EN.601.414/614 Computer Networks

Introduction

Xin Jin

Spring 2019 (MW 3:00-4:15pm in Shaffer 301)

https://github.com/xinjin/course-net

Introduction

- **Instructor: Xin Jin**
  - PhD in Computer Science from Princeton in June 2016
  - On the Hopkins faculty since July 2017
  - Research areas: computer networks, distributed systems
  - Current research
    - Co-design networks and distributed systems with new-generation programmable switches
    - Design low-latency data analytics systems with approximate and sub-linear techniques
    - Design self-driving networks with SDN and AI
  - EN.601.714 Advanced Computer Networks (fall semester): exciting new developments of computer networks

Introduction

- **Teaching assistants: Zhihao Bai, Hang Zhu**
  - PhD student in computer science
  - Interested in computer networks and distributed systems
- **Course assistants: TBD**

Office Hours

- **Monday: 4:15-5:15pm**
- **Wednesday: 4:15-5:15pm**
- **Friday: 4:15-5:15pm**
- **Tentative, starting next week**

- **Location: TBD**

601.414/614 in CS Curriculum

- **601.220 Intermediate Programming**
  - High-level logic -> Programs
  - Coding skills learned in 601.220 are critical for 601.414/614 assignments

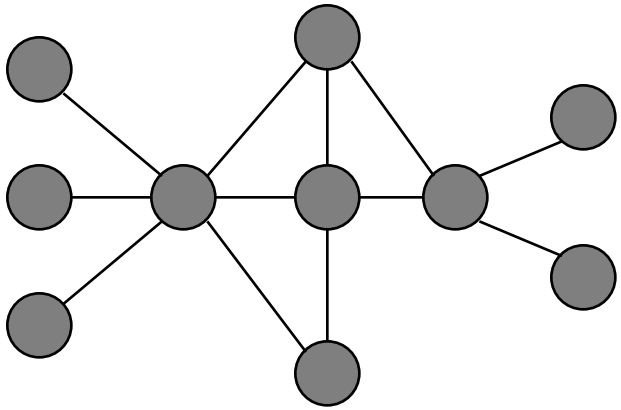
- **601.229 Computer System Fundamentals**
  - How do machines work?
  - Execute programs, interact with users, etc.
  - Many concepts of 601.229 will be useful

What is missing

- **How do we access most services?**
  - Examples include search engines, social networks, video streaming, etc.
- **How do two machines communicate?**
  - When they are directly connected
  - When they are not directly connected
- **Using a network**

What is a network?

- **A system of “links” that interconnect “nodes” in order to move “information” between nodes**



- **Yes, this is very vague**

There are many different types of networks

- **Internet**
- **Telephone network**
- **Transportation networks**
- **Etc.**

We will focus primarily on the Internet

The Internet: An Exciting Time

- **One of the most influential inventions**
  - A research experiment that escaped from the lab
  - … to be a global communications infrastructure
- **Even wider reach**
  - Today: more than 3 billion users
  - Tomorrow: more users, computers, things, ...
- **Near-constant innovation**
  - Apps: Web, social networks, Bitcoin, blockchain, ...
  - Links: optics, WiFi, cellular, satellite, ...

Transforming Everything

- **The ways we do business**
  - E-commerce, advertising, cloud computing, …
- **The way we communicate and socialize**
  - E-mail, Facebook, Twitter, Instagram, Snapchat, ...
- **The way we learn**
  - Wikipedia, MOOCs, search engines, ...
- **How we think about law**
  - Interstate commerce? National boundaries? Smart contracts?
- **The way we govern**
  - E-voting, censorship, democratic organization on blockchain, ...

