CS433: Wireless Protocols for the Internet of Things

Syllabus - Spring 2025

Course Staff

Instructor
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Overview

The Internet of Things promises a world of computers woven into our physical world. A common need for these devices is low-power, wireless communication. The goal of this course is to introduce students to a variety of wireless networks that target low-power, machine-to-machine communication as is common in the Internet of Things. While we introduce the physical layer and have a goal of getting data to the internet at large, the focus of this course is on the wireless protocols themselves. How are packets structured, and why? How are they designed to enable low-power communication? How do they deal with contention and reliability? What makes them more or less suitable for different applications? We will explore local-area protocols such as Bluetooth Low Energy, Thread (and other 802.15.4 protocols), low-power, wide-area networks (LPWANs) such as LoRaWAN and Sigfox, and other related topics such as backscatter and localization. The class will include lectures on these topics, practical hands-on lab sessions interacting with networks, homeworks to practice wireless topics, and a final design project.

Course Materials

There is no course textbook. We'll be interacting with plenty of specifications and a few research papers. But they are all freely available online.

Location and Time

Lecture time: 12:30-1:50 PM Central, Tuesdays and Thursdays
Location: Tech L160

Lectures are in person. We will attempt to record all lecture sessions so that you can later review them if you want, but the expectation is that students will attend class in person. The strength of this class will be in discussion, so plan on attending every lecture and being willing to speak up.

Lab time: Fridays, 11:00-12:20 PM Central
Location: Frances Searle Building, Room 2370

Labs are in person and attendance is expected on most Fridays. If you will not be able to attend a lab session, you must reach out to the instructor to let them know as soon as possible.

Pre-requisites

CS340, or CS346/CE346, or EE326 or graduate standing.

This course expects students to have a background in C programming. The course will also build on top of your existing knowledge in computer networks and embedded systems. Students are NOT expected to know both, but are expected to have background in one of them.

Communication

All course materials will be posted to Canvas including grades, lecture materials, and class recordings. Piazza will be used for course discussions and questions. **All questions should go to Piazza rather than to email.** We will enroll you in Piazza.

Office hours will also be available, with the regular schedule available on Canvas. Office hour appointments can also be made with the instructors or TA by Piazza post to “Individual Student(s) / Instructor(s) → Instructors”.

Class Structure

Schedule

The course schedule is available on the Canvas homepage for the course. Be aware that it is subject to change, although warnings will be given to students for any major changes.

Labs

Labs will be hands-on activities targeted towards increasing your practical understanding of wireless protocols. These will usually consist of programming some hardware to perform wireless communication. Labs will usually be performed in small groups. Most labs are worth 10% of your grade, except for the first which is worth 5%. The tentative list of labs are:

1. Wireshark (worth less)
2. Bluetooth Low Energy
3. Thread
4. WiFi
5. LoRa

Labs will be started on Fridays during the scheduled class lab section. However, you are not expected to finish during the lab time, and will continue outside of the lab time.

Homeworks

Homeworks will be on-paper exercises to practice wireless topics. They are completed individually. Most homeworks will be worth 5% of your grade, while a longer cellular-focused homework is worth 10%. The tentative list of homeworks are:

1. Background
2. BLE Packets
3. Matter
4. Cellular (worth more)

Quizzes

These will evaluate your understanding of course material. Quizzes will be given roughly every three weeks, with a total of three quizzes throughout the class. Students will be given a limited amount of time to complete several questions on lecture material since the last quiz.

Final Design Project

The final design project is an end-to-end task to design and evaluate a communication scheme for an Internet of Things application. Loosely, this will be an exercise of: "You're an engineer at startup X, building application Y, with requirements 1,2,3,4. What do you design and *why*?" The expectation is that students will invest significant time into considering real-world technologies.

The final design project will be due during exam week and will be worth a significant portion of your overall grade.

Grades

Percentage grades will be converted to letter grades using the standard letter grade system (93% A, 90% A-, 87% B+, etc.). However, these grade bins may be moved at the instructors' discretion for the advantage of students. Note that the percent grade displayed by Canvas is not always accurate and may not take late penalties or slip days into account, as described below.

Each category of assignment has a total value, which is divided between assignments as specified above.

Category	**Count**	**Total Value**
Labs	5	45%
Homework	4	25%
Quizzes	3	15%
Final Design Project	1	15%

Late Policy

The final design project may not be taken late without prior coordination by the instructor.

