

# CSE 461: Computer Networks

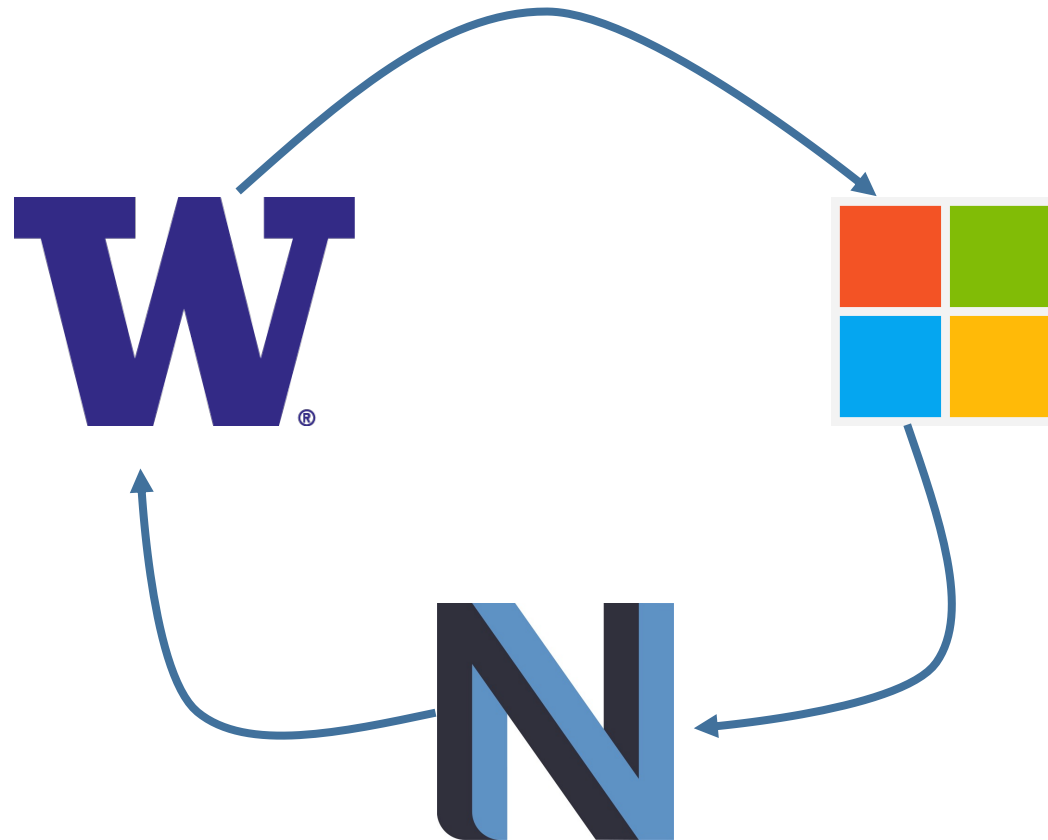
Spring 2023

Ratul Mahajan

Gaith Boksmati, Tapan Chugh, Mohan Kukreja, Xieyang Xu, Jason Zhang

Who we are

Ratul



# Ghaith Boksmati

Hometown: Jeddah, Saudi Arabia

Year: Undergrad senior, graduating this spring!

Some fun facts about me:

- Love swimming, skiing and hiking
- Entry-level techno fan
- Addicted to chess (and blundering)
- Doing my first open-water swim this summer!



# Tapan Chugh

4<sup>th</sup> Year PhD Student

Research: Distributed/ML Systems

Hometown: Delhi, India

Some fun facts about me:

1. I have a dog (Stormy) and lots of food plants. Enjoy cooking
2. Love the PNW outdoors: hiking, biking, hanging out at parks
3. Frequently found in the IMA gym or playing table tennis



Mohan Kukreja

Hometown: New Delhi, India

Year: MS ECE (Spring 2024)

Some fun facts about me:

- Passionate about Software Development.
- Spends most of my screen time on leetcode
- I enjoy eating food and cooking meals
- Into soccer and cricket
- Previously served as a TA for this course last quarter also