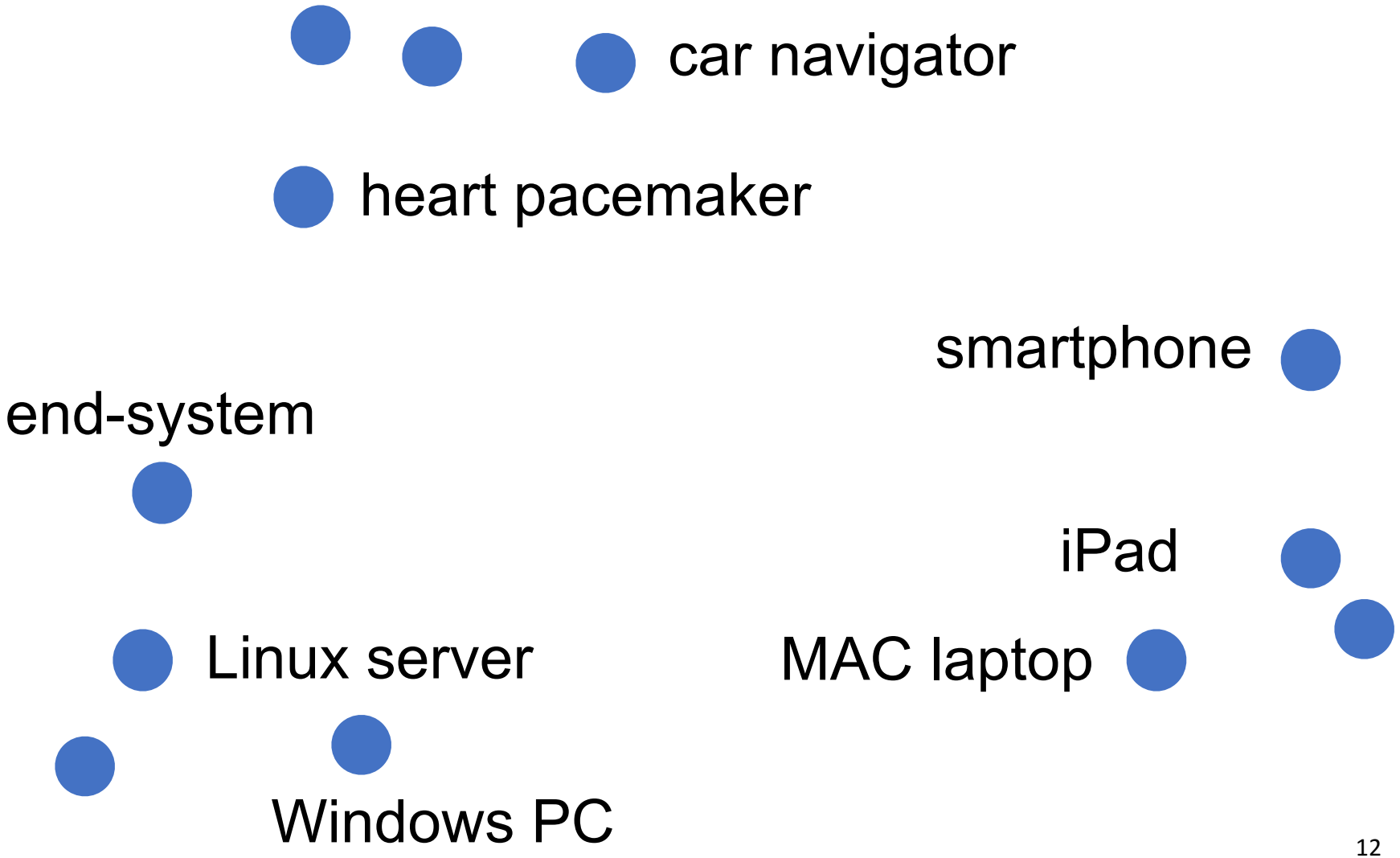
So, what is Internet?

