EE 579: Wireless and Mobile Networks

Design and Laboratory

Spring 2018

Theme: Mobile Design in the Era of Big Data, AI, and IoT

MW: 2:00-3:50pm

Location: KDC 236

Units: 3.0

Course Syllabus

<u>Instructor:</u> Erick Moen

<u>Office hours:</u> 4:00pm Monday (PHE 335)

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Course Description

There are more devices on the internet than people, and this asymmetry is increasing each day. With this explosive growth, there is greater opportunity for information collection and dissemination as well as collaboration and actuation. Though the concept existed in the literature long before the term had been coined, the Internet of Things (IoT) has evolved far beyond it's circa-1999, RFID-tag roots. Advances in low-power electronics, energy harvesting, distributed computing, sensors, wireless technologies, parallel processing, and artificial intelligence (AI) have thrown gasoline on the fire and allowed for the rapid emergence of IoT as a means to connect us more viscerally and intelligently to the world around us.

In IoT networks, sensors and actuators embedded in physical objects (ranging from cars and buildings to pacemakers and phones) are linked to each other, often using the same Internet Protocol (IP) that connects the Internet. The development of the next generation of these "smart communities," as well as the "smart" objects, buildings, and personalized medicine platforms that make them up, will require us to design network protocols and highly innovative applications in fundamentally different ways. Bleeding-edge research in topics ranging from AI to Augmented Reality (AR) will be required to feed this innovation. Furthmore, as these systems develop, new technological, and even ethical, questions will need to be answered, like how to design intuitive interfaces that allow users to parse information relevant to them or how user privacy can be safeguarded in an age of ubiquitous connection. These questions will require engineers to possess an unprecedented variety of skills and knowledge. This course is intended to help students build a firm, yet broad, foundation in a number of subjects critical to the new IoT landscape, while providing exposure across the entire spectrum of design, research, and development.

To accomplish these goals, the course is split into two halves. The first half consists of several programming/lab assignments meant to allow students to become familiar with key technologies and methods. The second half involves students forming groups and defining a project to pursue that satisfies a compelling user need or research goal. The

course is ideal for advanced graduate students interested in gaining familiarity with a wide range of hot topics in networked mobile computing. Additionally, as the course is lab and project-oriented, students will gain hands-on experience in a few of these subjects and have evidence of this experience for perspective employers.

Learning Objectives

The primary goal of this course is to give students the opportunity to learn how to develop at every layer, or across the "Full Stack," of IoT using a variety of wireless and mobile devices. This is a laboratory course, so the learning will be primarily hands-on. Students will be introduced to a range of hardware platforms with a focus on Android-based mobile devices and Linux-based servers. The course will also expose you to a wide range of relevant wireless technologies, including Bluetooth/BLE, IEEE 802.11, and Cellular. There are a correspondingly wide range of languages and software environments required to program these devices and log their information. Some of these include: C, Java, JavaScript, Python, SQL, XML, MQTT, CoAP. Additionally, the course will introduce students to a wide range of subjects relevant to networked mobile computing, such as storing and processing information in the cloud using databases and computing frameworks, AI and machine learning (ML) algorithms, signal processing and data cleaning, sensor development and integration, privacy and security mechanisms, and data visualization. Special attention will be paid to the possibility of AR as a new visualization technology and possible interface for IoT networks.

The first half of the course will focus on core platforms and technologies, introducing them through hands-on, in-class activities and assignments. In the second half of the course, students will work in groups to define and propose a substantial project that they will work on for the rest of the semester. For this project, you may choose any hardware/software combination of interest to you and work at any layer: MAC / Routing / Transport / Application. The main expectation is that each project should satisfy a compelling user need or research goal. It should be something substantial, novel, and cool, while reflecting the capability of graduate students at a top-ten engineering school! The best projects from the class will be showcased. While you work on these projects, we will continue to meet to discuss your progress through team meetings and critiqued oral presentations.

Note that this is a very programming-intensive course. It is expected that the students taking this course already have a strong background and considerable experience with object-oriented and network programming (through courses such as CS 402, CS 551, or other prior experience). This laboratory course will not teach you how to program. Beyond a very brief introductory tutorial in class, and pointers to a wide range of online resources, you are going to be left on your own to master the software development environments, libraries, and interfaces that are unique to each platform. If you do not feel comfortable about your ability to master a new and unfamiliar programming environment largely on your own, and spend countless (often frustrating!) hours coding, debugging, and testing software, this is not the right class for you. On the positive side, the unique learning process used in this class, which emphasizes self-motivated knowledge acquisition, independent problem-solving, hands-on experience, open-ended design, innovation, and communication (both orally and in writing), is sure to prepare you well for a real-world engineering environment beyond USC.

