

Final Report, Deadline September 15, 2025

Project title: Creating CU Cyber Range to Make UCCS and CU Denver a National Leader in Cybersecurity Education and Workforce Development

Date: 12/14/2025

PI: Dr. Shouhuai Xu (UCCS)

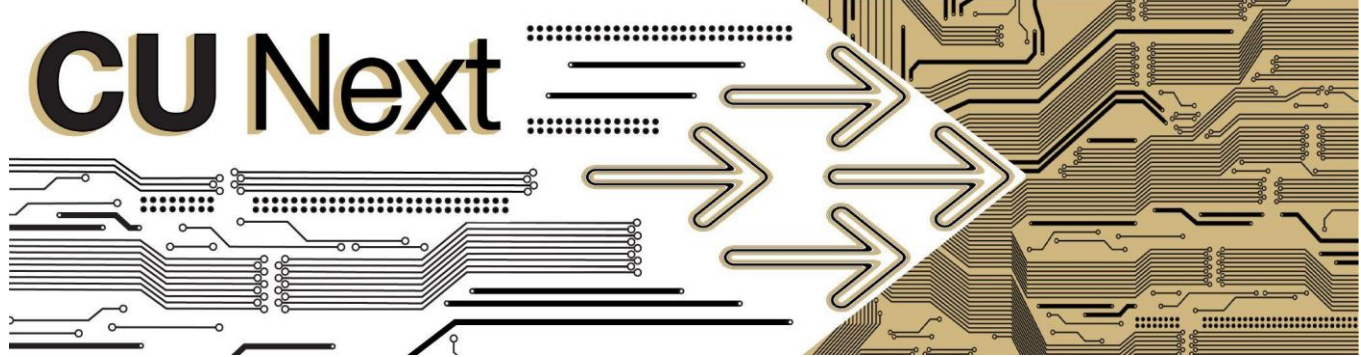
Co-PIs: Haadi Jafarian (CU Denver)

1. What has your team accomplished?

The **goal** of the project is to address the knowledge gap between the cybersecurity education received by college students and the demand by cybersecurity workforce, through the creation of two new introductory and advanced courses on Defensive Cyber Operations which are aligned with well-reputed federal and industrial cybersecurity frameworks. To maximize the success of these two new courses, the project will build a Cyber Range to be used by these courses. These two courses formulate a seamless sequence, meaning that the first course teaches knowledge and skills for introductory defensive cyber operations and the second course teaches advanced defensive cyber operations. Taking these two courses will make students well prepared to take real-world defensive cyber operations jobs.

The project has achieved what is planned. As planned, these courses have been designed based on the following well-accepted government and industrial frameworks/guidelines/documents.

- NIST Framework for Improving Critical Infrastructure Cybersecurity, v1.1, <https://nvlpubs.nist.gov/nistpubs/cswp/nist.cswp.04162018.pdf>
- NIST Security and Privacy Controls for Information Systems and Organizations, 800-53 Rev. 5, <https://doi.org/10.6028/NIST.SP.800-53r5>
- NIST Workforce Framework for Cybersecurity (NICE), 800-181, Rev. 1, <https://doi.org/10.6028/NIST.SP.800-181r1>



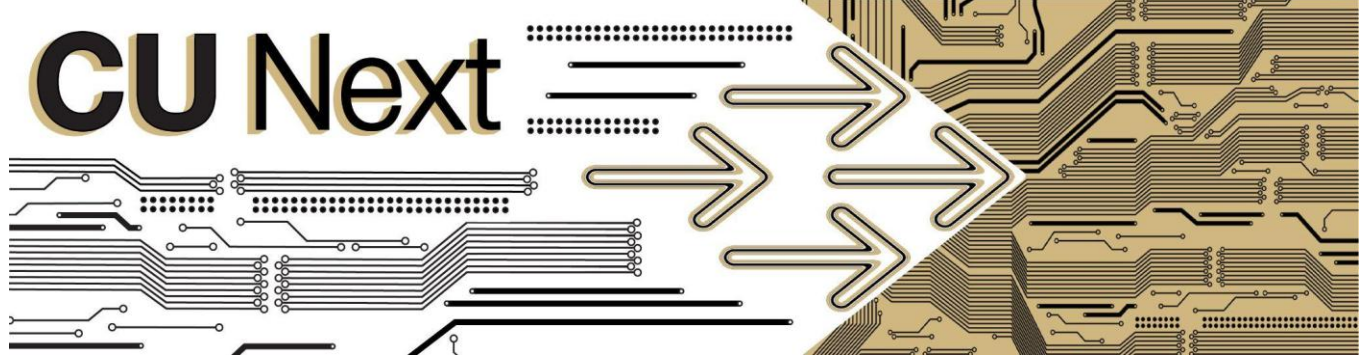
- NIST Computer Security Incident Handling Guide, 800-61, Rev. 2, <http://dx.doi.org/10.6028/NIST.SP.800-61r2>
- Cyber Kill Chain and Unified Cyber Kill Chain, <https://www.unifiedkillchain.com/assets/The-Unified-Kill-Chain.pdf>
- MITRE ATT&CK, <https://attack.mitre.org/>
- MITRE D3FEND, <https://d3fend.mitre.org/>
- NIST Risk Management Framework, <https://csrc.nist.gov/projects/risk-management/about-rmf>
- FAIR framework, <https://www.fairinstitute.org/>

