Course Syllabus

CSCI 5180: Advanced Network Management and Automation
Spring 2025 (12:30–1:45 p.m., Tues. & Thurs., Rm. ECCS 1B14, 3 Credits)

Course Description and Objectives

Students in this course should gain a much greater appreciation of the technologies and procedures required in managing, maintaining, and operating networks. The complex interactions among these aspects are shaping the future of this critical sector of network engineering. Topics will range from technical to soft skills and include best practices and the key theories behind them.

In the Network Management and Automation course, students enforce the theoretical knowledge by incorporating hands-on labs about the technologies, services, and tools industry and research institutions utilize to manage and troubleshoot networks through the following key objectives:

- Understand the core technologies, theories, and dilemmas that face network engineers in this field.
- Understand, evaluate, implement, and demonstrate historical and future services needed for network functionality, maintenance, and troubleshooting such as SNMP, DHCP, IPv6, Autoconfiguration, NETCONF/YANG, SDN, and scripting/automation/DevOps technologies
- Apply and evaluate current management suites utilized to manage networks
- Given the instructor's years of experience managing network operations and services in the telecommunications industry, engage in real-world discussions of the current controversies with implementing and troubleshooting networks.

The Network Management and Automation course covers these topics and achieves these objectives through hands-on lab exercises built around real-world applications and theories presented in the lectures. The course is split into the following units of study:

- Unit 1: Network Management
- Unit 2: Network Operations
- Unit 3: Automation & DevOps
- Unit 4: Network Design

Students successfully completing this course should gain a much greater appreciation of the technologies and procedures required in managing, maintaining, and operating networks. The complex interactions among these aspects are shaping the future of this critical sector of network engineering. The resulting understanding should enhance employment or promotion opportunities in the network engineering sector and enhance the student's ability to participate in the public discourse regarding the future of the network management and operations. By the end of the course students will be competent in the technologies, services, and tools used to manage and troubleshoot complex networks.

Course Outcomes

Upon completion of this course, students are able to:

- Explain, apply, analyze, evaluate, and create original work in the field of network management and automation
    - Understand, implement, and analyze historical network management system software solutions
    - Understand, implement, evaluate, and analyze cloud computing technologies
    - Understand, implement, analyze, and create original work related to network auto-configuration technologies
        - Develop software applications to create original ARP, ICMP, Telnet, and TCP SYN packets to reinforce the theoretical understanding of these protocols and demonstrate understanding of the technology and test execution of auto-configuration technology implementations
    - Explain the technologies and concepts of software-defined networking
    - Learn why traditional networking technologies do not operate efficiently on scale by designing, developing, and implementing network automation software applications using technologies to configure both virtualized and physical network infrastructures
    - Understand, implement, analyze, and create original work related to network automation and DevOps technologies
    - Analyze and evaluate network automation tools used in industry and explain the trade-offs
    - Analyze and evaluate DevOps and CI/CD principles and tools and learn how to perform code reviews, unit testing, and version control
    - Enforce theoretical understanding of how network abstraction alleviates problems in traditional network engineering
    - Implement the concepts of zero touch provisioning, infrastructure as code, and network source of truth
    - Examine network design principles and create advanced network design solutions utilizing proper documentation and execute proof of concept configurations, code, and implementation of the required network design

Instructor

Dr. Levi Perigo
Scholar in Residence | Professor of Network Engineering, Department of Computer Science
levi.perigo@colorado.edu
303-735-5131

Office Hours

Time: TBA, and by appointment (scheduled via email)
Location: ECOT 535

Graduate Student Assistant

TBA

Office Hours: TBA

Course Prerequisites

Understanding of network engineering technologies, Python programming, and Linux system administration is strongly recommended. The required learning objectives can be obtained from courses such as:

- CSCI 5010: Data Communications or CSCI 4273: Network Systems
- CSCI 5020: Fundamentals of Network Programming
- CSCI 5030 / CSCI 4113: Fundamentals of System Administration or Unix System Administration

Grading

Pop Quizzes, Discussions, and Class Participation	20%
Homework Labs and Assignments	60%
Midterm Exam	10%
Final Exam (practical & theory)	10%

To do well in this course, you will need to be prepared for each class by being ready to discuss and engage in critical thinking on issues covered in the readings. Be forewarned: pop quizzes will often be given at the start of class on the assigned reading material for the class.

All labs, homework, and assignments are due based on the due date in the syllabus. No exceptions to deadlines for course work will be made. Classroom absence may be permitted either for an emergency or prior notification to the professor stating the date and reason for the classroom absence two weeks in advance.

Grading Scale

100 – 93%	A
92 – 90%	A-
89 – 87%	B+
86 – 83%	B
82 – 80%	B-

Class Readings

There is not a required textbook for the course. Students will be expected to have read the class readings noted in the course syllabus before attending the class.