Internet

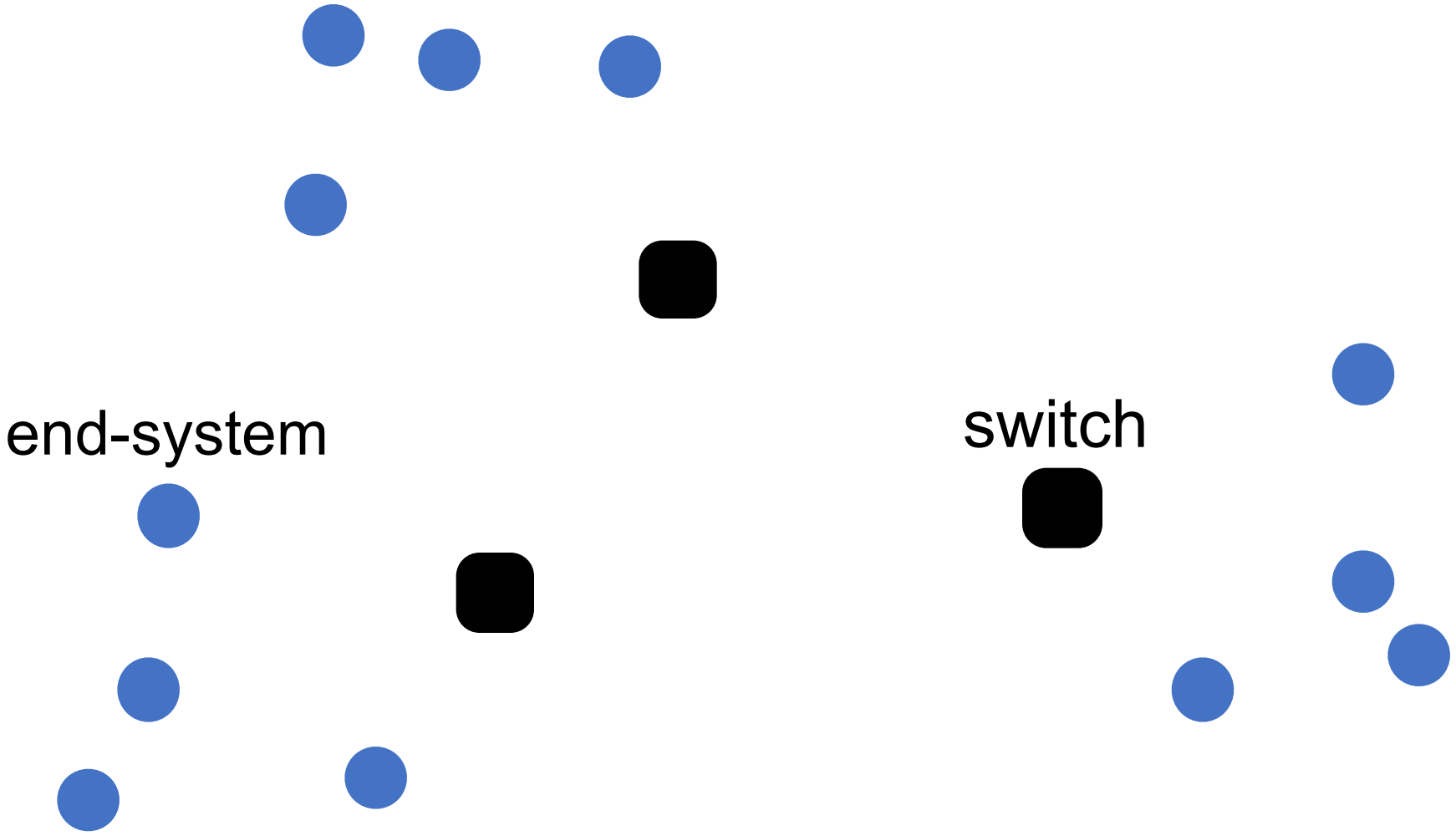
Inter-net

A network of networks

