CSE 461: Computer Networks

Kurtis Heimerl (Kurtis) - kheimerl@cs

Who we are...

Kurtis Heimerl

ICTD

- Information and Communication Technology for Development
    - Development -> Poverty Alleviation (not software development)
    - Broad field covering health, justice, and **access**
- Why?
    - Lots of natural intuition from Alaska, I know rural.
    - Able to use networking skill -> Many opportunities (NSRC)
- My subfield: Cellular access
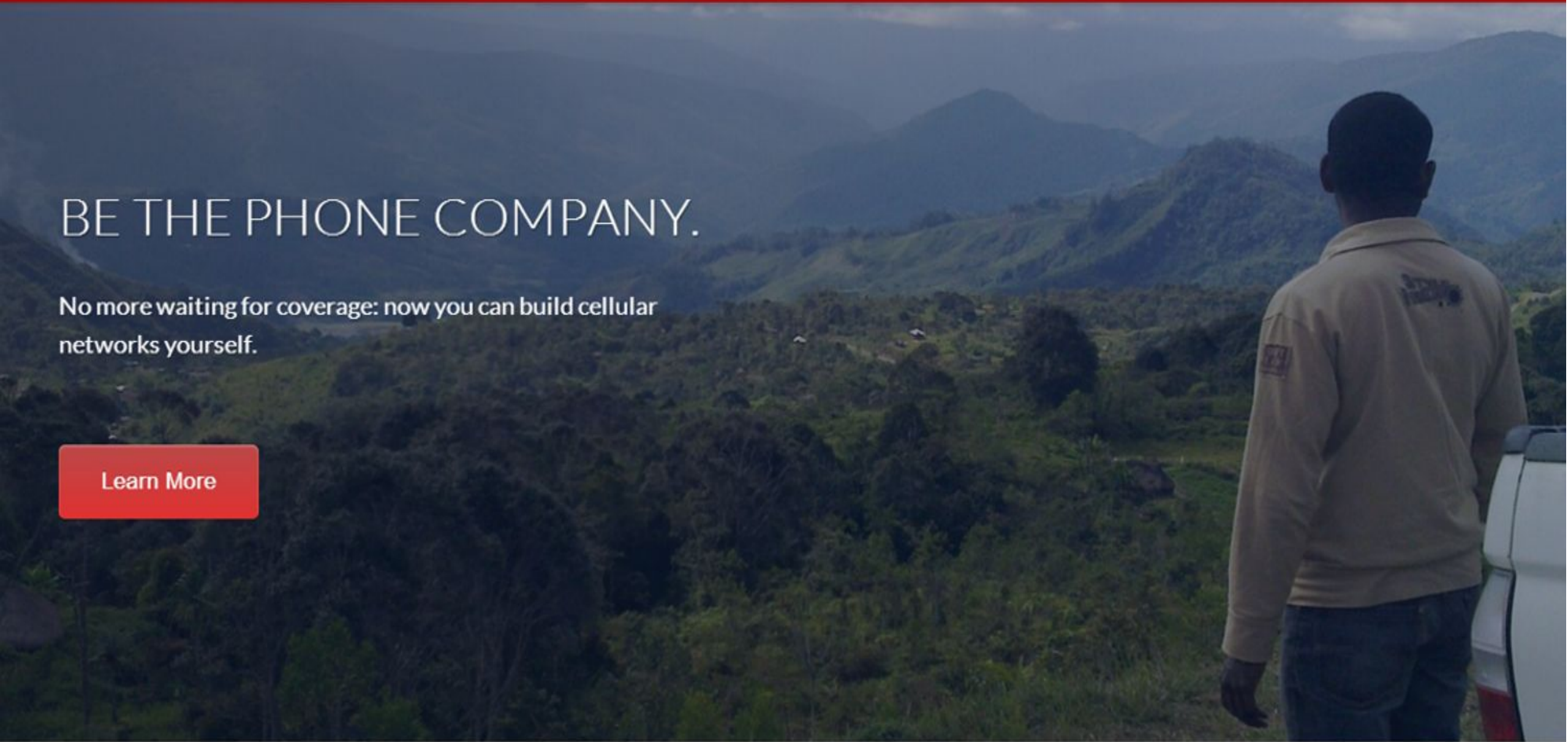- My Answer: Community Cellular

BE THE PHONE COMPANY.

No more waiting for coverage: now you can build cellular networks yourself.

Learn More

TAs Now!

David Song (David)

- Pronouns: He/Him

- Hometown: Seattle

- Year: 4th Year Undergrad

- Some fun facts:
    - Do network-related research in ICTD Lab
    - Budget travel is the best travel
    - Can occasionally find me in the IMA at 6AM

Eric Daniel (Eric)

