CS 6900 – Software Defined Networking & Radio

Spring Semester 2016-17
School of Electrical Engineering and Computer Science
Ohio University, Athens, Ohio.

Course Description

Students in this course will experience computer networking from a software networking perspective. In the first part, students will study digital communication techniques and traditional hardware digital radios. Next, the same baseband signal processing functions used in these hardware digital radios will be implemented in software (MATLAB/GNU radio), and will be tested using real IQ samples collected by real SDRs. Recent research on cognitive radio and cognitive networking – two techniques which rely on the versatility of SDRs - will then be presented by the students.

Moving upwards in the networking stack, students will study the hardware implementation of networking appliances such as switches and routers. Then, OpenFlow-based software defined networking will be introduced as an abstraction of these appliances. Students will build and simulate such networks using the Mininet simulator, and will incorporate recent frameworks such as Frenetic.

Course Topics

Software defined radio: complex representation (I-Q) of baseband signals, Fourier analysis, random processes and their spectral description, signal space concepts, optimal AWGN receiver, synchronization, equalization, channel modeling, channel coding, equalization, cognitive radio/machine learning, spectrum sensing and cyclostationary techniques, optimization, estimation, detection, random matrix theory

Software defined networking: separation of control plane and data plane, routing versus forwarding, switching fabrics, access control lists, network management, OpenFlow, Northbound and Southbound APIs, Bufferbloat, OSPF/RIP/BGP routing protocols, the Mininet OpenFlow emulator, the Frenetic SDN programming languages, the Kinetic event driven framework for network control

Lecture sessions

Tu,Th 3:05 PM to 4:25 PM Academic & Research Center 108

Required Materials

1. Software Receiver Design: Build your Own Digital Communication System in Five Easy Steps. C. Richard Johnson, Jr, William A. Sethares, Andrew G. Klein. September 2011. ISBN: 9780521189446

Recommended Textbooks

1. Fundamentals of Digital Communication, Upamanyu Madhow, March 2008, ISBN: 9780521874144.
2. Introduction to Communication Systems, Upamanyu Madhow, ISBN-13: 9781107022775)
3. SIGNAL PROCESSING FOR COMMUNICATIONS, Paolo Prandoni and Martin Vetterli
4. The Scientist and Engineer's Guide to Digital Signal Processing, By Steven W. Smith, Ph.D.

Instructor

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Course website

Blackboard: https://blackboard.ohio.edu/

Office Hours

Instructor: TBD
Appointments required at other times. Please make an appointment via Catmail/Outlook's calendar system at least 1 day in advance. Instructor will be available 24/7 on Piazza ($E[response\ time] < 24\ hours$).

Prerequisites

Introductory undergraduate or graduate course in computer networks

Course Policies

1. Assignments are due electronically on Blackboard, unless specified.
2. Late submissions: no consideration will be given to excuses such as (but not limited to) unavailability of resources (e.g. internet was down, my laptop broke), unavailability of time (e.g., travel, Bengals made it to the Superbowl). Do not wait until the last minute to submit a homework or lab report. You will lose 100% of your score if we do not receive your homework or report on time.
   a. Why this policy? Professionally used document submission systems for time sensitive deadlines (e.g. HotCRP/EDAS for technical conferences) are extremely strict when it comes to closing the submission window. One second late? Better luck next *year*!
3. Attendance in lecture sections is strongly recommended but not required.
4. Students are strongly discouraged from having open laptops/smartphones in class during lectures unless instructed.
5. **All work is to be the original work of the individual. Depending on the severity, individuals performing plagiarism, cheating, and/or any other violation of the Student Code of Conduct may result in a zero for the assignment, may receive a grade of F for the class, and may be referred to the Ohio University Judiciaries for disciplinary action. Students may appeal academic sanctions through the grade appeal process. The Office of Community Standards and Student Responsibility may impose additional sanctions**
6. Any student who suspects s/he may need an accommodation based on the impact of a disability should contact the class instructor privately to discuss the student's specific needs and provide written documentation from the Office of Student Accessibility Services. If the student is not yet registered as a student with a disability, s/he should contact the Office of Student Accessibility Services
7. Preferred Name Policy: See https://www.ohio.edu/policy/12-021.html
8. The lectures, classroom activities, and all materials associated with this class and developed by the instructor are copyrighted in the name of Harsha Chenji on this date 1 January 2017.

Grading

Final Project (individual)	50%
Homework Assignments (individual)	40%
Class Participation	10%

Letter Grade Calculation

All grading is based on the 12-point system. [100-93] A, [92-90] A-, [89-87] B+, [86-83] B, [82-80] B-, [79-77] C+, [76-73] C, [72-70] C-, [69-67] D+, [66-63] D, [62-60] D-, [59-0] F. Instructor reserves the right to lower the limits above, but I promise not to raise them.

Student Outcomes vs. Course Learning Objectives

A: An Ability to Apply Knowledge of Math, Science and Engineering

1. Ability to understand wireless networking at the PHY layer.
2. Ability to understand medium access control mechanisms.
3. Ability to understand spectral resource tradeoffs in PHY link design.
4. Ability to understand design decisions behind widely used wireless protocols.
5. Ability to design large scale wireless networks with limited system resources.

B: Design and Conduct Experiments, Analyze and Interpret Data

1. Ability to evaluate network protocol performance using network simulators.
2. Ability to implement protocols on wireless networking testbeds.
3. Ability to design, build and program individual wireless network nodes.

Final Exam/Project

TBA

Tentative Course Schedule

Week 1	Review of DSP and digital communication basics	
Week 2	HW digital radios, I-Q samples, channel modeling	Homework 1 due
Week 3	Modulation, demodulation, coding	
Week 4	Recovery, filtering, and equalization	Homework 2 due
Week 5	Framing, retransmission, medium access control	Project 1 checkpoint
Week 6	Cognitive radio & spectrum sensing techniques	
Week 7	Machine learning basics & optimization	Homework 3 due
Week 8	Spring Break	
Week 9	Review of networking basics; Intro to Mininet	Project 1 presentation
Week 10	Review of HDL; hardware design of switches	Homework 4 due
Week 11	Forwarding, switching, control/data plane separation	
Week 12	SDN programming using Frenetic	Project 2 checkpoint
Week 13	Routing algorithms and simulations in Mininet	Homework 5 due
Week 14	Bufferbloat/TCP and simulations in Mininet	
Week 15	Recent research in SDN	Project 2 presentation