RECOMMENDED BOOKS:
Clemm, Alexander. (2006). *Network Management Fundamentals*. ISBN-10: 1-58720-137-2

Chappell, L. (2013). *Wireshark 101: Essential Skills for Network Analysis (Wireshark Solutions)*. ISBN-10: 1-89393-972-3

Duffy, M. (2015). *DevOps Automation Cookbook.* ISBN-10: 1784392820

D. Gedia, and L. Perigo, "NetO-App: A Network Orchestration Application for Centralized Network Management in Small Business Networks" in *4th International Conference on Computer Science, Engineering and Information Technology (CSITY-2018)*, Sydney, Australia, July, 2018, pp. 61-72, DOI: 10.5121/csit.2018.81106.

D. Gedia, and L. Perigo, "A Centralized Network Management Application for Academia and Small Business Networks" in *Information Technology in Industry (ITII)*. Aug, 2018, pp. 1-10, Vol. 6, No. 3.

Odom, W. (2016). *CCENT/CCNA ICND1 100-105*. ISBN-10: 1-58720-580-7

Oppenheimer, P. (2011). *Top-Down Network Design*, Third Edition. ISBN-10: 1-58720-283-2

Peterson, L., Cascone, C., O'Connor, B., & Vachuska, T. (2023). *Software-Defined Networks: A Systems Approach.* Source*:* https://sdn.systemsapproach.org/index.html

Many of the readings will be posted on the Canvas web site. To access Canvas, go to: https://canvas.colorado.edu/. You can login using your IdentiKey username and password. Once you login, click on the course name to go into the course[1].

Course Outline (Subject to Change)

Date	Topic, Reading, and/or Work Assignment
1/13/2025	Lecture: Introduction to Course & Network Engineering Review Reading: ● Chapter 1 (Clemm) ● Chapters 0-5 (Chappell) ● Basic Switching and Routing Understanding ● Basic OSI Model Understanding Homework: ● **Lab 0.4 (Not Graded)** – Wireshark & TCPDUMP

[1] Please visit https://canvas.colorado.edu/ to watch videos and learn more about using Canvas. If you run into any problems using Canvas, contact the help desk at: help@colorado.edu or at (303) 735-HELP.

1/20/2025	Lecture: Simple Network Management Protocol (SNMP) Reading: ● Chapters 6-8 (Clemm) Reference Reading: ● RFC 1157 Homework: ● **Lab 1** – SNMP & NMAP (Due 1/27) ● **Assignment 1** (Due 1/27) – Write a one-page executive summary proposal evaluating two Network Management Systems (NMS). ● **Graded Discussions on CANVAS**
1/27/2025	Lecture: Dynamic Host Configuration Protocol (DHCP) & IPv6 Autoconfiguration Reading: ● ADTRAN DHCP: Pages 1-4 ● ADTRAN DHCPv6: Pages 1-11 ● Cisco DHCP: Pages 65-67 ● Scapy (for lab) Reference Reading: ● RFC 2131 - https://www.ietf.org/rfc/rfc2131.txt ● RFC 3315 - https://www.ietf.org/rfc/rfc2131.txt Homework: ● **Lab 2** – DHCP (Due 2/3) ● **Assignment 2** (Due 2/3) - Write a one-page executive summary on IPv4 to IPv6 transition mechanisms, and recommendations on best practice techniques to implement when transitioning from an IPv4 to IPv6 network. ● **Graded Discussions on Canvas**

2/3/2025	Lecture: Network Automation with Python Reading: ● Automating - Cisco ● Trigger ● Netmiko ● NAPALM Homework: ● **Lab 3** – Network Automation (Due 2/10) ● **Graded Discussions on Canvas**
2/10/2025	Lecture: DevOps and Zero-Touch Provisioning (ZTP) Reading: ● Flask ● Zero Touch Provisioning (ZTP) ● Arista ZTP ● Juniper ZTP ● Cumulus ZTP Homework: ● **Lab 4** – Network Automation - DevOps (Due 2/17) ● **Assignment 3** (Due 2/17) – Write a one-page executive summary reviewing DevOps Automation tools: Ansible, Chef, Puppet, & Saltstack. ● **Graded Discussions on Canvas**
2/17/2025	Lecture: Software-Defined Networking (SDN) (T); Midterm Review (TH) Reading: ● Feamster – Road to SDN (Canvas) ● Cisco Whitepaper– SDN (Canvas) ● Software Defined Networking – Cisco Edition (Canvas) – Chapter 1 ● Open Networking Foundation (ONF) ● Peterson - Ch. 1-2 Homework: ● **Lab 5** – Midterm Lab (Due 3/3) ● **Assignment 4** (Due 3/3) – Write a one-page executive summary about best practices when transitioning from a traditional network to a software-defined network. ● **Graded Discussions on Canvas**