To assit in both your personal and project development, this class will also develop your ability to search and critically read cutting-edge technical paper from the primary literature. It is our hope that this will open up your horizons to new developments in the field, and inspire a process of life-long learning. As an additional supplement, throughout the semester, we will have some guest speakers from industry and academia giving us diverse perspectives on the technological challenges and developments in the IoT domain.

Prerequisite

One from (CSCI 551 or EE 550 or EE 555)

Recommended Preparation

A strong programming background and familiarity with computer networking

Course Notes

This course will make lecture materials and other class information available on Blackboard as it becomes available.

Required Readings and Supplementary Materials

There is NO required text for this course. Pointers to many useful online references and forums will be posted on Blackboard.

Grading Policy

Assignments (4-5 programming projects), 50%; final project, 50%

Programming / Lab Assignments	40%
Manuscript/Tech Review	10%
Project Proposal	10%
Project Update Report	10%
Final Project and Report	30%

The final letter grade will reflect your score in the course relative to others to some extent, but more so your absolute performance.

Grading Scale

Course final grades will be determined using the following scale:

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Attendance

You are expected to attend ALL lectures and discussion sections. More than two unexplained absences will result in grade reduction.

Course Schedule*

	Topics	Materials	Notes
Week 1 (01/08 – 01/12)	Course introduction Android and device programming	Course Notes	
Week 2 (01/15 – 01/19)	Network (Medium Access Control) and Communication protocols (MQTT, Bluetooth, LoRa, Zigbee)	Course Notes	No Class 01/15 (MLK Day)
Week 3 (01/22 – 01/26)	Sensors & Hardware Wearables & Low Power Devices (Energy Harvesting)	Course Notes	Lab 1 due 01/22
Week 4 (01/29 – 02/02)	Databases From SQL to NoSQL	Course Notes	
Week 5 (02/05 – 02/09)	Data Cleaning/Signal Processing Sensor fusion (Health Signals) Differential Privacy	Course Notes	Lab 2 due 02/05
Week 6 (02/12 – 02/16)	Mobile Data Analytics And Statistical Methods	Course Notes	
Week 7 (02/19 – 02/23)	AI/ML for Networked Mobile Devices (Mobile & Crowdsourced Sensing)	Course Notes	No Class 02/19 (President's Day) Lab 3 due 02/23
Week 8 (02/26 – 03/02)	ML/AI APIs Data Visualization	Course Notes	
Week 9 (03/05 – 03/09)	AR as an IoT Interface VR as a Dev Environment	Course Notes	Lab 4 due 03/09
Week 10 (03/12 – 03/16)			No Class 03/12 or 03/16 (Spring Break)
Week 11 (03/19 – 03/23)	Collaboration Environments (GitHub, Bitbucket, etc.) Invited Talk: IoT testbed	Course Notes	Project Proposal due 03/23
Week 12 (03/26 – 03/30)	UX/UI (TTS/STT) Invited Talk: IoT+M&E	Course Notes	
Week 13 (04/02 – 04/06)	Bots/Personal Assistants Invited Talk: AR/VR/XR	Course Notes	
Week 14 (04/09 – 04/13)	Connected/Autonomous Vehicles Invited Talk: IoT+Health	Course Notes	Project Update due 04/09
Week 15 (04/16 – 04/20)	Parallel, Distributed, and Dispersed Computing	Course Notes	
Week 16 (04/23 – 04/27)	Blockchain for IoT Final Presentations	Course Notes	Project Presentation due 04/27

FINAL			Final Report due
(05/07)			

*Some of this material is subject to reorganization or alteration based on student interest/final project needs.

Statement on Academic Conduct and Support Systems

Academic Conduct and Accommodations:

Plagiarism –
Presenting someone else's ideas or work (including code and pseudocode) as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" (policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. Review the additional information available in SCampus as well as the university policies on scientific misconduct (http://policy.usc.edu/scientific-misconduct). You are expected to maintain the highest standards of academic conduct. Any form of plagiarism or other violation of academic integrity will be referred to Student Judicial Affairs and will result in a stiff penalty (ranging from a letter grade reduction to an "F" in the course). See information on Scampus, including
(https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriatesanctions)

Academic Accommodations –
The Office of Disability Services and Programs (http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html) provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information (http://emergency.usc.edu) will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

Safety and Support:

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity (http://equity.usc.edu) or to the Department of Public Safety (http://adminopsnet.usc.edu/department/department-public-safety). This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men (http://www.usc.edu/student-affairs/cwm/) provides 24/7 confidential support, and the sexual assault resource center webpage (http://sarc.usc.edu) describes reporting options and other resources.

Agency Descriptions and Contact Information

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.
engemannshc.usc.edu/rsvp

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support
Incidents of bias or hate crimes need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Provides overall safety to USC community. dps.usc.edu