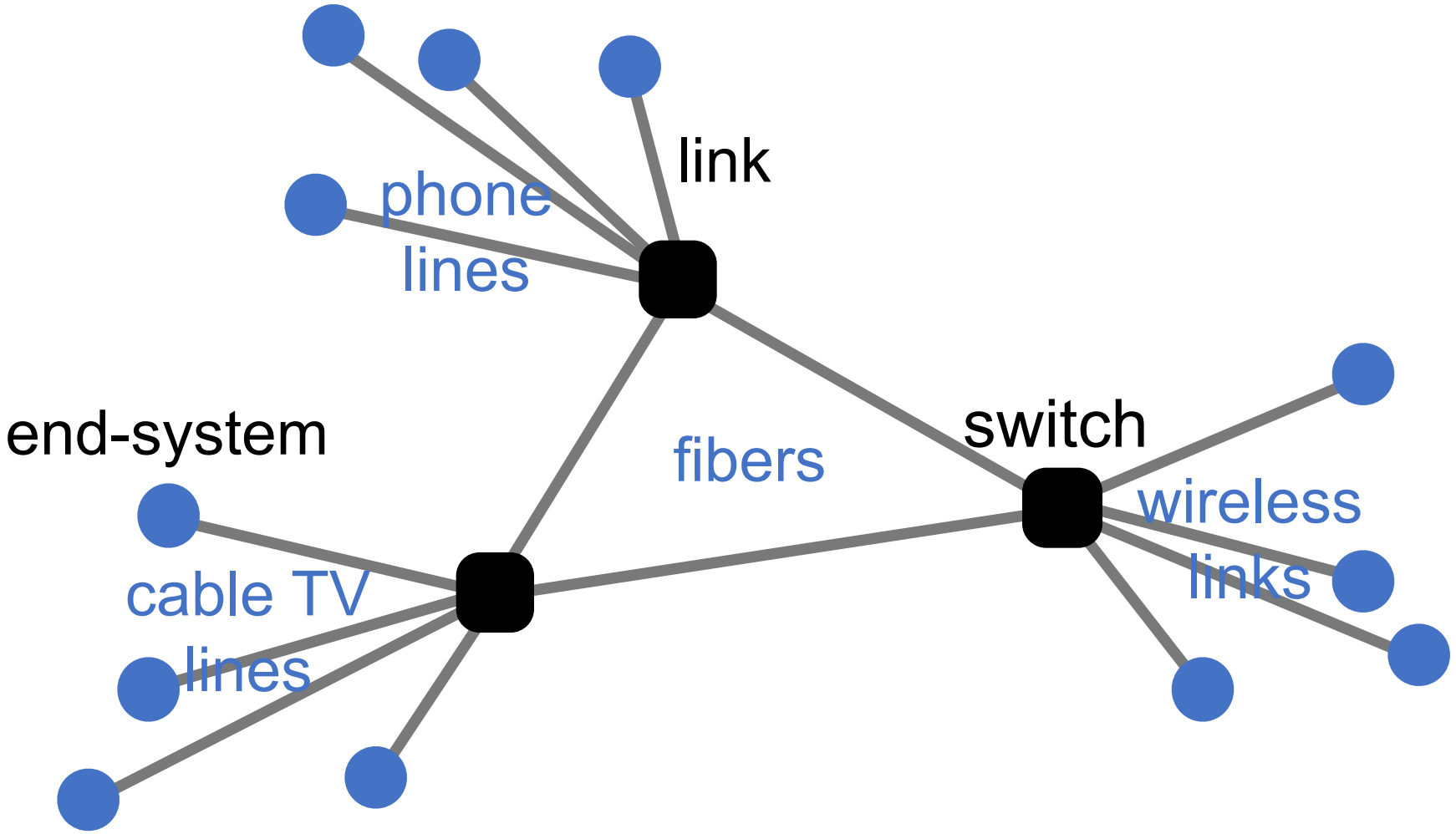
The Internet consists of many end-systems