Completion of the Design and Development of the Introductory Course: The first course, **CS 3920: Introduction to Defensive Cyber Operations**, was initially launched in Fall 2023 (the first repetition) and offered in Fall 2024 (the second repetition) and offered in Fall 2025 (the third repetition). We have completed the design and development of the course syllabi and content, including hands-on modules based on the CU Cyber Range. This course was reviewed and approved by the CSE faculty at CU Denver, and students from CSCY undergraduate program at CU Denver can take this course remotely. Students from both UCCS and CU Denver campuses have registered and will attend the first offering of this course this coming Fall. The catalog description of this course is as follows:

CS 3920: Introduction to Defensive Cyber Operations will give students a systematic overview of key aspects of defensive cyber operations, including technical and non-technical aspects as well as principles and operations with a special focus on experiential learning conducted on an extensive and scalable Cyber-Range testbed that provides students with a virtual environment for realistic, hands-on labs and exercises.

Detailed Syllabus Development for Advanced Course: The syllabus design for the second course, **CS 4915/5915: Defensive Cyber Operations**, has been completed. The first offering of this course was Spring 2024, the second offering of this course was Spring 2025, and the third offering of this course is scheduled for Spring 2026. The catalog description for this course is as follows:

CS 4915/5915: Defensive Cyber Operations will teach students advanced technical skills for defensive cyber operations. The content includes advanced tactics, techniques, and procedures with hands-on defensive cyber operation experiments and research components. The course equips students with key technical skills for conducting real-world defensive cyber operations.



Course Offering Repetitions and Students Enrollment

Repetition	Semester	Course	Enrollment
1	Fall 2023	CS 3920	8
	Spring 2024	CS 4915/5915	13
2	Fall 2024	CS 3920	13
	Spring 2025	CS 4915/5915	7
3	Fall 2025	CS 3920	28
	Spring 2026	CS 4915/5915	(TBA in Spring 2026)

Advertisement and Announcements: The courses have been announced and advertised through communications both at UCCS and CU Denver.

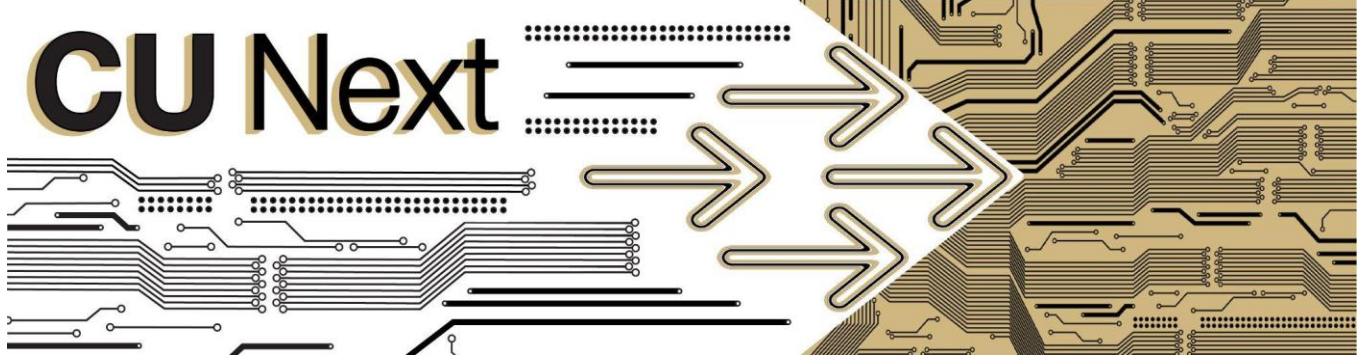
Cyber Range Status: We have accomplished the initial design of the Cyber Range, together with UCCS OIT staff. We have purchased devices and equipment for building the Cyber Range. We have been constantly refining the Cyber Range design and purchasing hardware and/or software to maintain the Cyber Range. The amount of work is tremendous and much more than we anticipated, but it's worthwhile.

Leveraging the CU Next project to earn federal funding:

- We have leveraged the CU Next project to earn federal funding worth **\$1.5M base + \$0.5M option**, as reported in this UCCS news article: <https://communique.uccs.edu/?p=150058>
- PI Xu has leveraged the testbed to win **FIRST PLACE** at the DoD NSIN/UC2 Cyber Innovators Challenge with a **\$150K** award and a **\$500K** research grant.