Homework and labs may be submitted late with a penalty of a 20% reduction in maximum points per day late with a minimum of zero points. For example, a homework assignment submitted two days late has a maximum score of 60%. Lateness is rounded up to the whole day, so an assignment that is five minutes late has the same penalty as an assignment 23 hours late.

Slip Days

To help you more flexibly manage deadlines, we will give you **three slip days**, which allow you to submit a homework or lab assignment late without penalty. Slip days are used in units of whole days, meaning a homework or lab submitted five minutes late consumes an entire slip day. **Slip days may only be applied to homework or lab assignments, not the final design project.**

You do not need to notify staff that you are using a slip day. We will track the total number of late days for your submissions and automatically apply slip days to optimize their usage. Slip days will not be assessed against homework or lab assignments you did not submit. No extra credit is awarded for avoiding the use of slip days. However, it is in your best interest to avoid turning in homework or lab assignments late, as the next assignment is often released slightly afterwards.

Slip days are applied individually, so for partner assignments be careful to communicate about plans to use slip days. It is possible for an assignment submitted one day late to have no penalty for one student (due to spending a slip day) and a one day late penalty for their partner with no slip days remaining.

Example slip day usage:

- Use two slip days to receive no penalty on a homework submitted two days late.
- Use two slip days to receive no penalty on two separate lab assignments each submitted one day late.
- Use three slip days to receive just a one-day late penalty on a homework submitted four days late.

Slip days are meant to automatically handle minor issues. If you are having a major issue, please contact the instructor as soon as possible, and we will work together on a solution. Particularly for issues outside of the student's control, such as major injury or sickness, deadlines can be shifted without penalty if you contact the instructor.

Academic Integrity

Your work must be your own. For group work, it is expected that all group members will have equally and substantially contributed to the work.

Collaboration is a really good thing, and we encourage it. On the other hand, cheating is a very serious offense, which carries serious consequences. It is OK to meet with colleagues, form study groups, discuss assignments with them, compare alternative approaches, go over examples from textbooks or other sources. **But it is never ok to share lab code or homework solutions, or even to see each other's lab code or solutions.**

What you turn in must be your own work. Copying (or even studying) code, solution sets, etc., from anywhere (e.g., other people, web, GitHub, AI) is strictly prohibited. It is acceptable to discuss possible issues and solutions verbally with each other, without viewing code.

Several assignments in this course include written components. Any writing must be your own work, and not the work of any generative AI tool or any other person. We have tools to check for academic integrity issues, and concerns will be reported to the dean for further investigation.

It is the responsibility of every student in this class to be familiar with and to adhere to the Academic Integrity Policies of Northwestern University and the McCormick School of Engineering. Any suspicion of violation of these policies will be reported immediately to the Associate Dean for Undergraduate Studies. If you are in doubt whether your actions constitute a violation of the above policies, ask the instructor (before doing what you are unsure about).

Sickness and Common Sense

Generally, if you are sick do not attend class. Instead contact your instructor as soon as possible and we'll figure out a way to handle the situation. I expect all students to use their discretion and make good choices for the community.

Accessibility

I believe in providing reasonable accommodations that allow for full access to learning for all. Please contact me for anything that might have an impact on your participation in this course (documented disability, language challenges, absences for religious observations, etc.).

Class Recordings

This class or portions of this class will be recorded by the instructor for educational purpose and available to the class during the quarter. Your instructor will communicate how you can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Diversity and Inclusion

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability—and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class.

Northwestern is committed to fostering an academic community respectful and welcoming of persons from all backgrounds. To that end, the policy on academic accommodations for religious holidays stipulates that students will not be penalized for class absences to observe religious holidays. If you will observe a religious holiday during a class meeting, scheduled exam, or assignment deadline, please let me know as soon as possible, preferably within the first two weeks of class. If exams or assignment deadlines on the syllabus fall on religious holidays you observe, please reach out so that we can discuss that coursework.

This course will also include a mix of undergraduates and graduate students with differing backgrounds in embedded systems, computer science, and electrical engineering. Do not feel discouraged by this. Each student will bring a different aspect of their knowledge to discussions, and we'll all be contributing towards increasing each other's understanding.

Northwestern University Syllabus Standards

This course follows the Northwestern University Syllabus Standards. Students are responsible for familiarizing themselves with this information.