- Pronouns: He/Him

- Hometown: Seattle

- Year: 4th Year Undergrad

- Some fun facts:
    - Did comp bio research in the SPE lab, now do systems ML
    - Love to play soccer
    - Will not be awake at 6AM
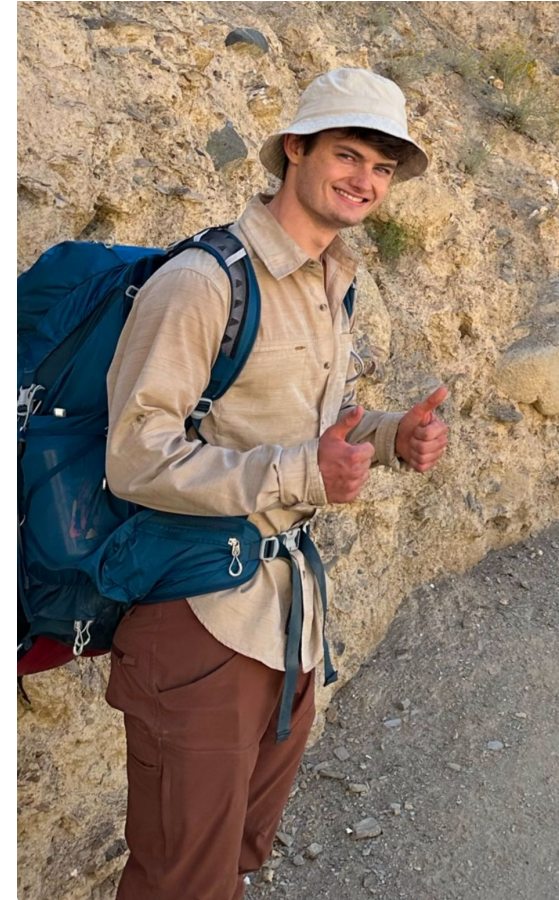
Wei Jun Tan (Wei Jun)

- Pronouns: He/Him

- Hometown: Malaysia

- Year: 5th year BS/MS

- Some fun facts:
  - Did research with Interactive Data Lab and Mobile Intelligence Lab
  - Casually play table tennis and chess
  - Love visiting national parks

Class Structure

Class sessions

- Lecture from me or other appropriate speaker
  - Will post slides the evening before class when possible
- Readings for each class will be posted on the course website
- Sessions will sometimes have small group work and questions, but not a full "flipped classroom"

Asynchronous Discussion Board

- Using ed for announcements and discussion
  - Also linked from canvas
- We'll try and respond to all questions by the end of each working day
- Any questions that are particularly "liked" we'll discuss live at the beginning of the following class

Grading

- **Assignments: 60 points**
  - Reading from the book (Peterson OSS textbook)
  - Online homework
  - Resubmissions + regrades

Grading

- Assignments: 60 points
- **Surprise Quizzes: 20 points**
  - Short unannounced timed quizzes during the quarter
  - Conducted on gradescope or in class
  - Drop lowest

Grading

- Assignments: 60 points
- Surprise Quizzes: 20 points
- **3 Projects: (100 points + 105 points + 105 points)%**
  - Use canvas groups (feel free to start making groups now)
  - 3 coding exercises:
    - Socket programming
    - Link and Network layer behavior
    - TCP Bufferbloat + Congestion Control

Grading

- Assignments: 60 points
- Surprise Quizzes: 20 points
- 3 Projects: (100 points + 105 points + 105 points)
- **Midterm: 90 points**
- **Final: 120 points**

Grading

- Assignments: 60 points
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- 3 Projects: (100 points + 105 points + 105 points)
- Midterm: 90 points
- Final: 120 points

Late Policy: Each **person** gets 5 late days for assignments and projects. Late days will be decided at end of quarter and selected as to have the most positive impact.

Administrivia

- Office hours
  - Opportunity to have more personal interactions with me and the TAs
  - Posted online, might have some changes
- Tools
  - Course Website: Calendar, project descriptions, syllabus, etc.
  - Ed Announcements: Primary communication platform
  - Gradescope (integrated w/ canvas): Assignments, Homework, and Projects
  - Ed Discussion: Back and forth discussions on class content
  - Canvas Gradebook: Grades will be posted here
  - Mailing list: backup class announcements

Administrivia (2)

- Slides
  - Adapted from David Wetherall, his talks are online
  - I will be posting my own updated slides around lecture
    - Pre-lecture slides will have fill-in-the-blank sections for key ideas from class
    - Space for some "groaner" bad jokes
    - After class will post the full annotated slides