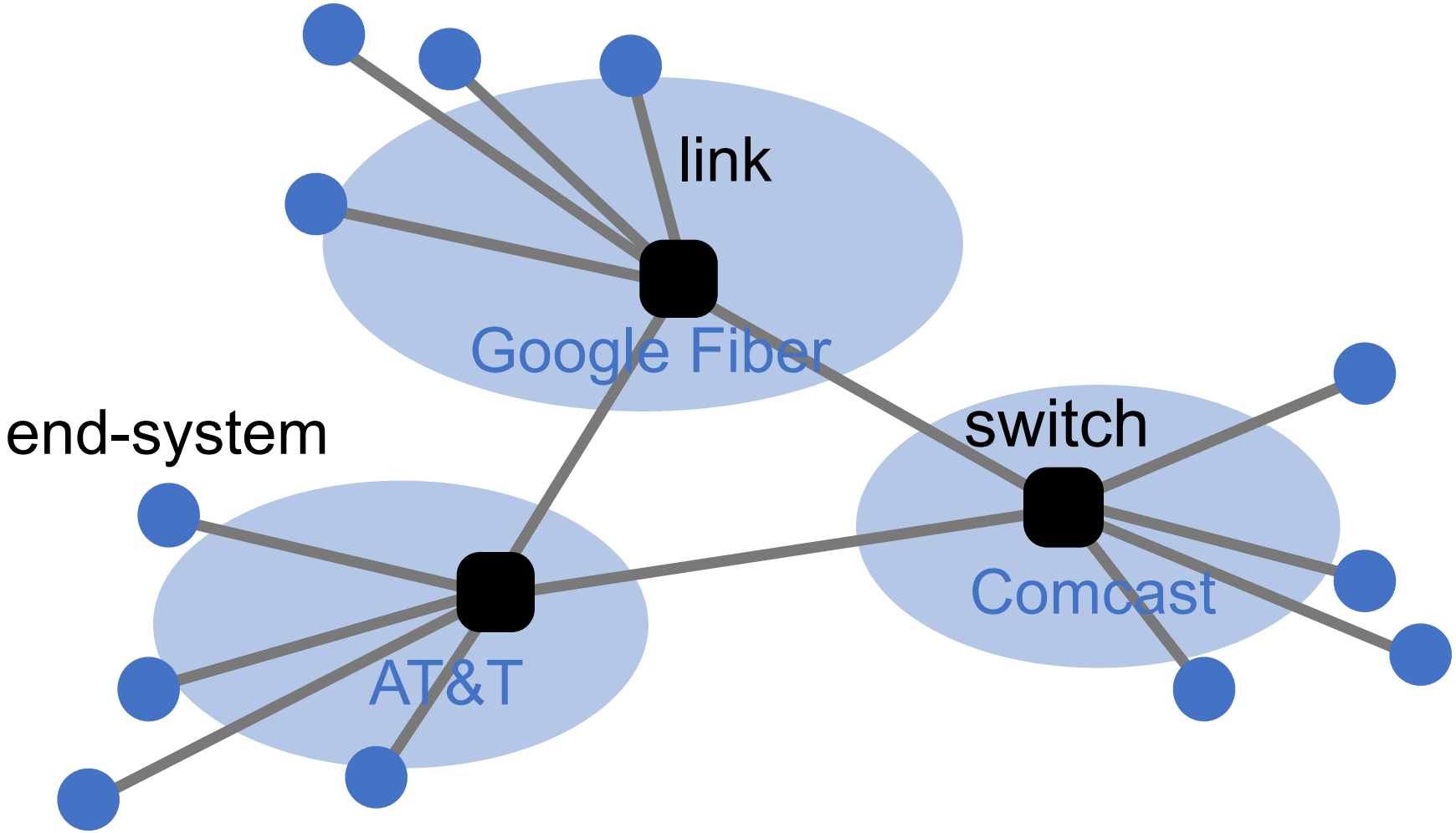
Connected by switches



And links

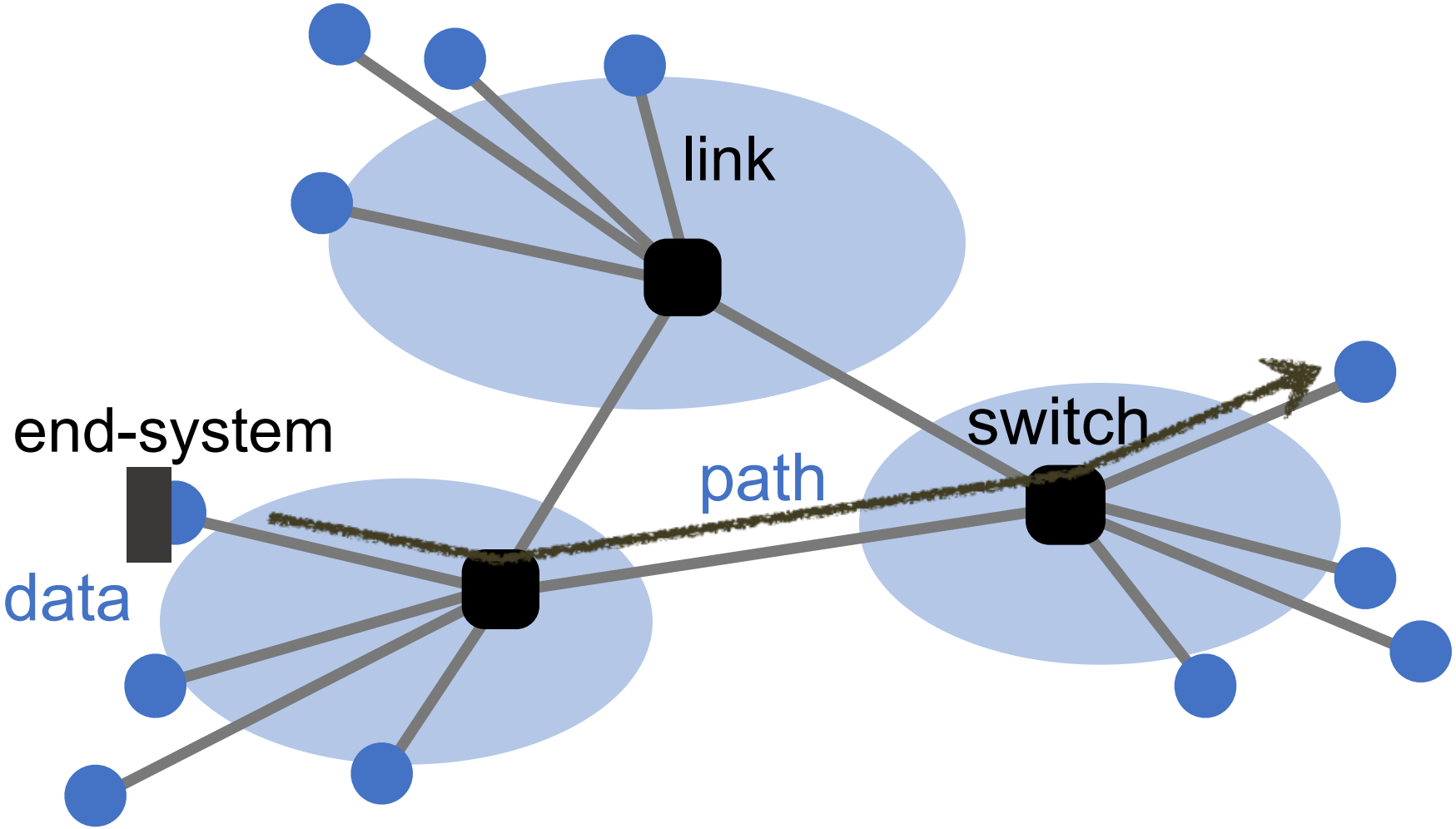

link
phone
lines
end-system
fibers
switch
wireless
links
cable TV
lines

