CSC/ECE 570: Computer Networks
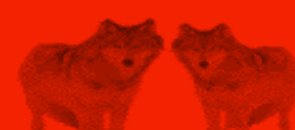
Course Introduction

Fall, 2024

Yuchen Liu, Computer Science, NCSU

Welcome to 570

- Introductions
- Course communication mechanisms
- Schedule/Topics
- Grading
- Policies
- Questions

Administrative Information

- Instructor: **Dr. Yuchen Liu**
  - Email : yuchen.liu@ncsu.edu
  - Office hours: Wednesday 3:15-4:00pm (zoom)
    https://ncsu.zoom.us/j/99012841293?pwd=0qx83VuE9T5P8BK78qSsbdsfbCiy0B.1

- TAs: **Zhizhen Li**

  - Email: zli92@ncsu.edu

  - Office hours: Tuesday 2:00 pm to 3:30 pm, zoom: https://ncsu.zoom.us/j/7685800976

- TAs: **Jinming Xing**

  - Email: jxing6@ncsu.edu

  -   - Office hours: Thursday 10.30am to 12pm

    zoom: https://ncsu.zoom.us/j/2407868069?pwd=OXMyczdHdldtcGhxNXUxNmJveG1EUT09

- Class website: Moodle
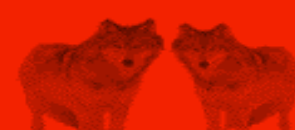
Research Group

Networking + Intelligence

- **networking and systems** (wireless, digital twins, Open RAN, protocols, and security)

- **mobile computing** (robotic networking, infrastructure mobility)

- **ML/LLM for data, networking, and sensing** (distributed/on-device learning, generative AI, data analytics)

- **new communication paradigms** (mmWave, THz, nextG Wi-Fi)

- **optimization and resilience** (theory, large-scale systems)

- **software development for computer networks** (differentiable simulator, open-source testbed, ns-3)

Course Delivery Mechanisms

- **Lectures: in-classroom, F2F**
  - Live sessions during <u>normal lecture hours</u>

- **Announcements:** Moodle

- **Submissions:** Moodle

- **Exams: in-person, F2F**

- **All are subject to change!**

- Instructor office hours
  - Via zoom from 8/26 (skip this week)
  - Link posted on Moodle
  - In-person in office by appointment

- TA office hours
  - Via Zoom (separate dates & times)
  - Posted on Moodle

  - Contact TA with course-related issues
  - Contact instructor with exception situations, policy questions (be prepared for delay)

Course Introductions

- CSC/ECE 570 Computer Networks
  - Entry-level graduate computer networking course
  - Focus on fundamental concepts in **different kinds of computer networks,** e.g., p2p communication, wired network, wireless network.
    - Different from CSC/ECE 573 Internet Protocols which focuses on the Internet
  - Emphasis on **theoretical and conceptual development**
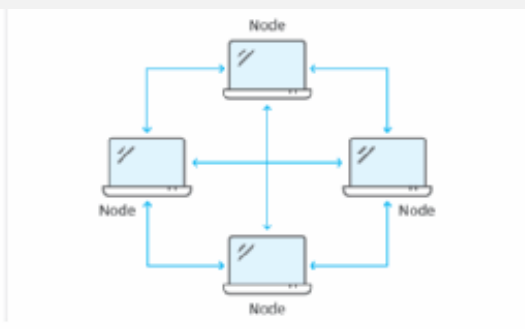   - Serve to prepare for advanced networking courses
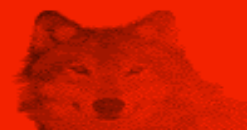
Examples

