CSC4290: Introduction to Computer Networking

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Objectives of the course

- **Ultimate goal:**
  - you can build any network (including the Internet) from scratch up!

- **Humble course objectives:**
  - To appreciate the underlying principles of computer networks
  - To build the foundation for students to understand advanced topics in networked systems (e.g., those that will be covered in CSC 6290 and CSC 7290)
  - To build up students’ skill set that is necessary for making innovative contributions to both networking technologies and applications

**Theme:**
Issues to consider when designing a brand-new network technologies?
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.)

- **Direct link networks**: encoding, framing, error detection, reliable transmission, media access control

- **Packet switching**: store-and-forward switches, bridges and extended LANs, cell switching, segmentation and reassembly

- **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
Topics (contd.)

- *Congestion control and resource allocation*: queuing discipline, TCP congestion control, congestion avoidance, quality of service control (integrated services, differentiated services)

- *Network security*: cryptographic algorithms, security mechanisms, firewalls

- *Network management*: components of network management, Internet network management framework, presentation services

- *Elements of distributed computing*: naming, caching, replication

- *Applications*: SMTP, HTTP, overlay networks, multimedia applications
Perspectives

- Internet

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

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Textbooks

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

- **Recommended references:**
Logistics

- Class timings
  - MW 4:30pm-5:50pm

- Office hours
  - MW 6:00pm-6:30pm in Suite 14101.3, Maccabees Building, or by appointment

- Course Assistant
  - TBA
Logistics (contd.)

- **Prerequisites**
  - Undergraduate courses in algorithms, operating systems, and computer architecture (e.g., CSC 2200, CSC 3100, or equivalent)
  - Or consent of instructor

- **Course website**

- **Course mailing list**
  - [csc4290@lists.wayne.edu](mailto:csc4290@lists.wayne.edu)
  - Web-section only: [csc4290-web@lists.wayne.edu](mailto:csc4290-web@lists.wayne.edu)
Logistics (contd.)

- **Grading**
  - Class participation: 10%
  - TinyExams: 50%
  - Project: 40%
  - TinyLabs: bonus points

- 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 (as exercises)

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

- Literature review of one of the following fields:
  - *Wireless, embedded networking* technologies and applications in
    - vehicles: 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.*
Project (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.*
Project (contd.)

- *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, etc.

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

- Protocol design and implementation in diff. operating systems
  - TinyOS
  - 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://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5325154

- Software defined networking: software defined ratio (WARP etc), OpenFlow

- Click modular router: http://www.read.cs.ucla.edu/click/click

- Other topics of your choice (with consent of instructor)
Rules

- Students are allowed to form groups in doing projects, but the number of students per group should be no more than 2.

- First choose one of the above research fields, and then start surveying the literature to understand the state of the art in the field.

- Report the history, development, and open issues of your chosen topic(s)/challenge(s).
  - It will be great if you can form your own opinions of the research topic you have chosen.

- It is **required** that, in your project report, you present whether and how the basic challenges (such as media access control, routing, and congestion control) in your chosen research field remain the same as or differ from what we have discussed in class.
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
- TinyExams and project required
- Exercises & TinyLabs strongly recommended
- Other WSU polices
How to succeed in this course?

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