# Xieyang Xu

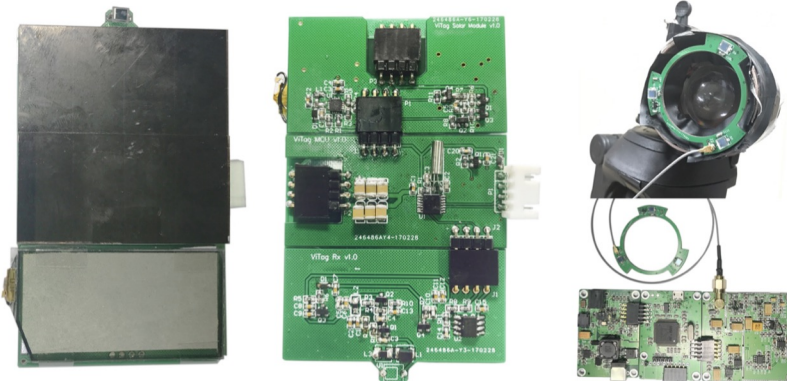
Born in Zhejiang, China

PhD CSE 4th Year

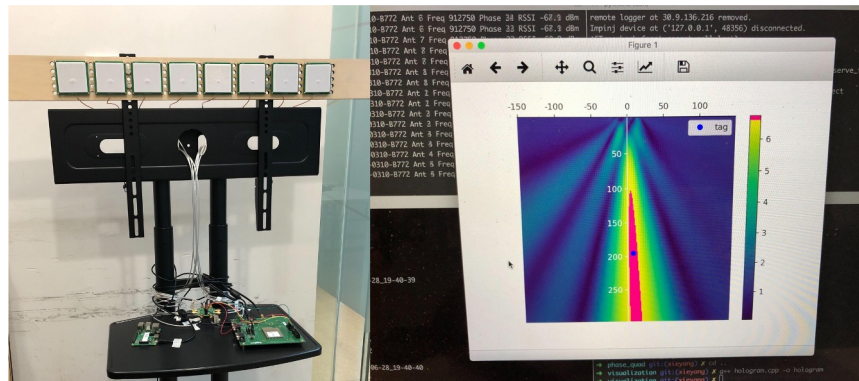
Xieyang enjoys foods, bouldering and building network systems!



Network systems Xieyang has built:

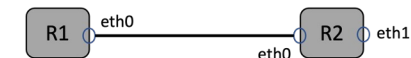


ID Card that communicates via visible light



Antenna-array RFID reader that localize tags

192.168.1.0/30	eth0	conn	192.168.1.0/30	eth0	conn
10.10.1.0/24	192.168.1.2	bgp	10.10.1.0/24	eth1	conn



```
1 interface eth0
2 address 192.168.1.1/30
3 bgp peer 192.168.1.2
4 import policy R2-to-R1
5 export policy R1-to-R2
6 policy R2-to-R1
7 if match 10.10.1.0/30
8 deny
9 if match 10.10.1.0/24
10 set local-pref 200
11 permit
12 policy R1-to-R2
13 ...

1 interface eth0
2 address 192.168.1.2/30
3 interface eth1
4 address 10.10.1.1/24
5 bgp peer 192.168.1.1
6 import policy R1-to-R2
7 export policy R2-to-R1
8 policy R1-to-R2
9 ...
10 policy R2-to-R1
11 if match any
12 permit
13 bgp network 10.10.1.0/24
```

Coverage analyzer for testing O(1M) routers

# Jason Zhang

Hometown: Mercer Island, Washington

Year: Undergrad Junior, graduating Spring 2024

Some fun facts about me:

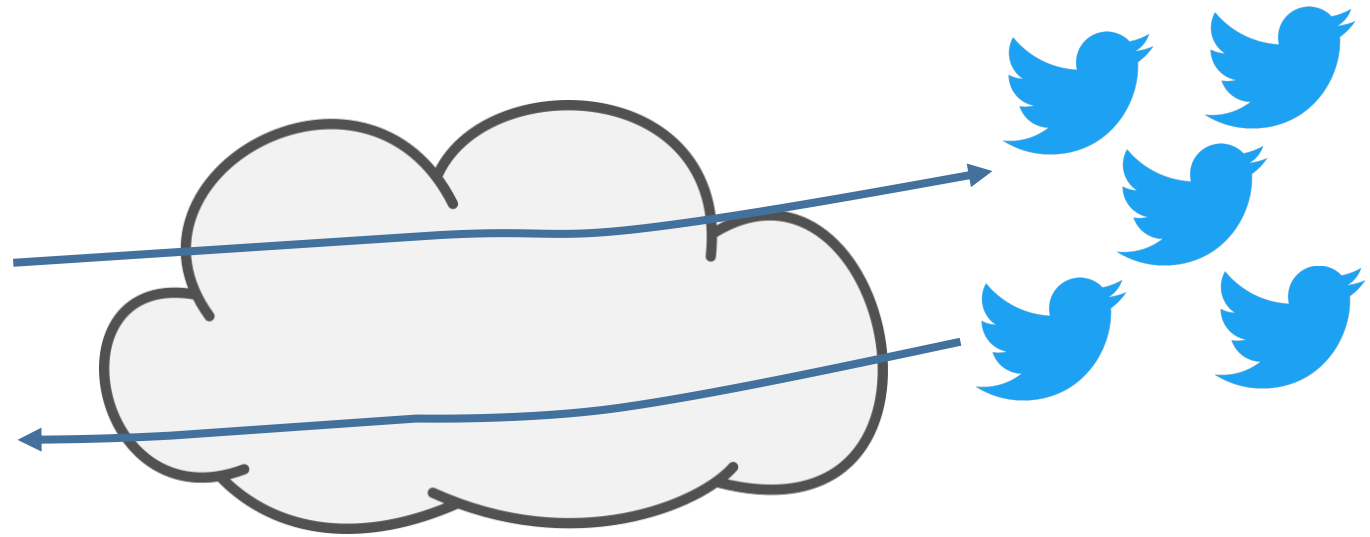
- Tetris is my favorite video game
- I listened to Mr. Brightside 206 times last year
- When I was a kid, a fortune teller foretold I would die by drowning