Client-server network
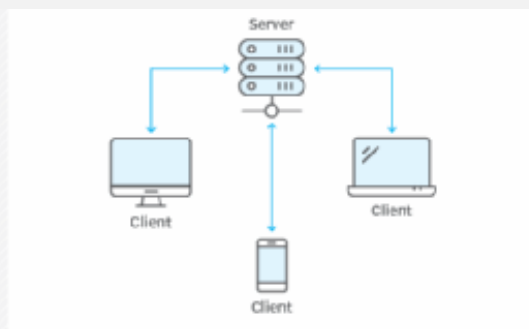
P2P network

Wired network
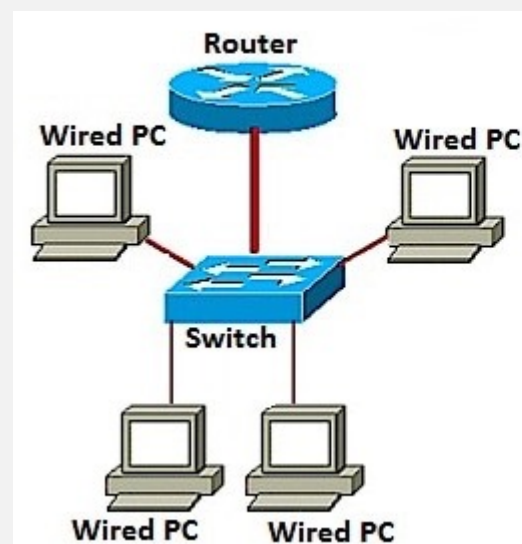
Wireless network
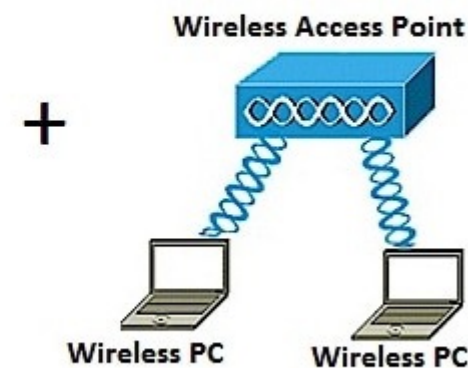
Goals

- Fundamental concepts in computer networks (protocols and algorithms)

- Technology, modeling, analysis and simulation methodologies for computer networking

- Evolved mechanisms in new generation networks, and theoretical and practical exposure to problems and solutions in network protocols

- Learning the capabilities and use of network simulation tools, and then using these tools to demonstrate and investigate network behavior.

Class Communications??

- **Moodle announcements**
  - **Always IMPORTANT!**
  - Reflect latest course updates or changes
  - Sometimes require quick responses related to graded materials

- **Piazza** course forum
  - **De facto place to ask offline questions or discuss!**
  - Both instructor/TA and peer students can answer
  - Instructor/TA can endorse good answers from students
  - Can send **private communications**: about grades, code, …

  - Emails will likely receive delayed responses!

Schedule

- Tentative
  - Lecture orders
  - # hws
  - Due dates
- Updates on Moodle

Lecture	Date	Topic	Learning Outcomes	Homeworks
1	8/19	Course Intro & Introduction	Syllabus, schedule, grading, other stuff, Introduction	
2	8/21	**Cancelled (No Class)**		
3	8/26	Functionality and Decomposition	packet- vs. circuit-switching, Layers, planes, NEs	**Hw1 Posted**
4	8/28	Network Performance and Design	Delay, throughput, loss, variability, capacity, queueing delay	
	9/2	**Labor Day (No Class)**		
5	9/4	Network Simulation	the basic use of ns-3, examples	
6	9/9	Physical Layer	Functionalities, modulation	
7	9/11	Physical Layer	Theoretical limits, SINR, wireless	
8	9/16	Data Link Layer	Bitpipes, framing, error control	**Hw1 Due**
9	9/18	Data Link Layer	Error control, retransmissions	**Hw2 Posted**
10	9/23	Data Link Layer	Retransmissions and ARQ	
11	9/25	Media Access Control	Shared medium access, collisions, ethernet	
12	9/30	Media Access Control	Modeling, wireless	
13	10/2	Media Access Control	Bridging, VLAN	**Hw2 Due**
	10/7	**Midterm Exam**		
14	10/9	Forwarding and Addressing	Addressing, header and lookup	**Hw3 Posted**
	10/14	**Wellness Day (No Class)**		
15	10/16	Forwarding and Addressing	IP addresses	
16	10/21	Forwarding and Addressing	IP forwarding, label forwarding	
17	10/23	Routing	Pathfinding algorithms, protocols	
18	10/28	Routing	Distributed approach, distribution, exterior and interior, ad-hoc	
19	10/30	Transport	TCP principles and basics	**Hw3 Due, Hw4 Posted**
20	11/4	Transport	End-to-end context, connection management	
21	11/6	Transport	Sliding window, congestion control	
22	11/11	Application Design	Client-server, concurrency, peer-to-peer, pub-sub	
23	11/13	Application Design	Sockets	
24	11/18	Wireless Networks	Wireless characteristics, WiFi/CSMA, cellular & mobility	**HW4 Due**
25	11/20	Advanced Topics for networks	TBD	
26	11/25	Report Day	Diverse Topics	
	11/27	**Thanksgiving Break (No Class)**		
27	12/2	Review		
	12/9	**Final Exam 3:30pm - 6:00pm: https://studentservices.ncsu.edu/calendars/exam/**		