COVID/Illness Effects

- Things have improved but…
- Our goal is to be generous but fair
  - Chat with us if there's a problem in any particular direction
    - We'll try to help
    - Much easier to be fair if not making retroactive changes– talk to us early!
- Be generous back
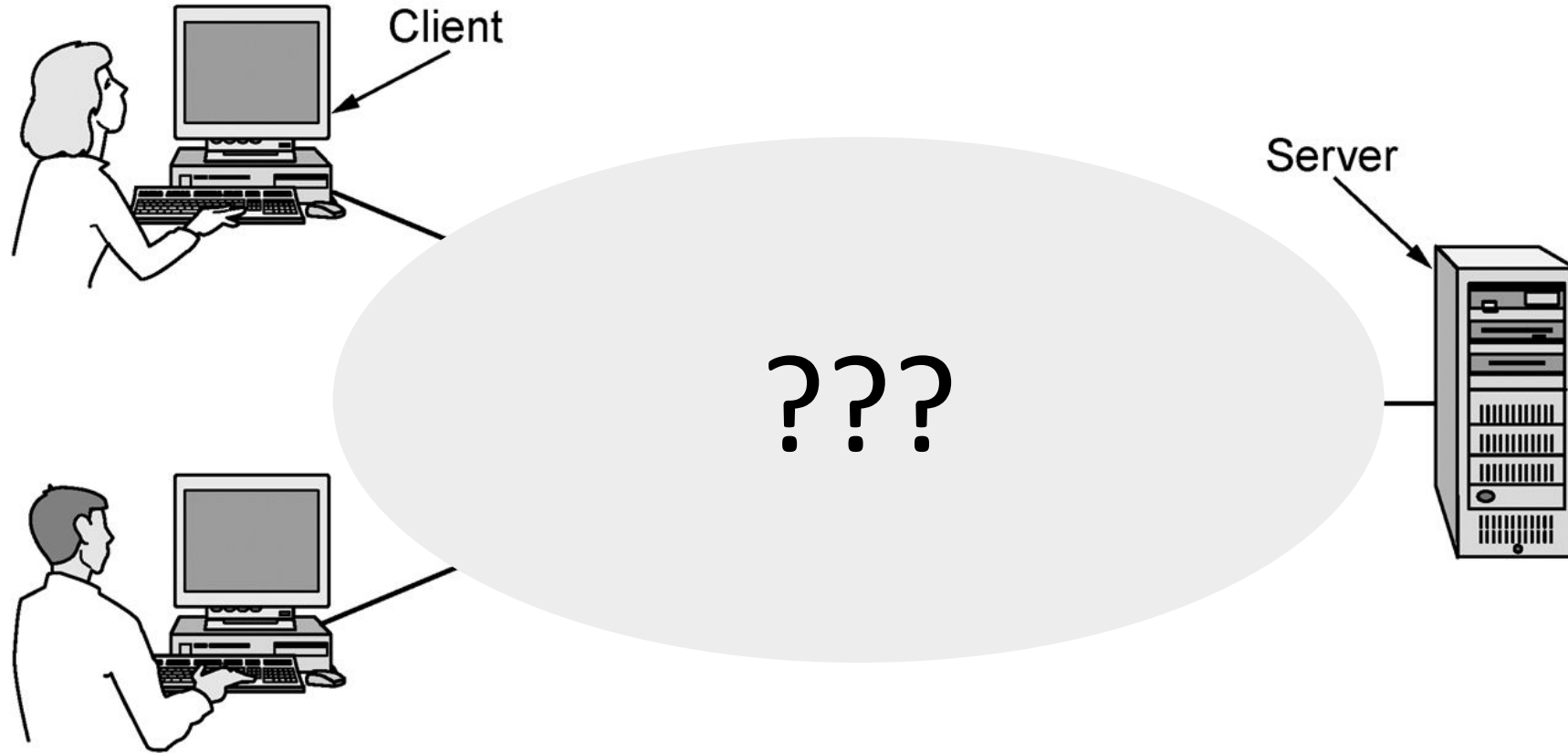 - Staff are people too
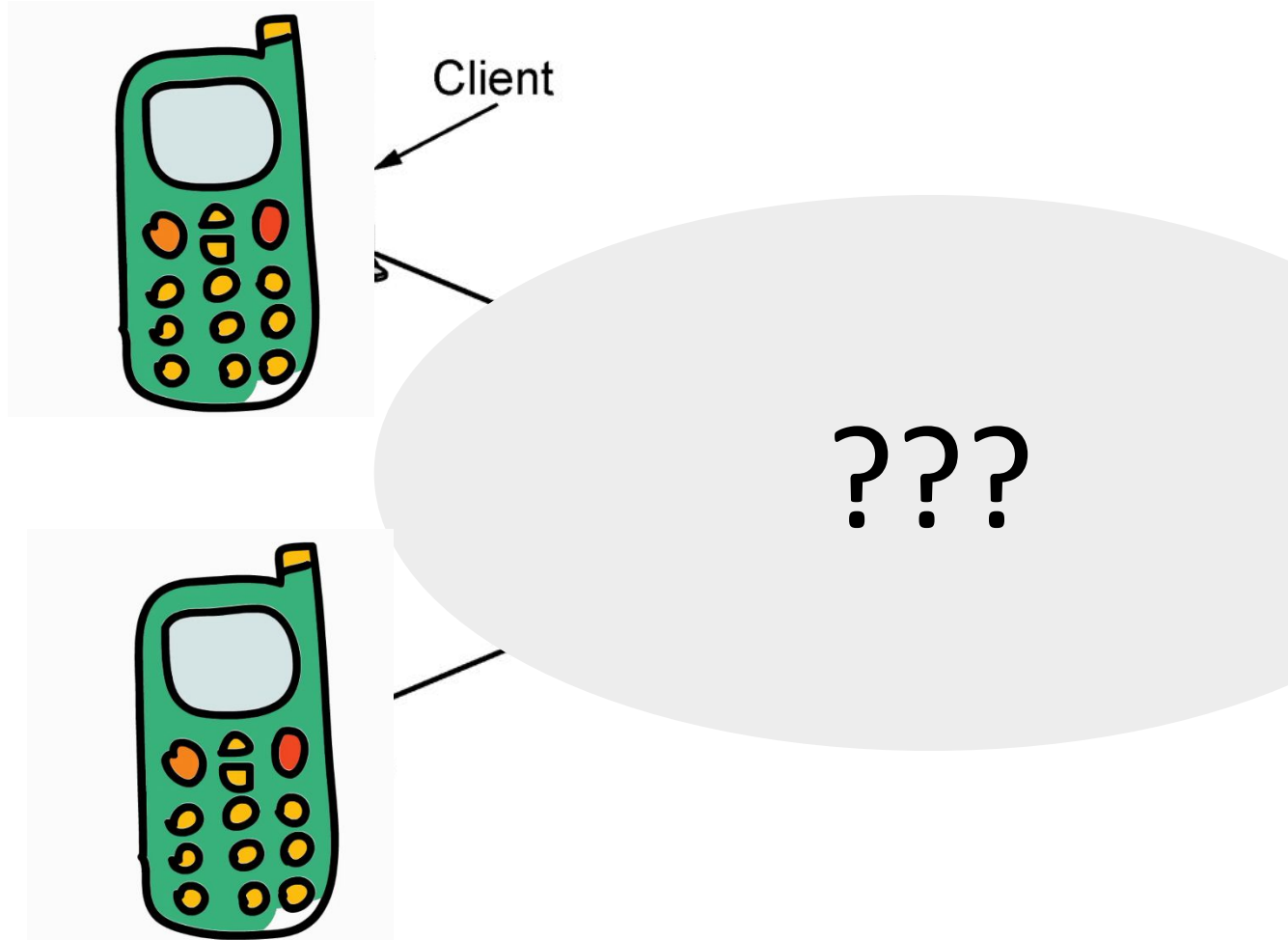 - For instance, daycare gets cancelled