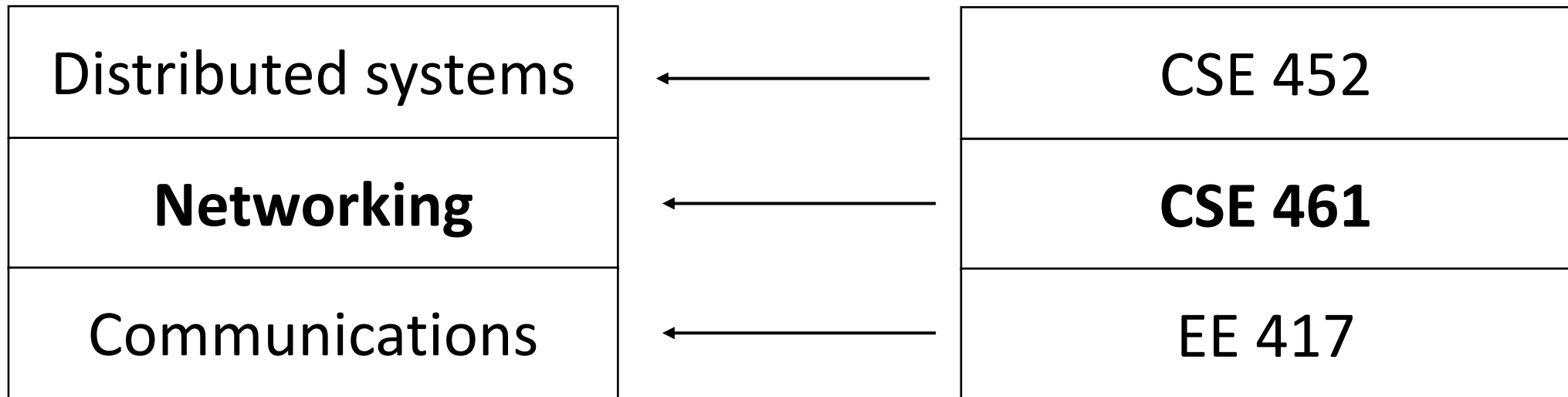
# CSE 461: Computer Networks

# Focus of the course



# Focus of the course (2)

Three “networking” topics:



# Main goals

1. Learn the fundamentals of computer networks
- 2. Learn how the Internet works**
  - What really happens when you “browse the web”?
  - TCP/IP, DNS, HTTP, NAT, VPNs, 802.11 etc.
3. Understand how and why of Internet design
  - SDN, Load Balancers, Architectures

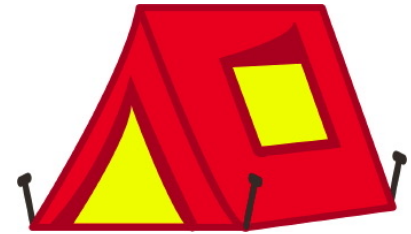
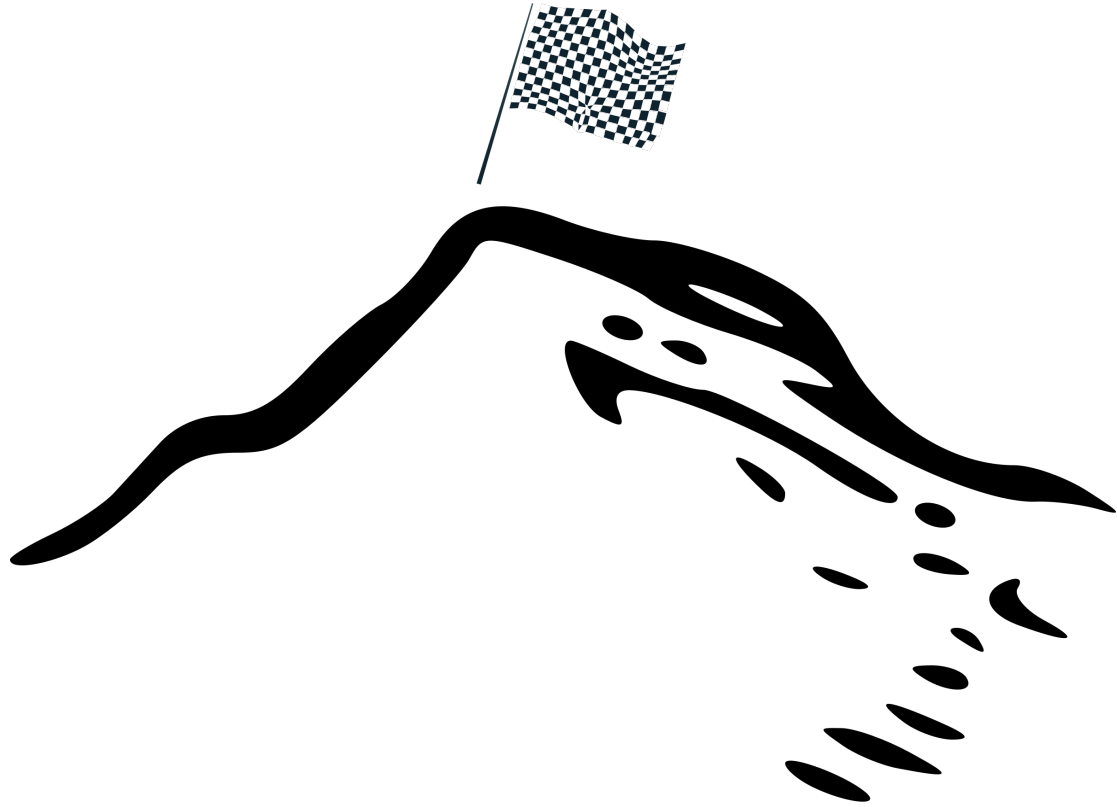
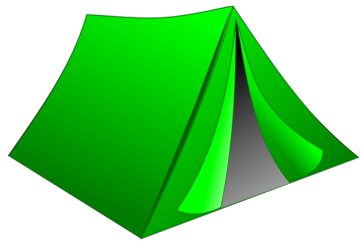
# Why learn the fundamentals?