Schedule

- Tentative
  - Lecture orders
  - hws
  - exams

- Updates on Moodle

- ✓ **Introduction to Computer Networks and Internet**
- ✓ **Network Performance and Metrics**
- ✓ **OSI Model and Protocol**
- ✓ **Network Simulation and Analysis** (Basic use of ns-3)
- ✓ **Physical Layer**
- ✓ **Data Link Layer and Media Access Control**
- ✓ **Routing Algorithms and Protocols**
- ✓ **Transmission Control Protocol**
- ✓ **Application Design**
- ✓ **Wireless Networking** (Wi-Fi, Cellular)
- ✓ **Other Advanced Topics** (5G, mmWave, security, machine learning for networks)

Grading

- Homeworks/Assignments
  - Completeness is expected
  - Demonstrate understanding
    - (don't really need to know the final answer. We already know it)
  - Brief, to-the-point, concise
    - Essays automatically earn zero
  - Do not skip steps
    - Magical answers automatically suspect

- HW + Participation + Midterm + Final Tests
  - 30% + 10% + 30% + 30%
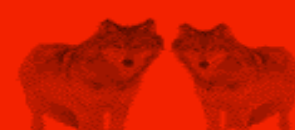 - Exams happen in-person during lecture time

Policy for Options

1. Options for an individual project (10%)

Option 1: 30% HW + 10% participation + 30% Midterm + 30% Final

Option 2: 30% HW + 10% participation + 30% Midterm + 20% Final + 10% Project

Policy for Options

For individual project (10%)

- Topics: related to computer networks, protocols, models, architecture, performance evaluations, simulations (discuss with me)

- Presentation (15min + Q&A) – include your discovery & evaluation

- Timeline: If you choose option 2 with the project, please send me your topic by 10/31 (12pm), as early as possible!

Grading

NCSU Standard Letter grade scale

97	≤	**A+**	≤	100
93	≤	**A**	<	97
90	≤	**A-**	<	93
87	≤	**B+**	<	90
83	≤	**B**	<	87
80	≤	**B-**	<	83
77	≤	**C+**	<	80
73	≤	**C**	<	77
70	≤	**C-**	<	73
67	≤	**D+**	<	70
63	≤	**D**	<	67
60	≤	**D-**	<	63
0	≤	**F**	<	60

Policies

- **Slides:** Lecture slides available on website on day of class
  - Lecture slides may NOT comprehensive – students are expected to attend classes/watch videos to "fill in" information
  - Classes will be interactive. Try to participate as much as possible.

- **Cheating:** Zero tolerance policy toward cheating. Any academic misconduct will be reported immediately. Collaboration on assignments allowed within group.

- **Attendance Policy:** Attend all (as many) sessions synchronously (as possible), and again – interact as much as possible.

  - Valid excuses for absence will be accepted before class.

Policies

- If you feel sick, stay home from classes.
  - If you feel sick before an exam, email me for alternatives.
  - A missed in-person exam will not have make-ups unless I am informed BEFORE the exam.
  - Similarly, a missed assignment due will be deducted 40 points automatically unless I am informed BEFORE the due date.

    (Exception: everyone has one chance of late submission within 24 hours without any penalty)

Textbook

- Recommended textbook (not required)
  - ***COMPUTER NETWORKS***
  - BY TANENBAUM, ANDREW S. AND WETHERALL, DAVID J.
  - PRINT ISBN-13: 9780132126953
  - PRINT ISBN-10: 0132126958
  - E-ISBNS: 9780133072624
  - PUBLISHER: PEARSON
  - EDITION: 5TH
  - PUB DATE: JANUARY 01, 2010

- **Class discussions + slides** + suggested reading

Why Study Computer Networks

- **Internet:** a one-size-fits-all solution for connectivity?

- Other than the Internet, what is one type of network that specifically interests you, and why?

What is a Network?

- Broadly, networks can be connections between humans, machines, vehicles, robots, documents, events, concepts, data, and other elements.

What is a Network?

- Specifically, it is a collection of computers (nodes) and transmission channels (links) that allow people to communicate over distances.
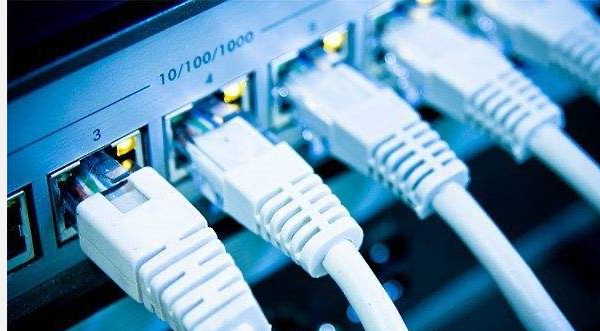
How to Achieve Network Connectivity?

