Wireless Protocols for the Internet of Things
CS397/CS497

Syllabus - Spring 2022

Course Staff

Instructor
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Location and Time

Lecture time: 3:30-4:50 PM Central, Tuesdays and Thursdays
Location: Lecture Room 4 (M113), Technological Institute

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, and a final project culminating in a presentation and short paper.

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 also expects students to have a background in C programming. The course will also rely on some knowledge of embedded programming and computer networks, which could be satisfied through CE346, CS340, or other means. For example, knowledge of C, experience with Arduino (or another microcontroller), and interest in networks should be sufficient to participate in the course.

Communication

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

Office hours are available at request (post to Campuswire or ask the instructor after class). 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 activities targeted towards increasing your practical understanding of wireless protocols. These include hands-on activities interacting with networks and thought exercises where you will investigate and plan out communication mechanisms. Labs will be performed in small groups.

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

Final Project

These are open-ended and can focus on any topic related to the class. They should be performed in small groups (2-3 students). The labs should help give you some basis for a project, but you can focus on any IoT wireless aspect of your choosing. Projects can be in simulation or on real hardware. Some budget is available for the purchase of project hardware.

Example ideas:

- Discrete event simulation of a wireless network
- Analysis of transmissions in a wireless network from a throughput or energy perspective
- Implementation and evaluation of a modified network

Project proposals will be due about 1/3rd of the way into class. They will include a short writeup of the project plan and a discussion with the instructor about the project.

Updates will be given once or twice between proposal and submission, detailing completed work, unexpected challenges, and revisions to the project goals.

An in-class presentation will be given for each project. The presentation will cover background and the work you have done, plus time for questions and should include a demo if appropriate. These will take place the last week of class.

A research-style paper describing the project is due at the end of the quarter. These will be up to six pages and include related work, design, implementation, and evaluation of your project.

The final projects themselves are also graded based on quality and difficulty. The instructor's understanding of these projects will come primarily through the presentation and paper. The proposal and updates will be used to guide students so that they can anticipate how their project will be judged.

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 instructor's discretion for the advantage of students. Note that the percent grade displayed by Canvas is not always accurate and may not take late penalties into account, as described below.

35% - Lab projects

Tentatively 7 projects total, with points divided evenly

65% - Final project

10% - Proposal
5% - Updates
10% - Presentation
10% - Paper
30% - Project quality

This class isn't graded on a curve, and you should note that there are no exams. Instead, course participation is expected (rather than graded), and you'll be graded predominantly on your final project.

Late Policy

The Final Project may not be submitted late. Labs may be submitted late within a week of the due date for 50% of the maximum points.

If you are having an issue completing any course materials, 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, sickness, or family emergency, deadlines can be shifted without penalty if you contact the instructor.

Accessibility

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/

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.).

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 computer science. 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 of wireless protocols and the Internet of Things.

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 Code of Conduct. With respect to classroom procedures, this includes:

- Policies regarding masking and social distancing evolve as the public health situation changes. Students are responsible for understanding and complying with current masking, testing, Symptom Tracking, and social distancing 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 Code of Conduct 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.

To protect the health of our community, Northwestern University requires unvaccinated students who are in on-campus programs to be tested for COVID-19 twice per week.

Students who fail to comply with current or future COVID-19 testing protocols will be referred to the Office of Community standards to face disciplinary action, including escalation up to restriction from campus and suspension.

Some (hopefully all) class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.

Maintaining the health of the community remains our priority. If you are experiencing any symptoms of COVID do not attend class and update your Symptom Tracker application right away to connect with Northwestern's Case Management Team for guidance on next steps. Also contact the instructor as soon as possible to arrange to complete coursework.

Students who experience a personal emergency should contact the instructor as soon as possible to arrange to complete coursework.

Should public health recommendations prevent in person class from being held on a given day, the instructor or the university will notify students.

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.