CSC6290: Data Communication and Computer Networks

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Objectives of the course

- You may have gained basic understanding of computer networks in undergraduate study, but not yet written any foundational networking software yet …

- Science and art of networking protocol design and implementation
  - Key network protocols
  - Network protocol reasoning from “distributed systems” point of view
    - Think distributedly!
  - Efficient, reliable protocol implementation
    - Think running-code!
Topics to cover

- **Prelude**: history, current status, and future directions of computer networks

- **Foundation**: system requirements, network architecture, implementation issues, performance metrics and evaluation
Topics (contd.)

- Network protocol design
  - *Direct link networks*: error detection, reliable transmission, media access control
  - *Packet switching*: store-and-forward switches, bridges and extended LANs
  - *Internetworking*: best-effort service model, global addressing scheme, IP, ARP, DHCP, ICMP, virtual networks, Internet routing, multicast
  - *End-to-end protocols*: TCP (connection establishment/termination, sliding window, flow control, adaptive timeout), UDP, remote procedure call
  - *Congestion control and resource allocation*: queuing discipline, TCP congestion control, congestion avoidance, quality of service control (integrated services, differentiated services)
  - *Elements of distributed computing*: naming, caching, replication
Topics (contd.)

- Network algorithmics/implementation
  - *Rules of the game:* network implementation models, implementation principles, practice
  - *Playing with endnodes:* copying data, transferring control, maintaining timers, demultiplexing, protocol processing
  - *Playing with routers:* exact-/prefix-match lookups, packet classification, switching, packet scheduling
  - *Endgame:* measuring network traffic, network security
Perspectives

- Internet

- Emerging networking technologies
  - vehicular networks
  - wireless sensor networks
  - disruption tolerant networks
  - mobile ad hoc networks
  ...
Textbooks

- Required:
  - [R0] Larry Peterson and Bruce Davie, *Computer Networks: A Systems Approach* (5th edition), Morgan Kaufmann.

- Recommended references:
Logistics

- Class timings
  - MW 3:00pm-4:20pm

- Office hours
  - MW 4:30pm-5:30pm in *Suite 14101.3, Maccabees Building*, or by appointment

- Teaching Assistant
  - TBA
Logistics (contd.)

- **Prerequisites**
  - Undergraduate courses in algorithms, operating systems, and computer architecture (e.g., CSC 4420, CSC 4100, CSC 5050, or equivalent)
  - Or consent of instructor

- **Course website**

- **Course mailing list**
  - csc6290@lists.wayne.edu
  - Web-section only: csc6290-web@lists.wayne.edu
Logistics (contd.)

- **Grading**
  - Class participation: 10%
  - TinyExams: 40%
  - TinyLabs: 25%
  - Project: 25%

- Letter grades will be assigned based on performance *relative* to other students;

A tentative grading scale:

- A: 93-100
- A-: 90-92
- B+: 85-89
- B: 80-84
- B-: 75-79
- C+: 70-74
- C: 65-69
- C-: 60-64
- F: 0-60
TinyLabs

- Hands-on labs with TinyOS, an operating system for networked embedded computing
Project

- Literature review on one of the following topics:
  - Protocol design and implementation in different operating systems
    - TinyOS, Contiki
    - Linux
    - Real-time OS such as uT-Kernel, Nano-RK, VxWorks, FreeRTOS
  - Broader topics on real-time OS for networked, embedded systems
    - uT-Kernel: [http://www.t-engine.org/what-is-t-kernel/mt-kernel](http://www.t-engine.org/what-is-t-kernel/mt-kernel)
  - Software defined networking: software defined ratio (WARP etc), OpenFlow, protocol and service evolution
  - Click modular router: [http://www.read.cs.ucla.edu/click/click](http://www.read.cs.ucla.edu/click/click)
  - Other topics of your choice (with consent of instructor)
Project context

- *Wireless, embedded networking* technologies and applications in
  - vehicles: 60GHz wireless, UWB, V2V, V2I, sensing and control, infotainment, etc.
  - power-grid: alternative energy microgrid, hybrid power grid, etc.
  - industrial control: feedback control, machine health monitoring, etc.

- Can focus on issues such as *MAC, interference management and control, routing, and transport control.*
Context (contd.)

- **Sensor network** applications and protocol design in
  - Healthcare
  - Engineering: structural health monitoring, factory automation & industrial control, etc.
  - Scientific study: environmental engineering, social sciences, etc.
  - Homeland security and military
  - Daily life: urban sensing, security monitoring

- Can focus on issues such as *MAC, routing, transport control, data storage and querying, and localization.*
Wireless mobile network applications and protocol design in traffic control: real-time road traffic condition detection and control
- Auto safety: DSRC
- Homeland security
- Social networks

Broadband wireless access network applications and protocol design
- WiMAX, LTE, 4G, 5G, etc.

Heterogeneous network applications and protocol design in integrated wireless networks (sensor networks, WiFi, cellular) and the Internet etc.
Project (contd.)

- Rules
  - Students are allowed to form groups in doing projects, but the number of students per group should be no more than 3
  - First choose one of the above research fields, and then start surveying the literature to understand the state of the art in the corresponding protocol design and implementation
  - Focus on 1-2 protocol design/implementation issues
    - Report the history, development, and open issues of your chosen topic(s)/challenge(s)
Project (contd.)

■ Deliverables
  ■ Written project report (in the form of a survey paper)
  ■ In-class presentation

■ Timeline
  ■ Select the topic and form your project group by 09/30/2014
  ■ Detailed project report outline & list of references are due on 10/31/2014
  ■ Submit slides for your presentation at least one day before your presentation (date to be decided)
  ■ Submit your project report electronically by midnight 12/17/2014

■ Evaluation criteria
  ■ Breadth and depth of your understanding of the literature, as evidenced by your project report and presentation
  ■ Presentation quality (e.g., clarity, readability, and conciseness) of your talk and written report
What is this course NOT for?

- Network programming
- Assemble networks with switches, routers, firewalls, etc.
- Design websites
Policies

- Frequently check out the course website for updated information
- Exercises strongly recommended
- TinyExams, TinyLabs, project required
- Other WSU polices
How to succeed in this course?

- Attend/follow lectures, read books
- Work on exercises, project, and TinyLabs
- Ask questions!!!

Questions?
Student questionnaire

- Name (optional):
- E-mail (optional):
- Major:
- Degree/Expected Year:
- Operating Systems/Architecture/Algorithm courses taken:
- Computer Networking courses taken:
- What do you expect to learn from this course? How do you think this course should be taught?
- How might this course contribute to your career objectives?