- A variety of transmission methods, both wired and wireless, are available today to provide connectivity between computers, networks, and people.

What is Connectivity Vision Now?

- Bandwidth-hungry applications; Smart X; Internet of Everything …
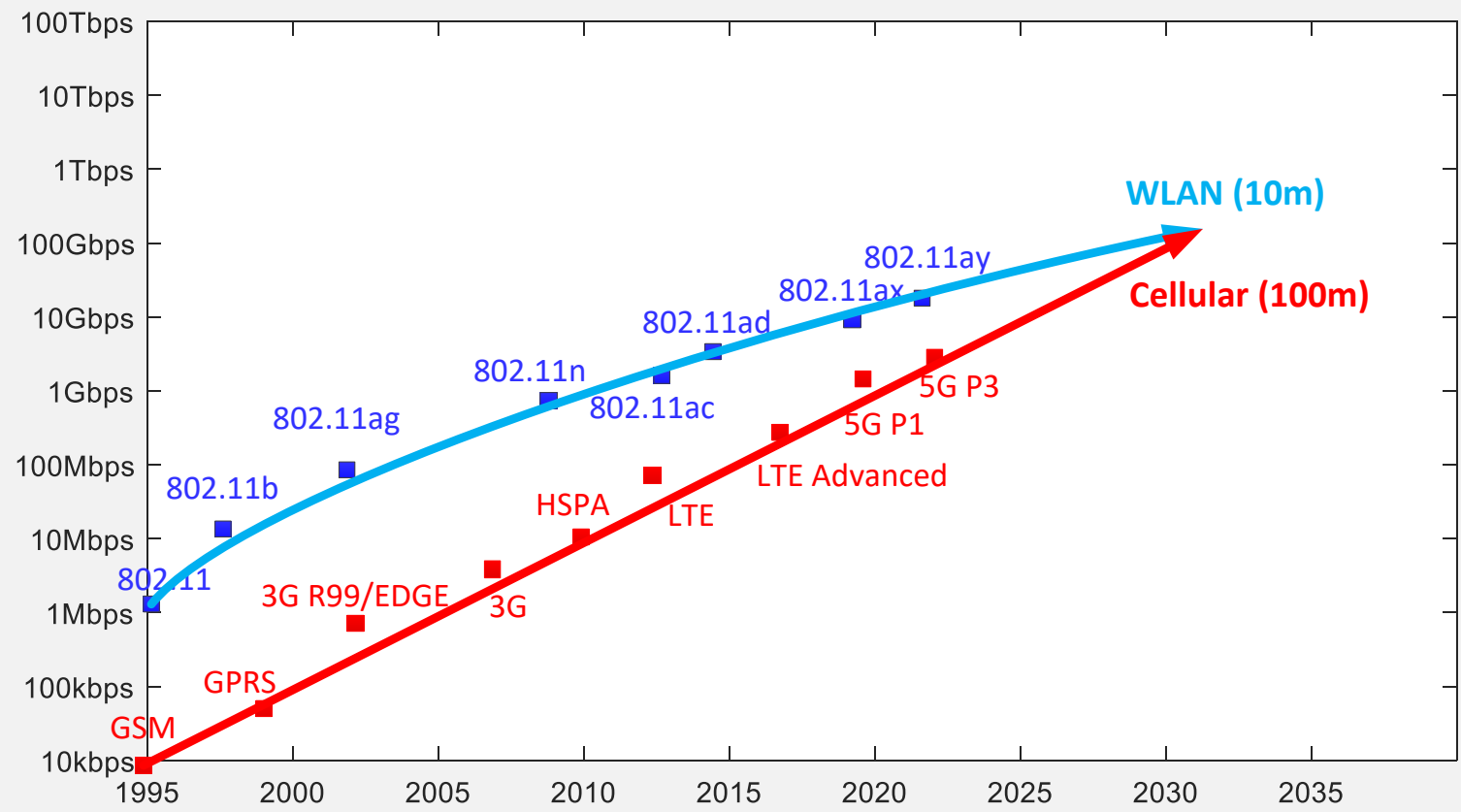
Networking & Connectivity

- Coaxial Cable

- Fiber Optics - 10 Gbps, 1000 Gbps, to1 Tbps

- Cellular Systems - 2G, 3G, 4G, 5G … (10 Gbps)

- WLAN - Wi-Fi

- Ad Hoc Networks

- Wireless Sensor Networks

- Satellites - StarLink

Cellular vs. WLAN

[1] https://5glab.de/