CS397/CS497: Wireless Protocols for the Internet of Things

Syllabus - Winter 2023

Course Staff

Instructor

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Location and Time

Lecture time: 3:30-4:50 PM Central, Mondays and Wednesdays
Location: Hive Annex 2340, Ford Engineering Design Center

The strength of this class will be in discussion, so plan on attending every lecture and being willing to speak up. However, we will attempt to record all lecture sessions so that you can later review them if you want.

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.

Prerequisites

No formal requirements. The course expects students to have a background in C programming. The course will also rely on some knowledge of either embedded systems or computer networks, which could be satisfied through CE346, CS340, or other means.

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 are available on request (post to Piazza to request). I'm absolutely happy to spend individual time with students discussing any questions they have.

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 be performed in small groups. All labs are equal points.

The schedule contains a tentative list of labs. This is subject to change though, as they are being developed during the quarter.

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 schedule contains a tentative list of homeworks. This is subject to change though, as they are being developed during the quarter.

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
Homework	4	25%
Labs	5	50%
Final Design Project	1	25%

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.

Accessibility

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

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers, please contact AccessibleNU to move forward with the university's established accommodation process (accessiblenu@northwestern.edu; 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

Should you need them, additional campus resources are available, including, but not limited to:
- Accessible NU: www.northwestern.edu/accessiblenu/
- CAPS: www.northwestern.edu/counseling/index.html
- Student Enrichment Services: www.northwestern.edu/enrichment/

Diversity and Inclusion

I consider this classroom to be a place where you will be treated with respect, and we 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.

This course will also include a mix of undergraduates and graduate students with differing backgrounds in programming. 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.

Support for Wellness and Mental Health

Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:
- https://www.northwestern.edu/counseling/
- https://www.northwestern.edu/religious-life/
- https://www.northwestern.edu/care/

COVID-19 Compliance

Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the COVID-19 Expectations for Students. With respect to classroom procedures, this includes:

- Policies regarding masking, social distancing and other public health measures evolve as the situation changes. Students are responsible for understanding and complying with current University, state and city requirements.
- In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.

If a student fails to comply with the COVID-19 Expectations for Students or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

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.

Class Recordings

This class or portions of this class will be recorded by the instructor for educational purposes 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.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.