EECE 261 & 262 Introduction to Local Area Networks, Internetworking, and Wireless Network Services and Applications

Textbook: *Data and Computer Communications, 8th Edition* – William Stallings (Prentice Hall, 2007: ISBN 0-13-243310-9)

Course Objectives: This course provides an overview of the field of voice/data local- and wide-area networks (LANs and WANs), as well as next-generation converged networking techniques. The proliferation of distributed computing applications through networking services (such as cable modems, xDSL, WIFI/WiMAX, and ad hoc mobile networks) makes knowledge of the underlying protocols and theories of these networking technologies essential. Moreover, by developing a concrete understanding of networking architectures, protocol design, and converged networks, students will have the requisite background to make critical design and implementation decisions for hardware and software communication through LANs and WANs.

The EECE 261 course will focus on the key concepts associated with LANs and WANs. It will first introduce students to transmission fundamentals and protocol architectures associated with LAN and WAN technology, such as techniques for flow control, time synchronization, multiplexing, and congestion control. This subject matter will be followed by a study of widely used asynchronous and synchronous networking architectures, such as ATM, SONET, and MPLS/IP. The course will cover material on cellular, wireless, and converged networking protocols and mechanisms, such as GSM, VOIP, and location-aware services. The emphasis of the course will be on ISO OSI reference model and its relationship to traditional and next-generation convergent LAN/WAN technologies and applications.

The EECE 262 course will be a projects course that will provide students with in-depth opportunities to implement applications and services based upon the concepts covered in EECE 261. Course assignments will involve network configuration of LANs/WANs, as well as smartphone programming using donated Google Android and Apple iPhone handsets, open source software-based PBXs (asterisk), and other convergent infrastructure provided by Vanderbilt ITS.

Class Schedule: 2 classes per week of 1hr 15m each

Overview of Topics:

- Transmission Concepts
- Protocol Architectures
- Encoding and Modulation
- Asynchronous and Synchronous Transmission
- Wide Area Interface Architectures
- Analog and Circuit Digital Switching
- Wireless Transmission
- Cellular Telephony
- Synchronous, Time, and Frequency Division Multiplexing
- Wide Area Network Protocols
- Static and Dynamic Routing with IPv4 and IPv6

- Session Management and Initiation Protocols, such as SIP
- Address Resolution Protocol (ARP)
- Internet Control Message Protocol (ICMP)
- Converged Networks
- Open-source platforms for next-generation network and mobile devices.
- VOIP Software Architectures
- P2P Network Message Routing
- Quality of Service Management for Packet-based Networks
- Software switching for VOIP
- Softphones
- Virtual Private Networks
- Open-source platforms for software PBXs
- Router and PBX Virtualization
- Open-source platforms for streaming media
- IP Multimedia Subsystem (IMS)
- Multiprotocol Label Switching

Grading:

There will be a short graded quiz at the end of class each Thursday, starting on August 28th. The exam and the quizzes will largely be based on material presented in class. It is therefore essential that you attend class in order to prepare for the quizzes and final exam. There will be no ``makeup'' quizzes unless you ask permission from me before the quiz. The relative weighting of each portion of the course is presented below:

- 20% Assignments, 20% In-class Design Problems
- 40% Quizzes
- 20% Final Exam

Note that I reserve the right to change the weights during the course of the semester.

EECE 261 Schedule of Course Topics:

The general outline of the course is below. Adjustments to the topics and scheduling may be made depending on class interest and time. Reading assignments for each week are listed and should be completed before class on Thursday (except the week of Aug 27).

August 27:

Course overview and Introduction to Network Convergence

Quiz 0

September 1-3

Stallings, Chapters 1-2

Quiz 1

September 8-10

Stallings, Chapters 10-11 + Chapter 8 pages 240, 241, 248 (8.2) up to TDM Link Control

Topics: Packet Switching, Circuit Switching, Frame Relay, X.25, Synchronous Time Division Multiplexing

Quiz 2

September 15-22

Stallings, Chapter 7

Topics: Flow Control, Error Detection, Error Control, HDLC

Quiz 3

September 29-October 1

Stallings, Chapter 12

Packet Routing

Quiz 4

October 6-8

Stallings, Chapter 13

Congestion control in data networks.

Quiz 5

October 13-15

Stallings, Chapter 15

Local area networks

Midterm

October 20

Stallings, Chapter 18

Internet protocols

Quiz 6

October 22-23, Fall Break

October 27-29

Stallings, Chapter 19

Internetwork Operation

Quiz 7

November 3-5

Stallings, Chapter 20

Transport Protocols, Session Management and Initiation Protocols, SIP

Quiz 8

November 10-12

Outside Reading

VOIP Software Architectures, Softphones, Software switching for VOIP, Open-source platforms for software PBXs, Open-source Platforms for Next-generation Network and Mobile Devices

Quiz 10

November 17-19

Chapters 3, 5 - Data Transmission

November 21-29, Thanksgiving Break

December 1-3

Chapter 6 - 7

Digital Data Communication and Link Control Protocols

December 8-10

Chapter 8 - Multiplexing

Final Exam

EECE 262 Potential Projects: EECE 262 will be run as a semester-long projects course similar to CS 279. Groups of students will develop large-scale software and hardware applications with a substantial networking component. All projects will be implemented on top of the iPhone or Google Android. Potential projects include:

On-demand Friends: Students will develop an application to spontaneously find other friends who are nearby and want to do a particular activity. For example, a student could send a query to the ten friends from their facebook profile that are within 2 miles to see if they want to go to a movie. Users could additionally specify a "social hop" setting to determine if the message propagates to friends of friends via transitive closure.

Receivers see a message like "Brian wants to play a pickup soccer game at 7pm." Or users may see "Brian, who knows Cory, who knows you, wants to play a pickup soccer game at 7pm." On-demand friends allows users to spontaneously find other people to participate in activities with.

Social Map Routing: Students will write an application so that the phone broadcasts its location data to a central server. The server uses the location data to determine how different users drive or get from one point to another. Users can query for the route that the highest percentage of users or their friends take to get from one specific location to another location. The system can also infer the "home" location of users based on their most common ending location at midnight. Users can also query for "how do the locals" get there, which searches for the routes that users who live near the starting point use to get to the ending point.

Homeland Security Sensors: Students will develop smartphone applications that will enable users to carry cell phone-integrated detector for various threats (e.g., "dirty bombs", chem/bio attack sensors, etc). The smartphones will also have GPS devices that enable a central server to continuously track their position via a Google Earth-based user interface. When the detector is in close proximity to a source of a potential attack, it sends an alarm using the mobile phone network.

Wreck Watch: Students will write a smartphone application for automatically detecting wrecks on roads. The application works by using the accelerometer on the phone to detect a potential car crash. When a violent acceleration is detected, a message is sent to a central server with the time, acceleration data, and location of the event. If the server sees a set of messages that occur close together and within a short time period, it marks a map with that spot as a potential accident. The server also uses the accelerometer data to try and reconstruct the angle and velocities of the cars in the accident.

Real-time Real-world Strategy Games: Students will write a group game like tower defender where the user's actual movements are reflected in the game. Users will place various gun towers, power-ups, and bases on the phone through a P2P interface. The placement of each item is tied to a real world location. When the game starts, players must run around trying to collect the virtual powerups by getting to their real-world location. Along the way, the user must not get shot by a virtual gun placement. Users can see the virtual bullets being fired on their phone screens and must run around in the real world to avoid them. Players can destroy tower placements by taking pictures of them from within a certain distance.