## Intellectual interest

## Reinvention, broad applicability

- Non-Internet networks
- Changing Internet

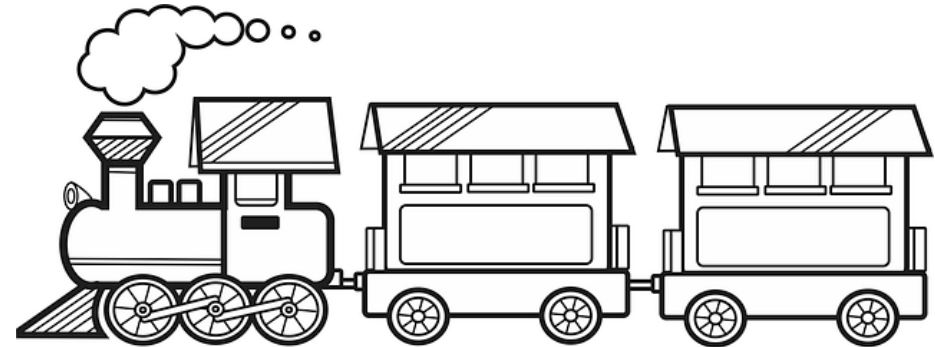
# Fundamentals - Reliable communication



# Fundamentals – Channel throughput



1 Gbps



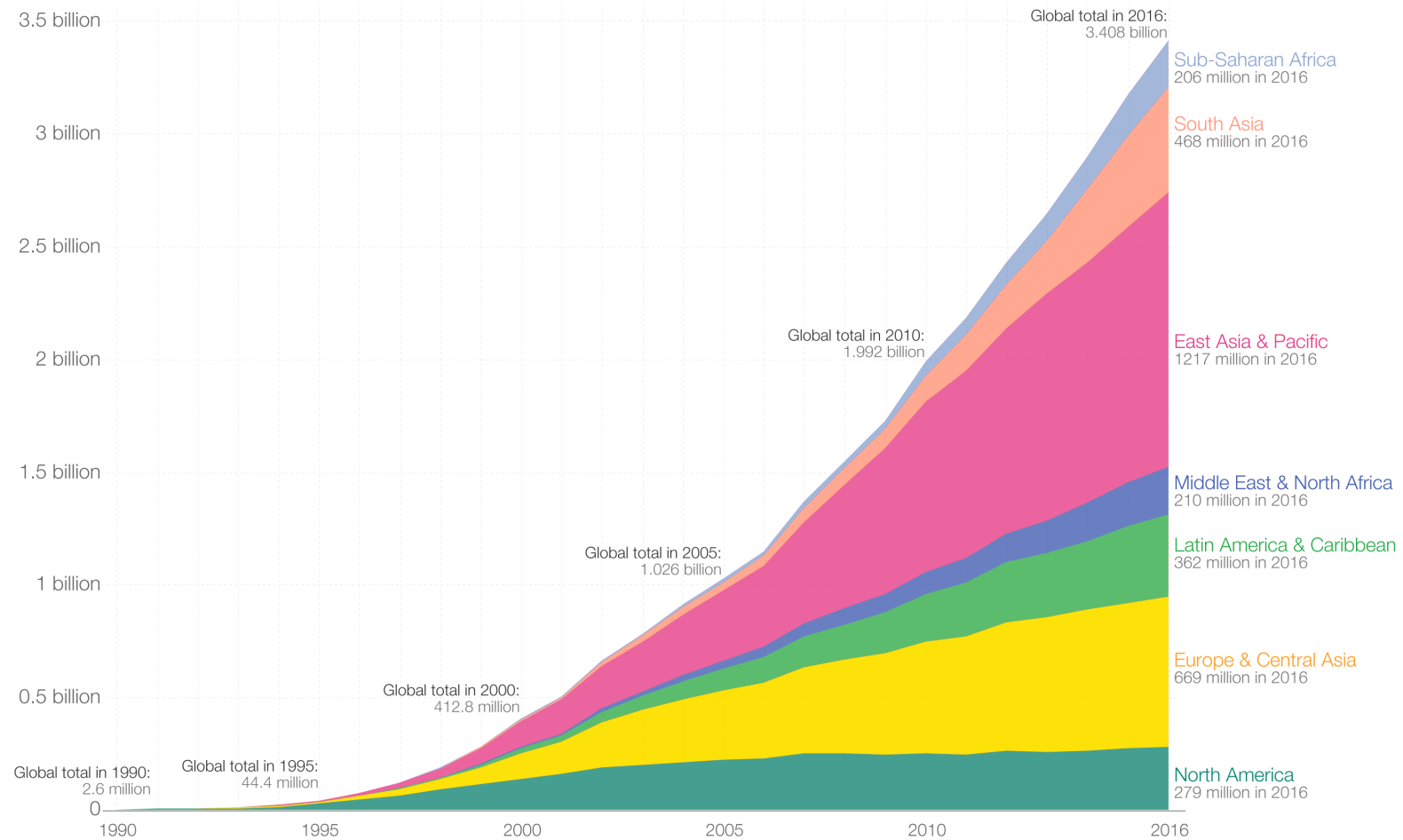
20ft container =  $2,350,080 \text{ in}^3$  (240 x 96 x 102)  
3.5in SSD =  $23 \text{ in}^3$  (4 x 5.75 x 1)  
SSDs / container = 50K (50% packing efficiency)  
Container capacity = 25PB (512 GB per SSD)  
Container speed = 100 mph  
SEA <> NYC throughput = ~2000 Gbps