Managed by many parties



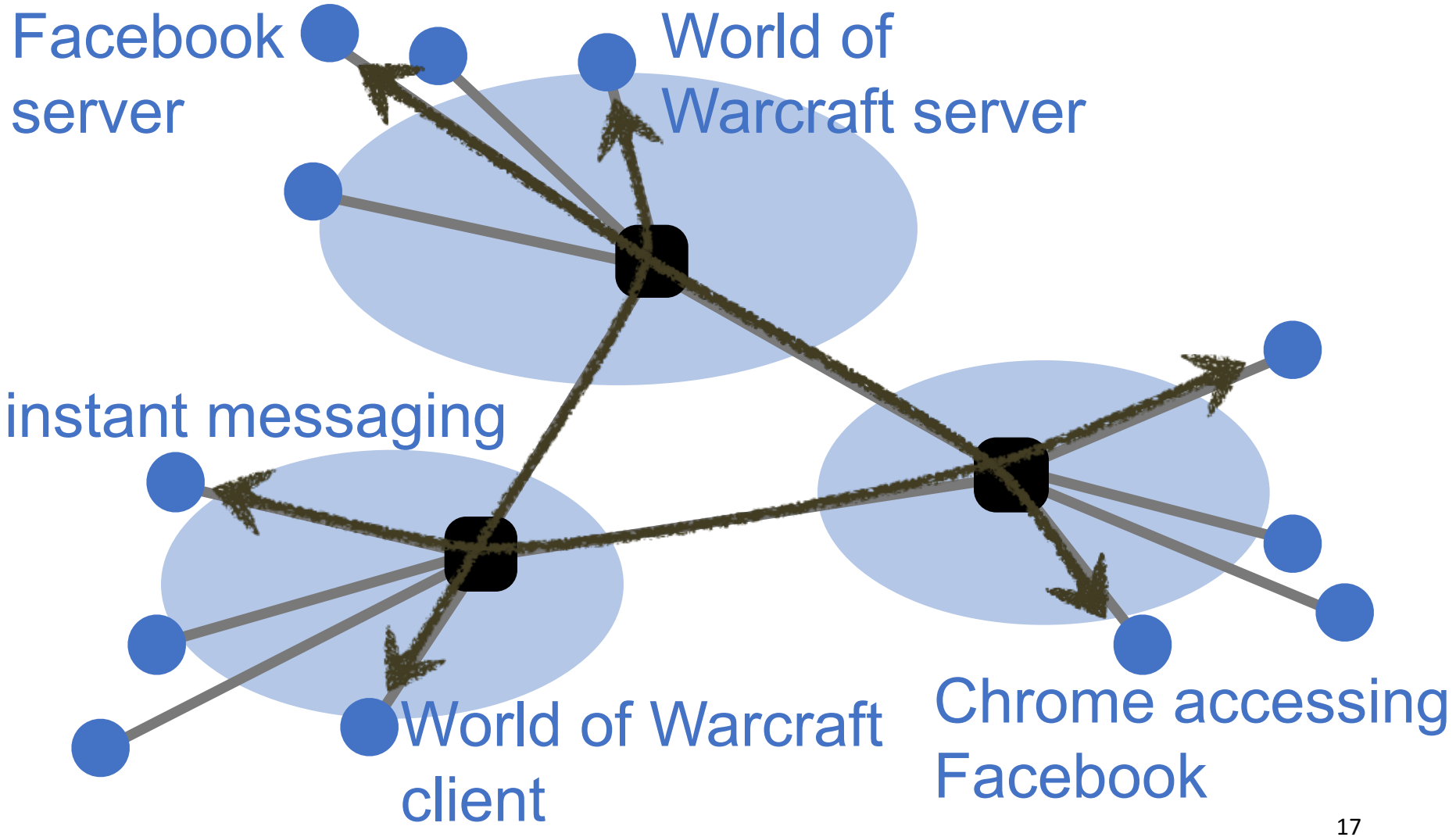
Internet Service Provider

Transfers data



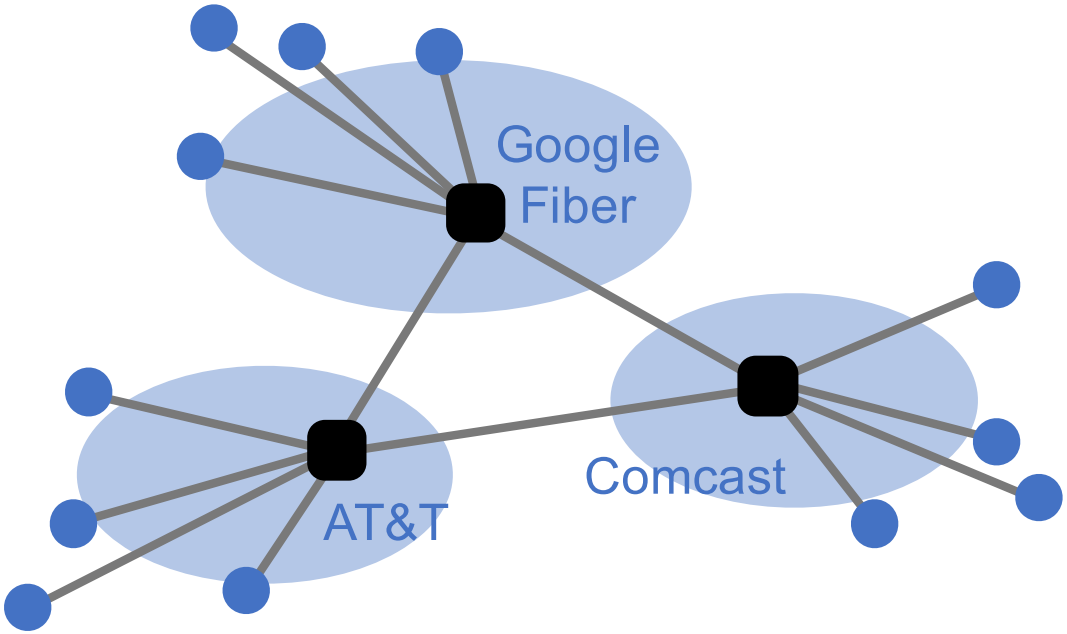
Internet Service Provider

Shared among many services



A federated system

- **The Internet ties together different networks by the IP protocol**
  - ➢One interface to bind them all together



Why a common interface?