Questions?

5 Minute Activity!

- Breakouts of 4-5 people
- Introduce yourselves to each other!
  - Could be a good way to start finding project teams…
- Quickly discuss some different components (really anything relevant) of what you think the Internet is made of…
  - We'll compile/categorize once done
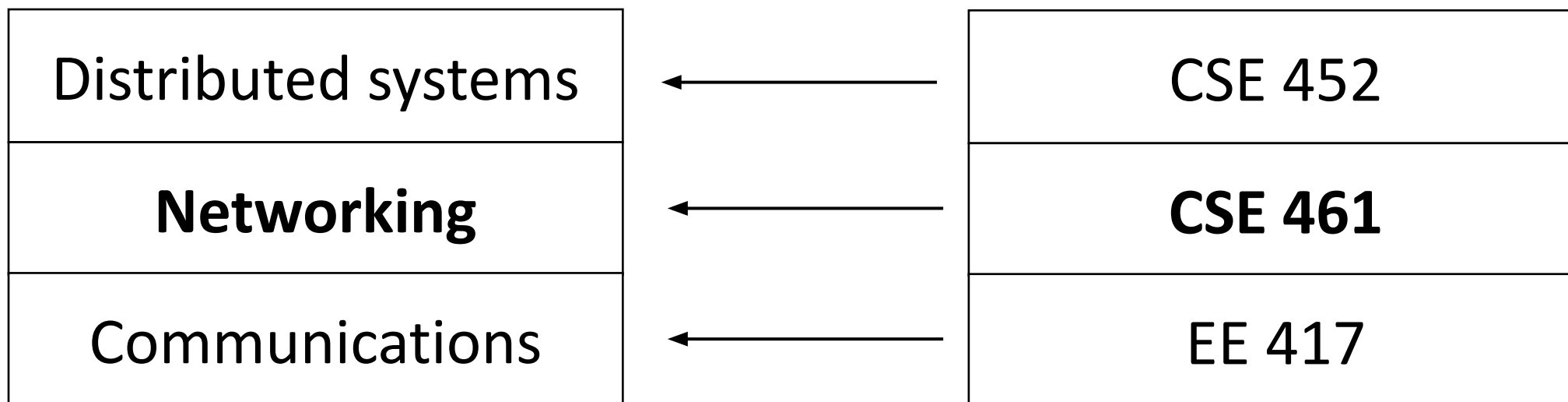
Debrief

Focus of the course

Focus of the course (in today's terms)

Client

???

Welcome to the UTAH DATA CENTER
IF YOU HAVE NOTHING TO HIDE YOU HAVE NOTHING TO FEAR

Focus of the course (2)

- Three "networking" topics:

Distributed systems	← CSE 452
Networking	← **CSE 461**
Communications	← EE 417

The Main Point

1. **To learn the fundamentals of computer networks**
2. Learn how the Internet works
   - What really happens when you "browse the web"?
   - TCP/IP, QUIC, DNS, HTTP, NAT, VPNs, 802.11 etc.
3. Understand why the internet is designed how it is designed
   - SDN, Load Balancers, Architectures

Why learn the Fundamentals?

1. Apply to all computer networks
2. Intellectual interest
3. Change / reinvention

Fundamentals – Intellectual Interest

- Example key problem: Reliability!
  - Any part of the Internet might fail
  - Messages might be corrupted
  - So how do we provide reliability?