# Fundamentals – Reinvention

- The Internet is constantly being re-invented!
  - Growth over time and technology trends drive upheavals in Internet design
- Today's Internet is different from yesterday's
  - And tomorrow's will be different again
  - But the fundamentals remain the same



# Internet growth



Data source: Based on data from the World Bank and data from the International Telecommunications Union. Internet users are people with access to the worldwide network. The interactive data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualizations on this topic. Licensed under [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) by the author Max Roser.

# Example upheavals

<b>Change</b>	<b>Enabling Technology</b>
Emergence of Web	Content Distribution Networks
Piracy	Peer-to-peer file sharing
Internet of Things	IPv6
Mobile Devices	Wireless, High bandwidth cellular
Cloud computing	Virtualization
Crypto currencies	Blockchains
....	....

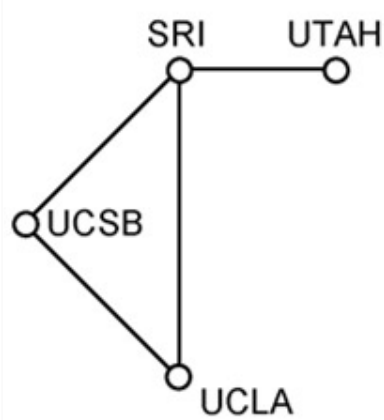
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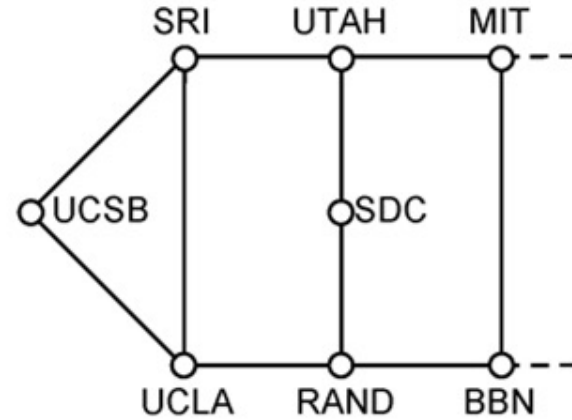
# Who cares about the internet?

1. Curiosity
2. Impact on our world
3. Job prospects!

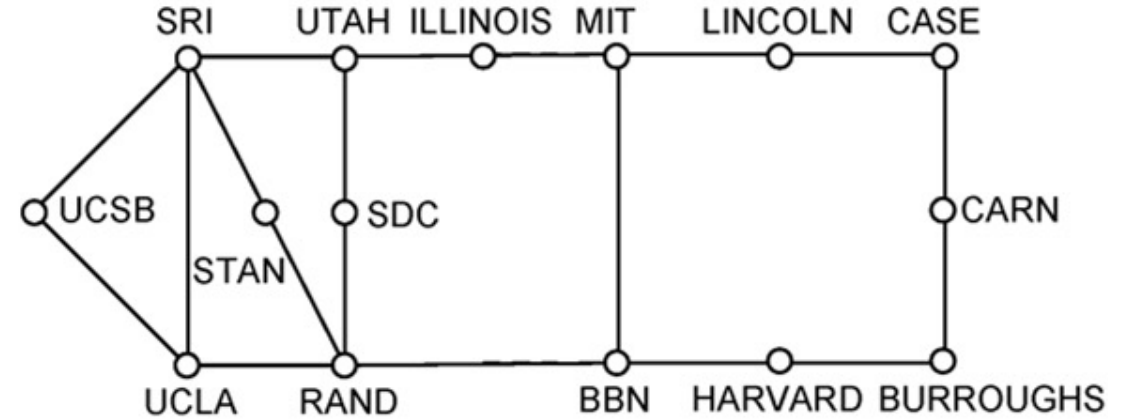
From this experimental network (~1970)...