- **The Internet ties together different networks**
  - >18,000 ISP networks

- **Interoperability between users and networks as well as between different networks**

Massive Scale

- **4.2 Billion users (55% of world population)**
- **1 Trillion websites**
- **200 Billion emails sent per day**
- **2.5 Billion smartphones**
- **2.2 Billion Facebook users**
- **4 Billion YouTube videos watched per day**
- **Routers that switch 10 Terabits/second**
- **Links that carry 100 Gigabits/second**

Diversity in all dimensions

- **Technology**
  - Optical, wireless, satellite, copper
- **Endpoint devices**
  - From wearable devices and cell phones to datacenters and supercomputers
- **Applications**
  - Video streaming, social networking, file transfer, live TV, gaming, remote medicine, messaging, cryptocurrency
- **Users**
  - Malicious, naïve, savvy, embarrassed, paranoid

The Internet is also

- **Constantly evolving**
- **Decentralized**
  - Many parties with (often conflicting) interests
- **Failure-prone**
  - Physical errors, logic errors, human errors, etc.
- **Constrained by technology**
  - Speed of the light is the limit (so far!)

Have we found the right solution?

- **We don't really know**
- **What we do know**
  - The early Internet pioneers came up with a solution that was successful beyond all imagining
  - Several enduring architectural principles and practices emerged from their work
- **Still, it is just one design with many questions**

The Internet is a lesson

- **In how to reason through the design of a very complex system**
  - What are our goals and constraints?
  - What's the right prioritization of goals?
  - How do we decompose a problem?
  - Who does what? How?
  - What are the interfaces between components?
  - What are the tradeoffs between design options?

What is 601.414/614 about?

- **To learn about (at a high level)**
  - How the Internet works
  - Why it works the way it does
  - How to reason about complicated design problems

- **What it's not about**
  - How to write web services
  - How to design web pages
  - …

What is 601.414/614 about?

- **Basics**
  - Packets, circuits, multiplexing, delay, loss, protocols
  - Application layer: HTTP
  - Transport layer: TCP, UDP, congestion control
  - Network layer: IP, routing protocols
  - Link layer: Ethernet, wireless
  - Standard network course (e.g., Princeton 461 and UMich 489)
- **New EXCITING materials**
  - Programmable networks, software defined networking (SDN)
  - Big network data processing, cloud computing
  - Blockchain, Bitcoin, and decentralized Internet applications

Class workload

- **Four programming assignments**
- **Exams**
  - Midterm exam: March 13
  - Final exam: final examination period

Grading

- **Class participation: 5%**
  - Small quiz in class
- **Programming assignments: 40%**
  - 10% for each assignment
- **Midterm exam: 25%**
- **Final exam: 30%**

Programming assignments

- Assignment 1: socket programming
- Assignment 2: routing algorithms
- Assignment 3: congestion control
- Assignment 4: programmable networks

- Updated from last year

Textbook

- Kurose and Ross, **Computer Networking: A Top-Down Approach**, 7th Edition, Pearson, 2017. ISBN 978-0133594140.
  - Earlier editions are ok, but translate reading assignments

Communication protocol

- **Course website: https://github.com/xinjin/course-net**
  - ➢Announcements, lecture slides, assignments
- **Piazza for discussion**
  - ➢Link on course website
- **Assignment submission via Gradescope**
  - ➢Link on course website

Policies on late submission, cheating, …

- **Description in the course website**
  - Assignments must be submitted within deadline to receive full points
  - Grace period: 96 hours for the entire semester.
    - Use them judiciously
  - After the grace period, 25% off for each 24 hours late, rounded up.

- **DO NOT cheat**

Participation

- **Ask and answer questions**
  - It helps you understand and others too
  - It helps you stay awake
  - It helps me stay awake
- **Sit toward the front**

Summary

- **Learning about the Internet and networking in general is**
  - important and relevant
  - lots of fun – challenging real-world problems

- **Next lecture**
  - Read 1.1 and 1.3 of K&R

Thanks!
Q&A