2/24/2025	Lecture: **Quiz: In-class Challenge (T)** & Midterm Exam (TH) Homework: ● **Graded Discussions on Canvas**
3/3/2025	Lecture: DevOps Tools Second Lecture – **Quiz: In-class Coding Challenge** Reading: ● Ansible ● Duffy – Chapter 2, 5, & 7 Homework: ● **Lab 6** – DevOps Automation Tools - Ansible (Due 3/10) ● **Graded Discussions on Canvas**
3/10/2025	Lecture: Network Automation and DevOps First Lecture(T) – DevOps and Jinja2; Second Lecture(TH) – Guest Speaker Homework: ● **Lab 7** – DevOps Automation Tools – Ansible and Jinja2 (Due 3/17) ● **Graded Discussions on Canvas**
3/17/2025	Lecture: Integrated Traffic Monitoring (ITM) and modeling: NetFlow, Network Configuration Protocol (NETCONF)/YANG, & OpenConfig Reading: ● Integrated Traffic Monitoring – Pages: 1-7 ● Netflow RFC – Sections 1-2 ● Understanding NETCONF and YANG – Network World ● Network Configuration Protocol RFC – Section 1 ● YANG – A Data Modeling Language for NETCONF – Section 1; 4.1-4.2.2 ● Overview of Network Management ● Creating the Programmable Network (Canvas) ● Cisco DevNet YDK-Py ● OpenConfig Homework: ● **Lab 8** – NETCONF (Due 3/31) ● **Graded Discussions on Canvas**
3/24/2025	Spring Break – No Classes

3/31/2025	Lecture: Jenkins Reading: ● Jenkins: The Definitive Guide Homework: ● **Lab 9** – Jenkins (Due 4/7) ● **Graded Discussions on Canvas**
4/7/2025	Lecture: Network Design Reading: ● Oppenheimer ● Cisco PPDIOO (1) ● Cisco PPDIOO (2) ● Cisco Campus Wired LAN Design Guide (Canvas) Recommended Videos: ● Organizational and Technical Constraints ● PPDIOO ● Characterize the Network Homework: ● **Lab 10** – Network Design Group Project (Network Design Due 4/14; PoC Due 4/21) ● **Graded Discussions on Canvas**
4/14/2025	Lecture: Network Design Lab – Team Presentations
4/21/2025	Lecture: Network Design Lab PoC – Team Presentations (T) & Final Exam Review (TH)
4/28/2025	Lecture: First Lecture (T) – Final Quiz: Practical In-class Challenge Second Lecture (TH) – Final Exam
5/5 (See MyCUinfo)	Final Deliverable

University Policies

Classroom Behavior
Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

Requirements for COVID-19
As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

As of Aug. 13, 2023, CU Boulder has returned to requiring masks in classrooms and laboratories regardless of vaccination status. This requirement is a temporary precaution during the delta surge to supplement CU Boulder's COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, let the instructor know that you will need to miss class.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about OIEC, university policies, reporting options, and the campus resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please let the instructor know two weeks in advance.

See the campus policy regarding religious observances for full details.

University Resources and Support Services

Counseling and Psychiatric Services

We offer confidential, on-campus mental health and psychiatric services for a variety of concerns such as academics, anxiety, body image, depression, relationships, substance use and more.

Contact Us: 303-492-2277 (24/7 support including crisis care)

CAPS Main Office

Fall hours

- Monday - Thursday: 8 a.m. to 6 p.m.
- Friday: 8 a.m. to 5 p.m.

Walk-in hours

- Monday - Friday: 10 a.m. to 4 p.m.

Center for Community, Suite N352

Our Services

We offer a range of mental health services tailored to fit the needs of CU Boulder students.

Counseling

CAPS is a place where students can receive confidential short-term counseling with a licensed therapist who respects and understands their needs.

Psychiatry

CAPS has psychiatrists and psychiatric mental health nurse practitioners who are specially trained to help students deal with or overcome mental disorders and psychological issues.

Workshops

Our educational workshops are designed to provide valuable information and insight to students on a variety of topics. They are a great option to address a variety of needs.

Process Therapy Groups

These confidential groups are contained settings where students can speak on and get support for a variety of topics. All groups are free for CU students.

Skill-Based Therapy Groups

These free, confidential groups focus on skill building in specialty topic areas such as Dialecticial Behavior Therapy (DBT) and Acceptance and Commitment Therapy (ACT).

Let's Talk: Informal Consultations

Let’s Talk is a free service where CU Boulder students can stop by for an informal and confidential consultation with a counselor. No appointment necessary.

Canine-Assisted Therapy

Canine-assisted therapy incorporates the presence of a dog during a counseling session. Dogs can reduce stress and help a student feel more comfortable discussing difficult issues.

Suicide Prevention

Recognize signs and find information about how to support someone in need.

Virtual Reality Therapy

The virtual reality therapy (VRT) program aims to integrate VR with traditional therapy techniques for students facing common mental health issues like anxiety, depression and phobias.

Eating Disorders Services

Through our eating disorders services, CAPS works in collaboration with other Health and Wellness Services unites to provide assessment and treatment to students struggling with issues related to food, weight, and body image, including mild to moderate eating disorders.

ADHD

We offer assessment and treatment of Attention-Deficit/Hyperactivity Disorder (ADHD).

Substance Use

In an effort to support students and help them succeed at CU, CAPS is committed to working with students to avoid pitfalls related to alcohol and drug use. CAPS offers several services to address these issues.