- Reliability solutions
  - Codes to detect/correct errors
  - Routing around failures …

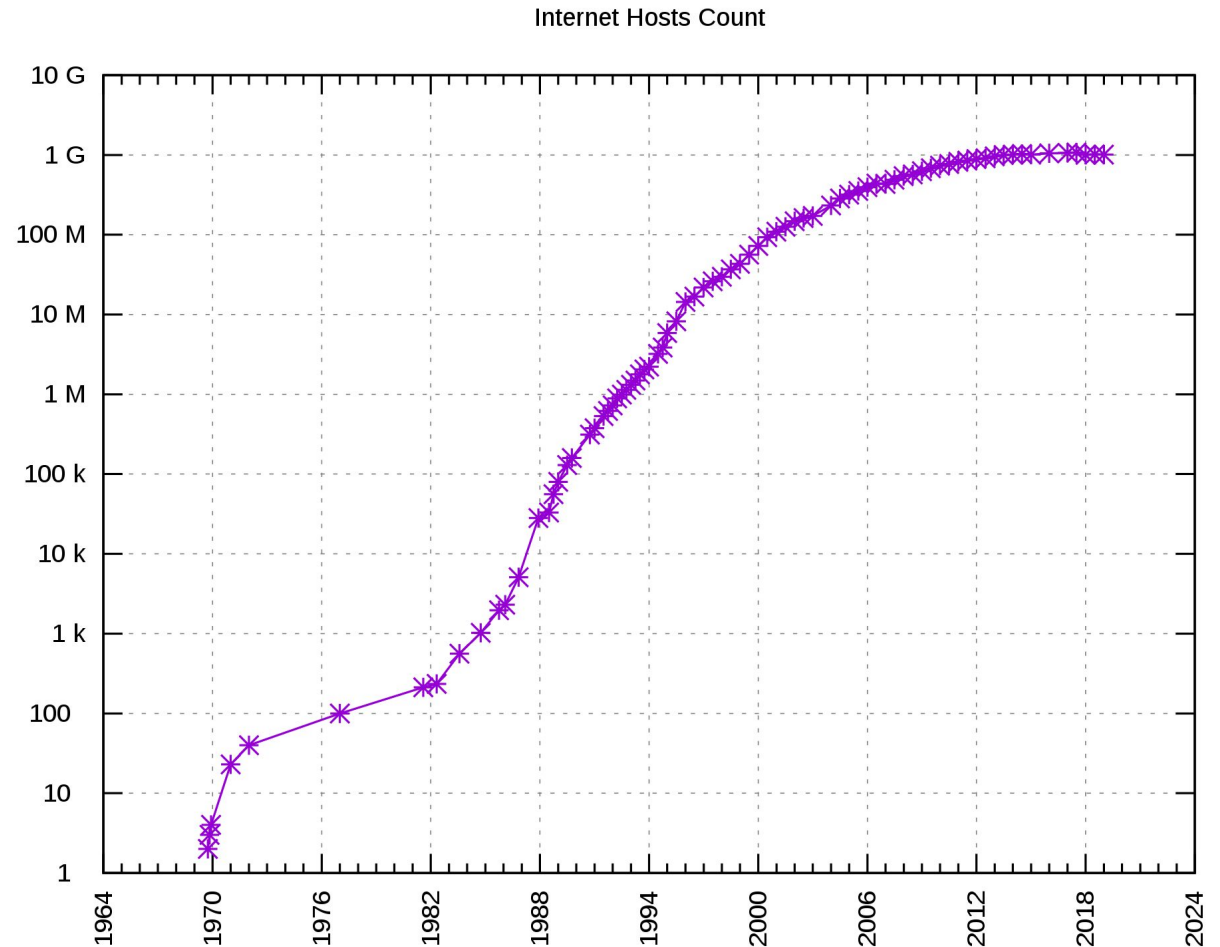# Fundamentals – Intellectual Interest (2)

Key problem	Example solutions
Reliability despite failures	Codes for error detection/correction (§2.4) Retransmission and backoff (§2.5)
Network growth and evolution	Addressing (§5.6) and naming (§9.3) Protocol layering (§1.3)
Allocation of resources like bandwidth	Multiple access (§2.6) Congestion control (§6.3, 6.4)
Security against various threats	Confidentiality of messages (§8.2) Authentication of communicating parties (§8.4)

Fundamentals – Reinvention

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

Fundamentals – Reinvention (2)

- Many billions of Internet hosts and growing …
  - 5B+ on Cell/Internet

Internet Hosts Count

Img: Kopiersperre , Ke4roh, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons

Fundamentals – Reinvention (3)

- Examples of upheavals in the past 1-2 decades

Change	Enabling Technology
Emergence of the web	Content Distribution Networks
Piracy	Peer-to-peer file sharing
Voice over IP (VoIP)	Quality of Service (QoS)*
Internet of Things	IPv6
Mobile Devices	Wireless Networking

*mostly actually spare capacity

Fundamentals – Reinvention (4)

- Upcoming/Ongoing upheavals?

