors," *IEEE Access*, vol. 11, pp. 97373–97390, Sep. 2023, doi: 10.1109/ACCESS.2023.3312376.

[14] I. Elgarhy, M. M. Badr, **M. Mahmoud**, M. M. Fouda, M. Alsabaan, and H. A. Kholidy, "Clustering and Ensemble Based Approach For Securing Electricity Theft Detectors Against Evasion Attacks," *IEEE Access*, 2023, doi: 10.1109/ACCESS.2023.3318111.

[15] A. H. Bondok, **M. Mahmoud**, M. M. Badr, M. M. Fouda, M. Abdallah, and M. Alsabaan, "Novel Evasion Attacks against Adversarial Training Defense for Smart Grid Federated Learning," *IEEE Access*, 2023, doi: 10.1109/ACCESS.2023.3323617.

[16] H. Habbak *et al.*, "Efficient One-Class False Data Detector Based on Deep SVDD for Smart Grids," *Energies 2023, Vol. 16, Page 7069*, vol. 16, no. 20, p. 7069, Oct. 2023, doi: 10.3390/EN16207069.

[17] A. A. Adeyemo, J. J. Sanderson, T. A. Odetola, F. Khalid, and **S. R. Hasan**, "StAIn: Stealthy Avenues of Attacks on Horizontally Collaborated Convolutiona

[18] T. A. Odetola, A. Adeyemo, F. Khalid, and **S. R. Hasan**, "FM-ModComp: Feature Map Modification and Hardware–Software Co-Comparison for secure hardware acc

[19] E. Oriero, F. Khalid, and **H. Syed**, "DeMiST: Detection and Mitigation of Stealthy Analog Hardware Trojans," *Proc. 12th Int. Work. Hardw. Archit. Suppo*

[20] M. A. Ayub, A. Siraj, B. Filar, and **M. Gupta**, "RWArmor: a static-informed dynamic analysis approach for early detection of cryptographic windows ransomware," Int. J. Inf. Secur., pp. 1–24, Sep. 2023, doi: 10.1007/S10207-023-00758-Z/METRICS.

[21] B. Northern and **D. Ulybyshev**, "Building Secure Environments for Microservices," Proc. - 2022 Int. Work. Secur. Reliab. Microservices Contain. SRMC 2022, pp. 27–31, 2022, doi: 10.1109/SRMC57347.2022.00008.

[22] T. Seyler and **D. Ulybyshev**, "SEMAFORE: Secure Mobile Field Diagnostics for Cyber-Physical Systems," Lect. Notes Networks Syst., vol. 578, pp. 445–458, 2023, doi: 10.1007/978-981-19-7660-5_38/COVER.

[23] **D. Ulybyshev**, **M. Rogers**, V. Kholodilo, and B. Northern, "End-to-End Database Software Security," Softw. 2023, Vol. 2, Pages 163-176, vol. 2, no. 2, pp. 163–176, Mar. 2023, doi: 10.3390/SOFTWARE2020007.

[24] 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 IEEE Conference on Fog and Mobile Edge Computing (FMEC), 2023.

[25] M. A. Ayub, A. Siraj, B. Filar, and **M. Gupta**, "RWArmor: a static-informed dynamic analysis approach for early detection of cryptographic windows ransomware," Int. J. Inf. Secur., pp. 1–24, 2023.

[26] M. Tidwell, C. Swindell, C. S. Johnson, **M. Gupta**, and C. W. Van Neste, "Wireless Communication of Buried IoT Sensors Utilizing Through the Soil Wireless Power Transfer for Precision Agriculture," in 2023 IEEE Wireless Power Technology Conference and Expo (WPTCE), 2023, pp. 1–5.

[27] 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 Prepr. arXiv2308.01783, 2023.

[28] **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, 2023.

[29] E. Becker, **M. Gupta**, and K. Aryal, "Using Machine Learning for Detection and Classification of Cyber Attacks in Edge IoT," in IEEE EDGE 2023, 2023.

[30] M. Gupta, R. Tomar, A. K. Yadav, and H. Sastry, "Future Connected Technologies: Growing Convergence and Security Implications." CRC Press, 2023.

[31] T. Burks and **M. Gupta**, "Understanding Blockchain Based Solutions for Cloud and Cyber Physical Systems," in Future Connected Technologies, CRC Press, 2023, pp. 35–56.

[32] M. Brotherton and **M. Gupta**, "A Survey of Quantum Computing for Cloud Security," in Future Connected Technologies, CRC Press, 2023, pp. 1–34.

[33] L. Praharaj and **M. Gupta**, "A Systematic Review of Access Control in Cloud Computing," Futur. Connect. Technol. Grow. Converg. Secur. Implic., p. 57, 2023.

[34] 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, 2023, pp. 279–281.

[35] S. Ameer, R. Krishnan, R. Sandhu, and **M. Gupta**, "Utilizing The DLBAC Approach Toward a ZT Score-based Authorization for IoT Systems," in Proceedings of the Thirteenth ACM Conference on Data and Application Security and Privacy, 2023, pp. 283–285.

[36] S. P. Otta, S. Panda, **M. Gupta**, and C. Hota, "A Systematic Survey of Multi-Factor Authentication for Cloud Infrastructure," Futur. Internet, vol. 15, no. 4, p. 146, 2023.

[37] S. R. Islam, I. Russell, and **M. Gupta**, "Incorporating the Concept of Bias and Fairness in Cybersecurity Curricular Module," in Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 2, 2023, p. 1358.

[38] 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.

[39] A. Brown, **M. Gupta**, and M. Abdelsalam, "Automated Machine Learning for Deep Learning based Malware Detection," arXiv Prepr. arXiv2303.01679, 2023.

[40] **M. Gupta**, R. Sandhu, T. Mawla, and J. Benson, "Reachability analysis for attributes in ABAC with group hierarchy," IEEE Trans. Dependable Secur. Comput., vol. 20, no. 1, pp. 841–858, 2023.

[41] K. Aryal, **M. Gupta**, and M. Abdelsalam, "Analysis of Label-Flip Poisoning Attack on Machine Learning Based Malware Detector," in In Proceedings of IEEE Big Data, 2023.

[42] I. Dasgupta, **S. Shannigrahi**, and M. Zink, "A hybrid NDN-IP architecture for live video streaming: From host-based to content-based delivery to improve QoE," Int. J. Semant. Comput., vol. 16, no. 02, pp. 163–187, 2022.

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