(a) Dec. 1969.



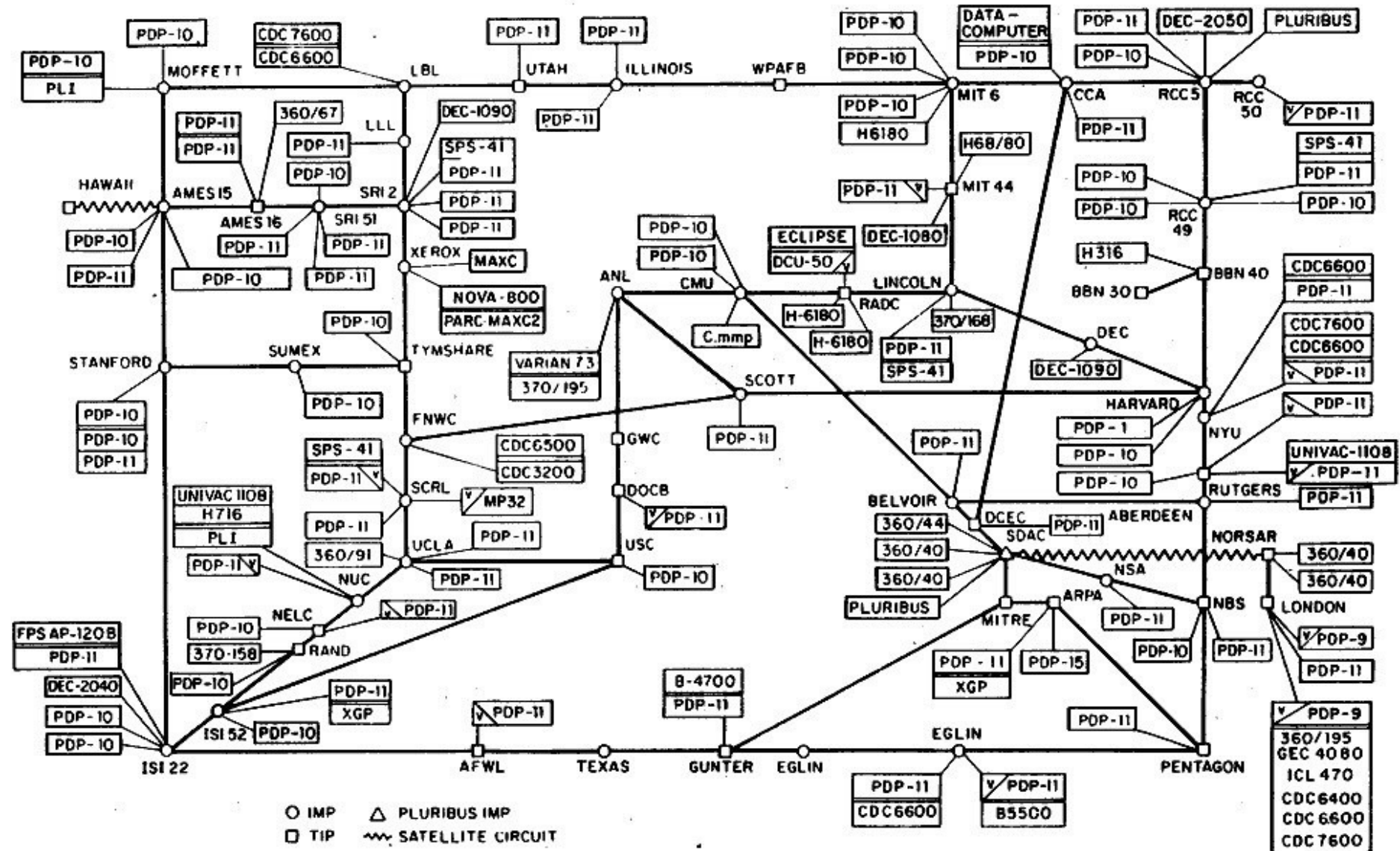
(b) July 1970.



(c) March 1971.