Change	Enabling Technology
Fake News	Social Media
No-power devices?	Backscatter
Generic Networks?	SDN
Ubiquitous Networks?	Satellite/Starlink
AR/VR	High-Bandwidth Mobile (5G)

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Who cares about the internet?
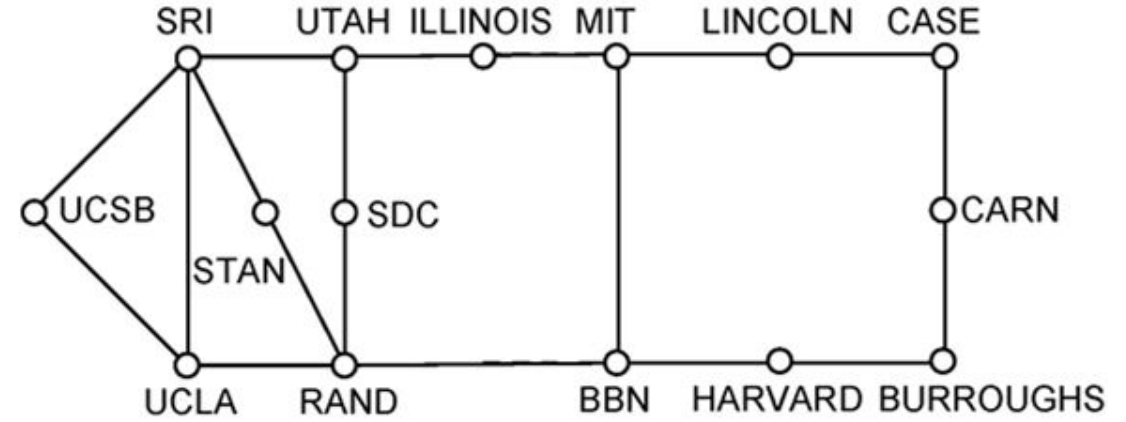
1. Curiosity
2. Impact on our world
3. Job prospects!
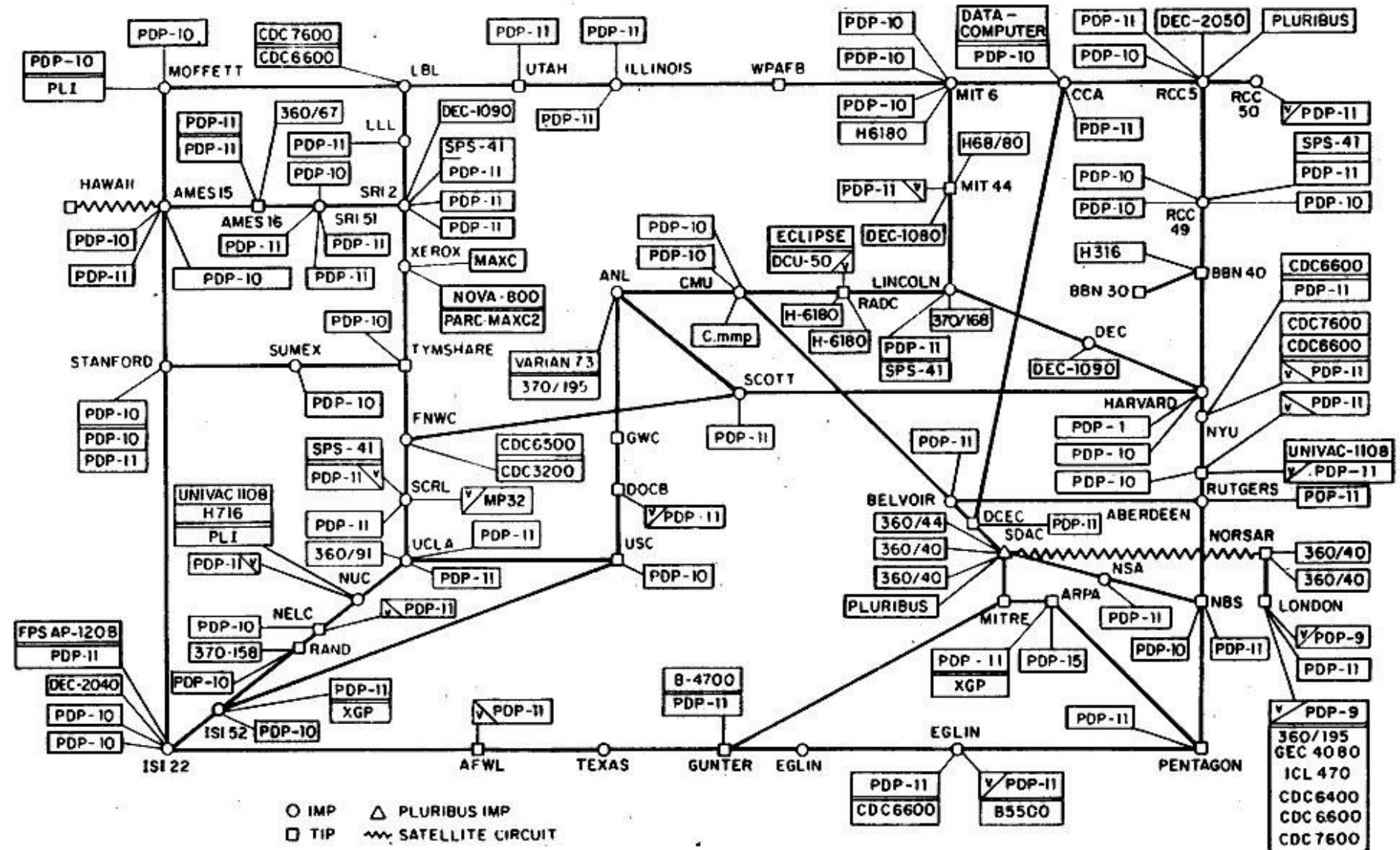
From this experimental network (~1970)...
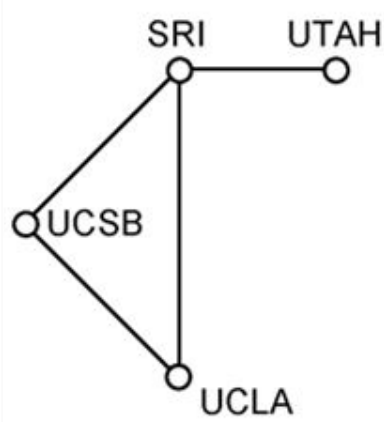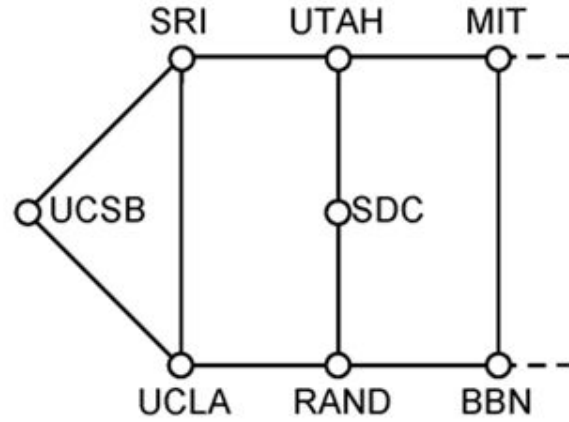
(a) Dec. 1969.   (b) July 1970.   (c) March 1971.