Example accomplishments of students who have taken the two courses:

- Caleb Chang, who has taken both CS 3920 and CS4915/5915, **won 1st place at the VICEROY Nationwide Cyber Competition in Spring 2025**. See news article at [this link](#).
- Caleb Chang and Luke Farchione (who is taking CS 3920 in Fall 2025) led a student team **winning 5th place at the VICEROY Nationwide Cyber Competition in November 2025**.



2. What are the challenges you encountered?

The workload that was required to create the courses was way above what we originally anticipated. Nevertheless, the project is fulfilling. As mentioned above, we have successfully accomplished the first 2.5 repetitions (Fall 2023-Fall 2025), with the last half one repetition scheduled for Spring 2026.

3. Have you considered modifying, or are you currently modifying, your direction? If yes, in what ways?

No, we have accomplished what we planned, and no change of direction has occurred or expected.

4. Are there any updates on the collaboration? Evolution, growth, obstacles, challenges - please provide any and all updates.

The project team has been working together nicely and effectively. We have been working closely in creating the curriculum materials for the first repetition and we are working closely in revising the curriculum materials for the second repetition. We anticipate this working style will continue in the third repetition.

5. Have any communications internal or external to CU about the project been created, shared, or published? Are there any on the horizon?

UCCS Communications

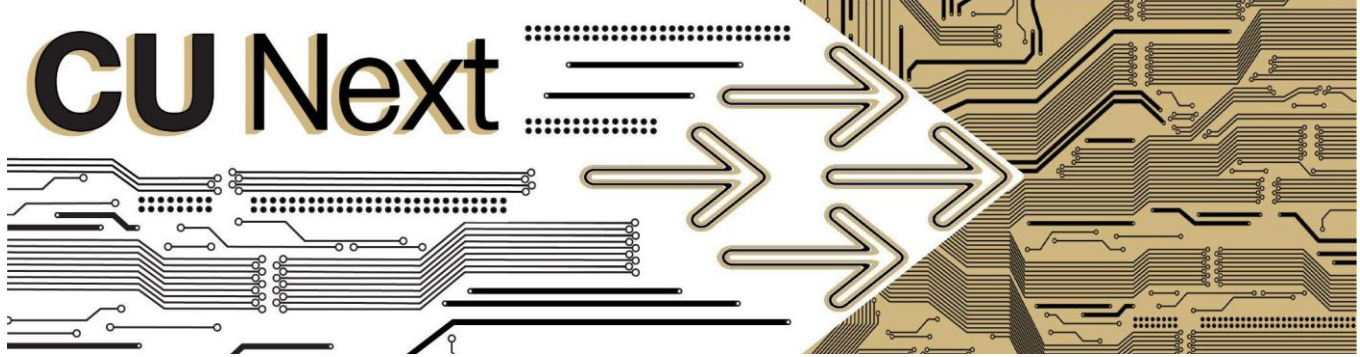
<https://communique.uccs.edu/?p=149562>

At UCCS, we have advertised the courses to students in multiple rounds, in both email and flyer.

CU Denver Communications

<https://ucdenverengineeringnews.com/2023/08/04/new-cu-cyber-operations-courses-set-to-launch-in-fall-2023/>

Also, we published on the Instagram and LinkedIn pages of our department:



<https://www.instagram.com/p/Cvu3poUL6sd/>

https://www.linkedin.com/posts/cudenvercse_cudenvercse-cudenver-uccs-activity-7095097901940408320-lSma?utm_source=share&utm_medium=member_desktop

In addition, two rounds of advertisements emails have been sent to students registered in the CSCY program in the Computer Science and Engineering Department of CU Denver.

A UCCS Communique article reporting PI Xu's winning DoD NSIN/UC2 Cyber Innovators Challenge is to appear soon.

6. Are there any issues in the way you will be collecting that data you propose to collect?

N/A

7. Is there anything that CU Next administration can do to support your efforts?

We thank CU Next for their support during several circumstances, including the flexibility in adjusting the course offering semester below.

For the third repetition of the two courses, the original plan was to offer

- CS3920 Introduction to Defensive Cyber Operation in **Summer 2025**
- CS4915 Defensive Cyber Operations in **Fall 2025**

However, PI Xu recently learned that very few students in computer science department will take courses in the summer because most of them will be doing Internship. As such, PI Xu proposed the following adjustment:

- CS3920 Introduction to Defensive Cyber Operation in **Fall 2025**
- CS4915 Defensive Cyber Operations in **Spring 2026**

This allowed us to extend it for one semester to maximize the impact in terms of having as many students taking them as possible.