# ARPANET LOGICAL MAP, MARCH 1977

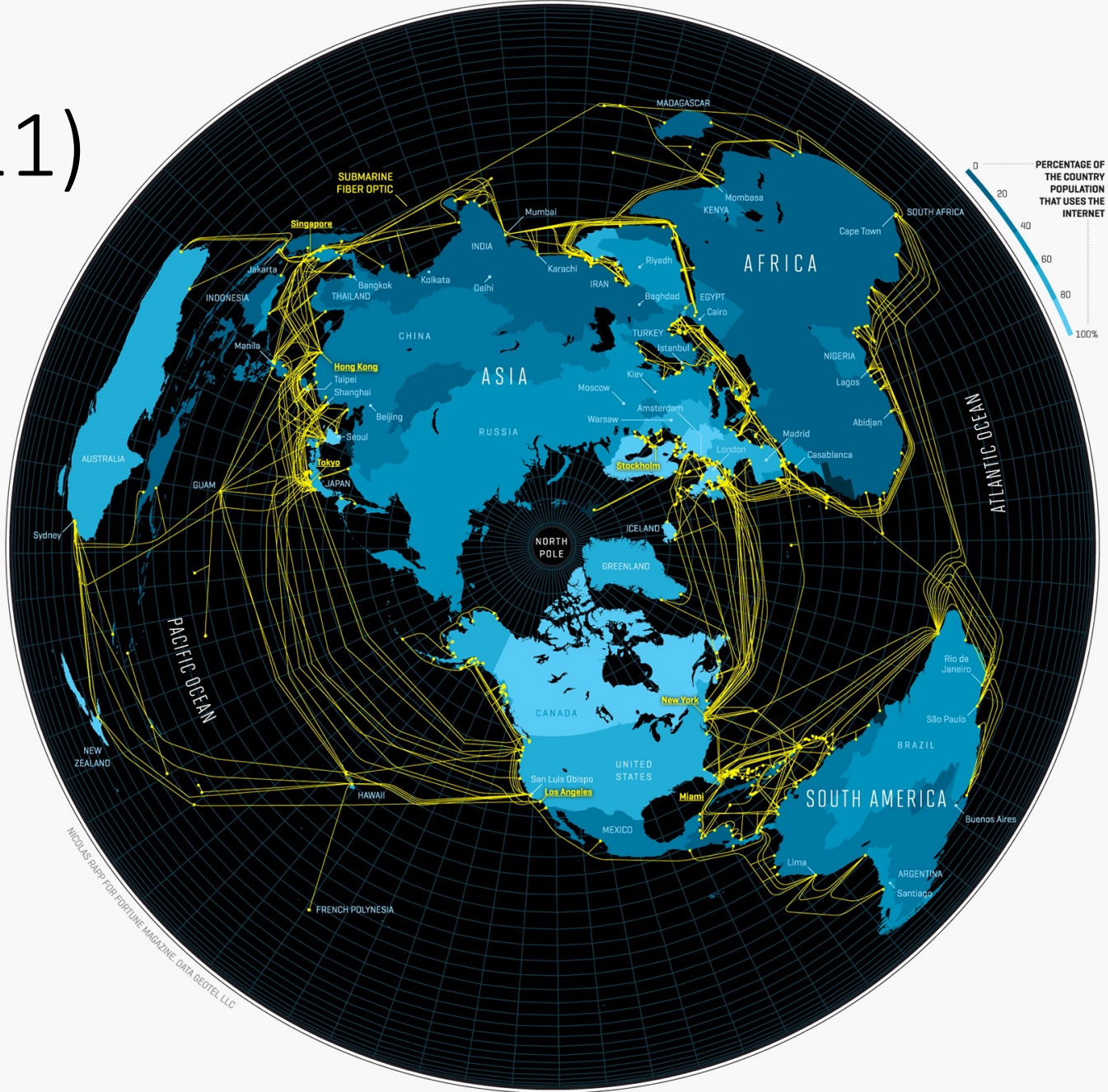
To this...