To this…

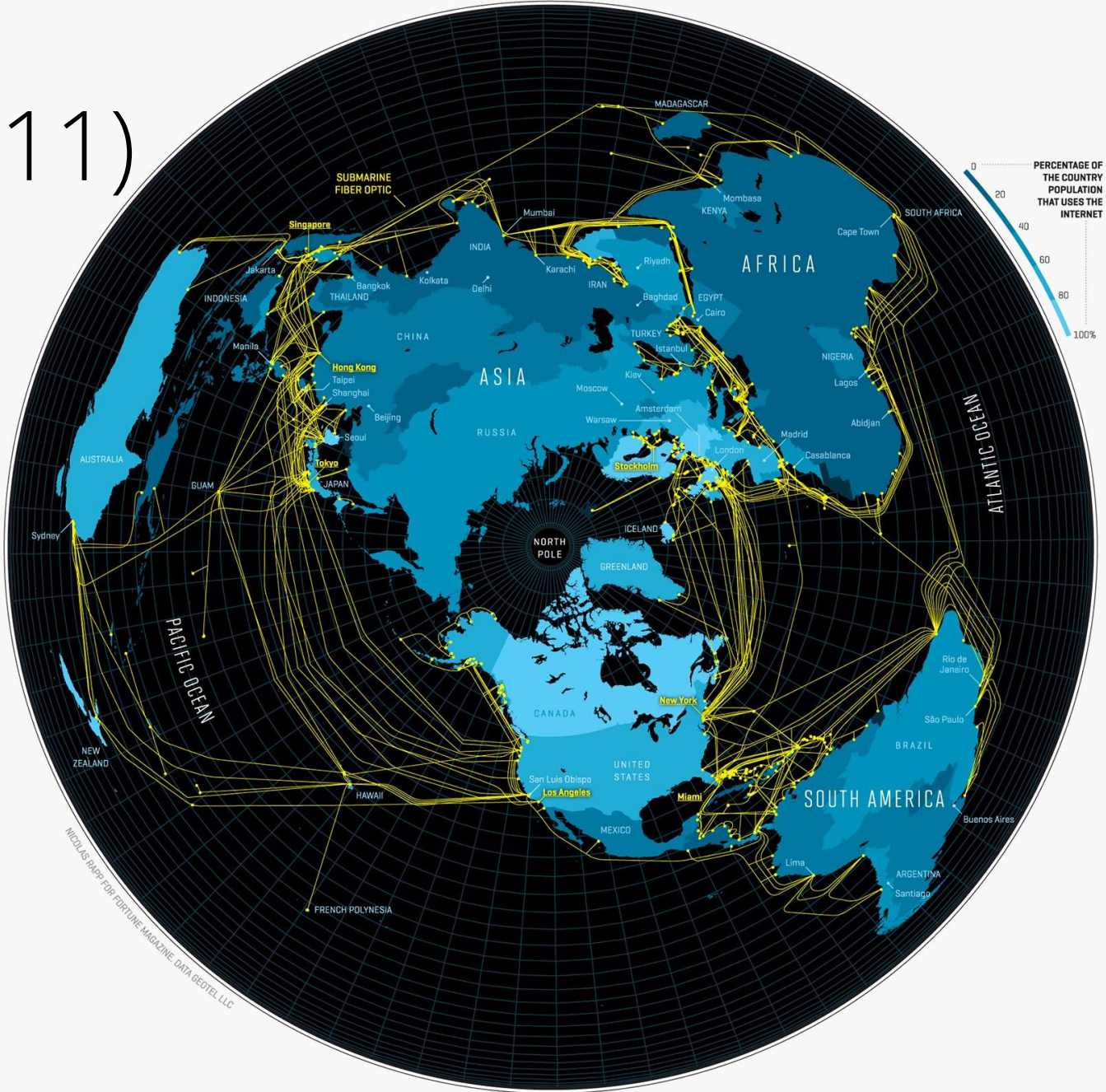ARPANET LOGICAL MAP, MARCH 1977

O IMP △ PLURIBUS IMP
□ TIP 〰 SATELLITE CIRCUIT

(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)
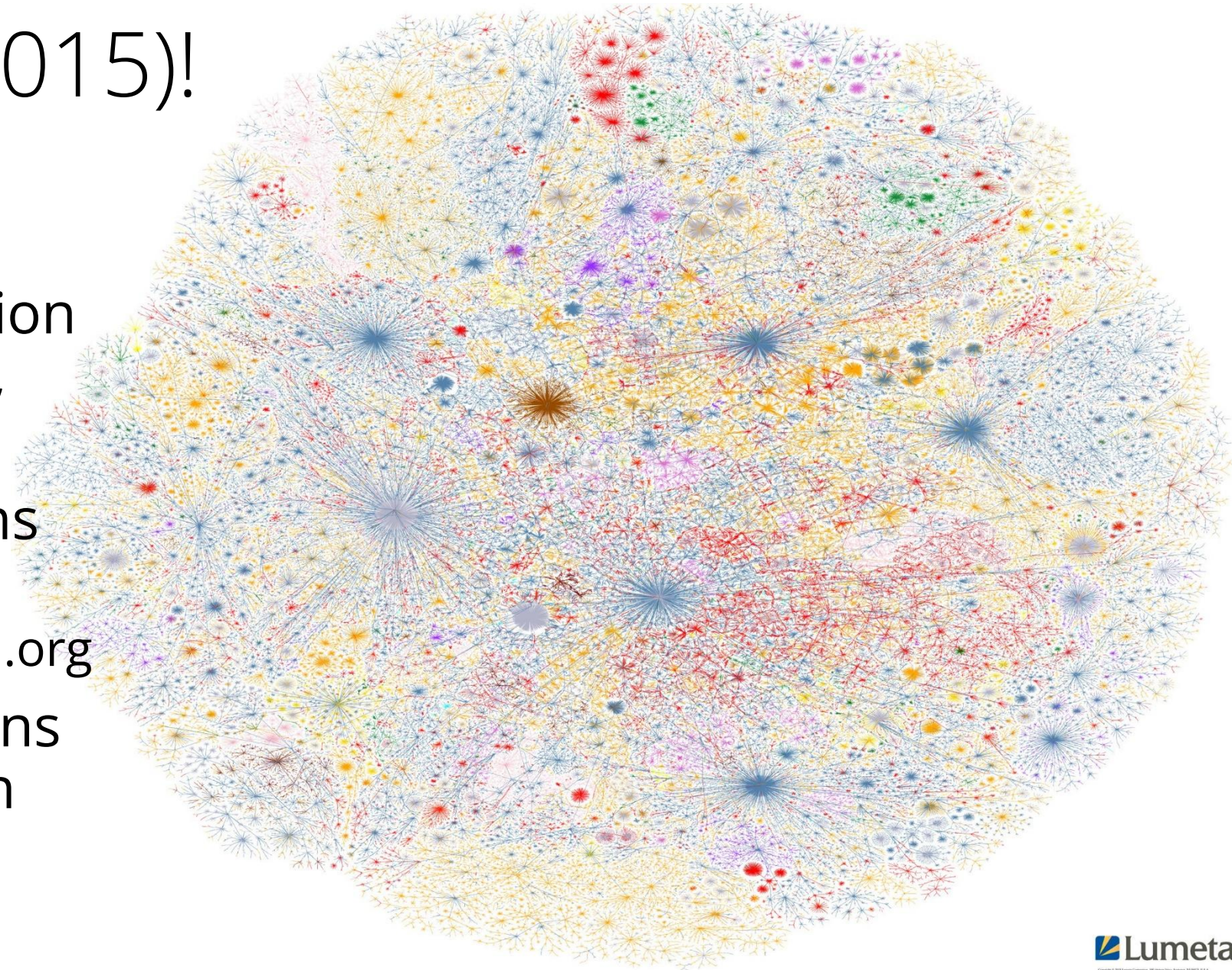
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES
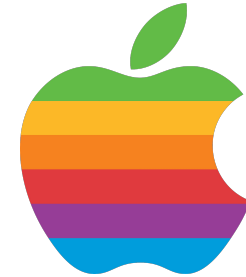
To this! (2011)

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 over 5 billion **people**!

Internet – Economic impact

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

Internet – Societal Impact

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

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Architectures

- Lots of ways to build networks with different **tradeoffs**
- Goals:
  - Open Access (Internet)
    - Safety--, Security--, Flexibility++, Privacy++
  - Identity First (Cellular)
    - Safety++, Security++, Privacy --, Flexibility--
  - Centralized (Comcast)
    - Complexity++, Freedom--
  - Decentralized (Mesh)
    - Complexity--, Freedom++

Why things are how they are

- A bit of a reach – might not make it here
- Modern networking
  - Software defined networks (SDN)
  - Content Delivery Networks (CDN)
  - Cellular Networks
  - Domain Name Service (DNS)
  - Debugging tools: Dig/traceroute/whois

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

Thanks!

Let's have a good quarter!