

## Project Instructions for CS/ECE 438 (Spring 2023)

For 4-Credit Students: This project is a required part of the class.

For 3-Credit Students: This project is not required. However, you can use it as a bonus opportunity. You can use this project to replace your weakest homework or MP score (you can pick what you want to replace, so that you get the maximum benefit).

If you do not want to use it for homeworks/MPs, you can use it to replace 25% of your Midterm grade or 20% of the final grade. For example, if your old midterm score is  $old\_score$ , and your project score is  $p$ , then your new score will be  $0.75 * old\_score + 0.25 * p$  (only if the new score is higher).

### Team Size

The preferred team size is two or three. Though it is very unlikely, we might accept teams of one or four for specialized or very large projects. You will need you to tell us in advance and convince us why you should work alone or in a team of four. If you do not have a partner already, feel free to use Campuswire to find one.

### Project Proposal (Due: April 5, 2023, 11:59 PM)

Please upload your proposal to GradeScope. **You cannot use your one-week extensions for this proposal.**

The proposal should include:

- Project Title and names of the students with email addresses. Please use a descriptive title. You can change the title for the final submission.
- A clear statement of the problem: what are you working on? This should ideally begin with a sentence that summarizes what you plan to do, followed by a paragraph.
- A clear statement of the methods: How are you doing to approach the solution that you motivated in the previous paragraph?
- Plan and Schedule: This should convince you and use that you can complete the project in the given time.

### Final Report (Due: May 3, 2023, 11:59 PM)

Please upload the final report on GradeScope. The final report should be written in a conference paper style and should be around four to six pages (at max 10 pages). Please follow formatting instructions here: <https://conferences.sigcomm.org/sigcomm/2022/submission.html>. This report should describe the project, your findings, the problem, solution approach, solution details, etc.

### Project Ideas

You are free to choose your own ideas and topics of interest. We encourage you to explore topics that you've found interesting in this class and to pursue your curiosities. We will suggest some topics below. We expect most projects to fall into two categories:

1. Survey of research papers: This will include an in-depth exploration of a topic of interest. Pick 4 or 5 research papers on an advanced topic in networking and write a survey on that topic. The

papers must be published in the last 15 years at a top networking conference: (SIGCOMM, NSDI, CoNext, IMC, MobiCom, MobiSys, SenSys). The papers must be related to one big topic.

2. Hands-on Projects: In these projects, you will interact and develop tools/analysis for deployed systems like IoT devices, Wi-Fi networks, deployed around you.
3. **(New this year)** You can make a series of three to five fun and short (3-minute) videos explaining a networking concept. Think of short videos you like to watch, like TikTok/Instagram Reels/Youtube Shorts, and create a video series explaining a networking topic in a fun and creative way. One video may not cover the concept, so you may need a series. But you can also use the series to cover related topics: udp, rdt, tcp, for example. Disclaimer: Some selected videos may be used by the course staff in future iterations.

### Example Survey Topics:

Your proposal must specify the topic, why is it important or interesting, the papers you plan to review and use to write your survey and why they are the most relevant. Your survey should be clear, summarize the papers, and explain the techniques presented in each paper. Do not just write a summary of each paper, you will not get full grade. You need to write it in survey format that makes the reader feel like this is one big topic. I suggest to Google and read some networking surveys before you write your own. This is another useful resource on survey writing [http://www.cs.ucf.edu/~lboloni/Teaching/EEL6788\\_2008/slides/SurveyTutorial.pdf](http://www.cs.ucf.edu/~lboloni/Teaching/EEL6788_2008/slides/SurveyTutorial.pdf). Some example survey topics are:

- 5G/6G Networks
- TCP variants, such as over wireless link
- Software defined networks (SDNs)
- Network Function Virtualization (NFV)
- Fundamentals of blockchains and their applications
- Content Distribution Networks
- Data Centers
- Network Verification
- Network Coding
- Wireless Sensing/Imaging
- Satellite Networks
- Low power networks like LoRA
- Cross Technology Communication (WiFi/ZigBee/Bluetooth)
- Internet of Things
- Backscatter/zero-power networks
- Network Security

### Project Suggestions

Below, we provide a list of project suggestions. The ideas in this document are only suggestions. They are not complete specifications; we haven't thought through the details in most cases (that's your job for whatever project you decide to work on).

- **Wireless:** Perform signal strength measurements of WiFi or LTE in various spots on campus. Create a coverage map and measure the variability of signal strength over time. Look at the correlation between signal strength and network performance. You'll probably want to track which AP or cell tower you're connected to at a given time. You can potentially further localize

the user based on which APs he can detect and their signal strength. You can use common tools like WiFi or LTE Analyzer Apps.

- **Satellite Networks:** Understand the topology of existing satellite networks like Starlink through simulation tools, use these simulation tools to estimate how many satellites a user can see at a given time, how often they need to reconnect to different satellites, what are the impacts of such reconnections on applications. You can potentially borrow a starlink terminal from us to run some tests. You can also merge your understanding with established knowledge (e.g., by reading research papers and validating their results).
- **Security:** Using encryption in networking protocols (e.g. https) can protect the privacy of the user. However, encryption only hides the content of the bits. It cannot hide the size of the data packets or the frequency at which these packets are generated. For example, watching a Netflix video probably requires much more traffic than accessing the New York Times website. Can you build a machine learning classifier that figures out which website or App the user is accessing simply by looking at Wireshark traces? Can you do better than this:  
<https://www.usenix.org/conference/woot16/workshop-program/presentation/saltaformaggio>
- **IoT:** If you have an IoT device in your home, you can investigate how it is connected to the Internet. Use WireShark to monitor its traffic and figure out where it is connected to, what kind of traffic does it send, what causes it to send / receive traffic, whether the traffic is encrypted, etc.
- **SDNs:** Learn how to use MiniNet (<http://mininet.org/>) and use it to create an OpenFlow controller that can modify the router's/switches forwarding tables. How large can you scale your network? What throughput and latency do you achieve? Can you add a firewall to your network? Can you compare to traditional network that does not use OpenFlow? Is your performance better?
- **BGP:** On January 27, 2011, attempting to inhibit the Facebook and Twitter-organized protests, the Egyptian government shut off essentially all Internet service to the country of 82 million people — a unique event in the history of the Internet which caused massive reconfiguration of BGP routes. Can you analyze BGP traces to discover how long did it take to sever all global networked communications of the 15th largest country in the world? Also, what other interesting insights can you bring from this available data?

You can download the needed data through: <http://archive.routeviews.org/>.

The Route Views Project maintains data of routing behavior on the live Internet, and stores these traces for later analysis. Multiple years of data sets are available. To produce the data, Route Views maintains a number of collectors. Each collector has BGP connections to several ISPs' routers. The collectors log two types of data: occasional snapshots of the collector's entire routing table (Routing Information Base, or RIB); and continuous logs of the BGP update messages received from the neighboring routers.

You can use tools like: libBGPDump (<https://bitbucket.org/ripenc/bgpdump/wiki/Home>)