(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

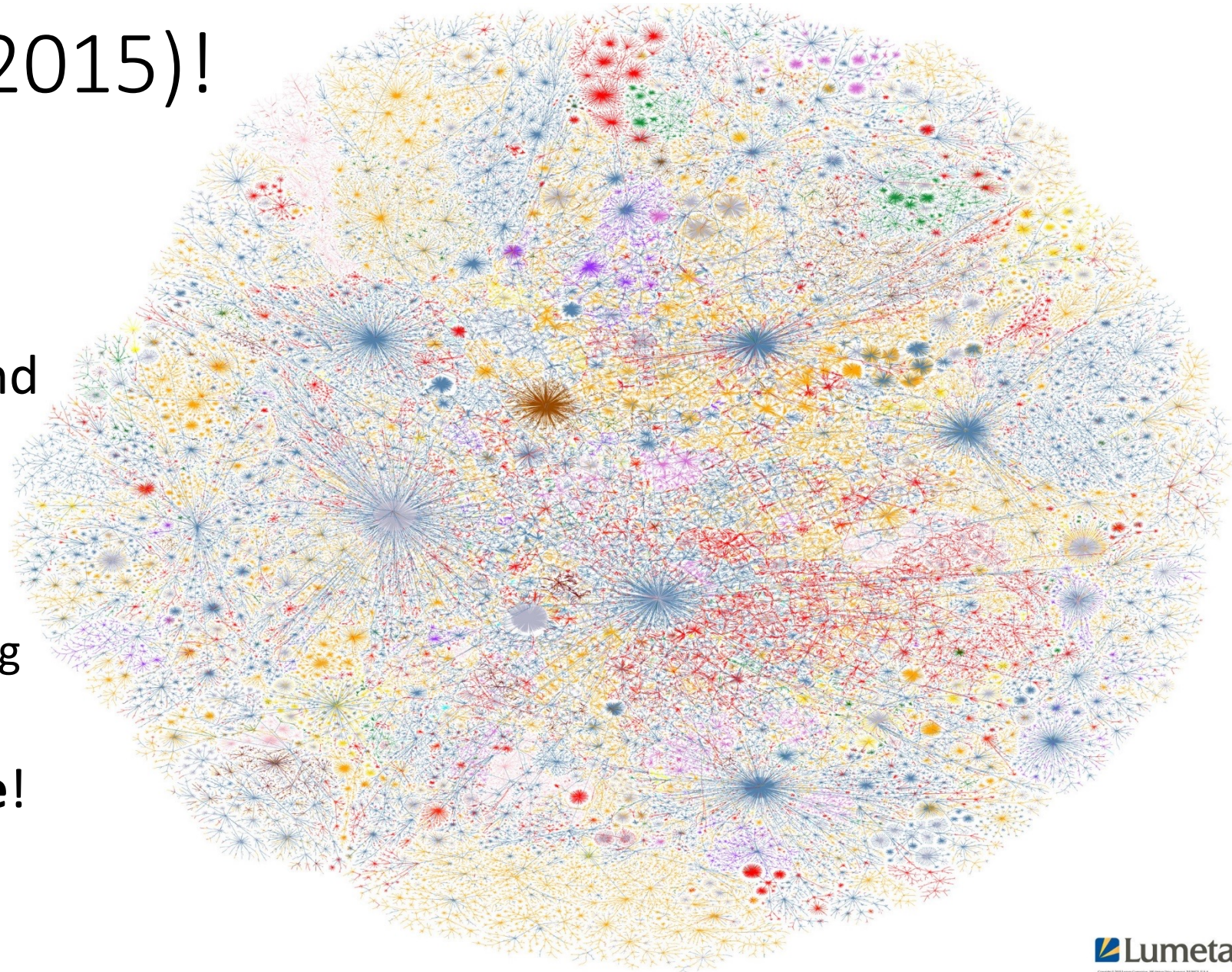
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

# To this! (2011)



# And this (2015)!

- An everyday institution used at work, home, and on-the-go
- Visualization contains millions of servers
  - Red = .com, Yellow= .org
- Network now contains literally 3 billion **people!**





# Internet – Societal Impact

- An enabler of societal change
  - Easy access to knowledge
  - Electronic commerce
  - Personal relationships
  - Private communications



WIKIPEDIA

**amazon**

**tinder**

**Tor**

# Internet – Economic impact

- An engine of economic growth
  - Information sources
    - And lots of ethical questions!
  - Online marketplaces
  - Social media/Crowdsourcing

The Google logo, featuring the word "Google" in its characteristic multi-colored font (blue, red, yellow, blue, green, red).The Facebook logo, consisting of the word "facebook" in white lowercase letters on a dark blue rectangular background.The eBay logo, featuring the word "eBay" in a stylized font with each letter in a different color (red, blue, yellow, green).The Craigslist logo, featuring the word "craigslist" in a purple, lowercase, serif font.

# Main goals

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# Architectures

Lots of ways to build networks with different **tradeoffs**

- Internet -- open access
  - Flexibility++, Privacy++, Security--
- Cellular -- identity first
  - Flexibility--, Privacy --, Security++,



# Not a Course Goal

## To learn IT job skills

- How to configure specific equipment or technologies
  - e.g., Cisco certifications,
  - Technical whack-a-mole
- But course material is relevant, and we use hands-on tools
  - Hopefully you'll be able to use these tools to build stuff at the end of class

# Main goals

1. To learn the fundamentals of computer networks
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Questions?

# Class Structure



# Grading

## **Assignments: 10%**

- Reading and homework from the book

# Grading

Assignments: 10%

**In-class Quizzes: 5%**

- Short quizzes during the quarter
- Drop lowest

# Grading

Assignments: 10%

In-class Quizzes: 10%

**3 Projects: (15 + 15 + 15)%**

- 3 coding exercises:
  - Socket programming
  - Link and Network layer behavior
  - Buffer bloat

# Grading

Assignments: 10%

In-class Quizzes: 5%

3 Projects: (15 + 15 + 15)%

**Midterm: 15%**

**Final: 20%**

**Participation: 5%**

# Grading

Assignments: 10%

In-class Quizzes: 5%

3 Projects: (15 + 15 + 15)%

Midterm: 15%

Final: 20%

Participation: 5%

Late Policy:

- 10% penalty for each late day
- Each **person** gets three late days

# Administrivia

- Office hours
  - Opportunity to have more personal interactions with course staff.
- Tools
  - Canvas: Assignments, quizzes, and projects
  - ed discussion: Back and forth discussions on class content, announcements
  - Canvas Gradebook: Grades will be posted here
- Slides
  - Adapted from Kurtis Heimerl, who adapted from David Wetherall
  - I will be posting my own slides online

Questions?