

EN.601.414/614

Computer Networks

Introduction

Xin Jin

Fall 2020 (TuTh 1:30-2:45pm on Zoom)



<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, computer systems
- Current research
 - Programmable networks
 - Systems + machine learning
 - Low-latency systems for data analytics
 - Software-defined networking
- EN.601.714 Advanced Computer Networks (spring semester): exciting new developments of computer networks

Introduction

- **Teaching assistants: Zhihao Bai**

- PhD student in computer science
- Interested in computer networks and machine learning systems

- **Course assistants:**

- Ziming Chen
- Kun (Ryan) Liu

Office Hours

- **Tuesday: 2:45-3:45pm**
 - **Thursday: 2:45-3:45pm**
 - **Will add two more slots**
 - **Tentative, starting next week**
-
- **Zoom links for office hours: on Piazza**

601.414/614 in CS Curriculum

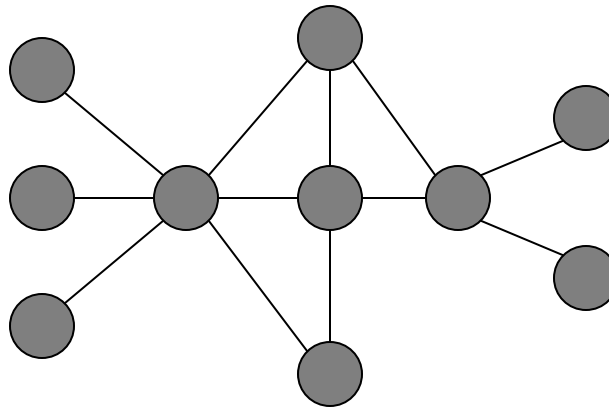
- **601.220 Intermediate Programming**
 - High-level logic → Programs
 - Coding skills learned in 601.220 are critical for 601.414/614 assignments
- **601.229 Computer System Fundamentals**
 - How do machines work?
 - Execute programs, interact with users, etc.
 - Many concepts of 601.229 will be useful

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

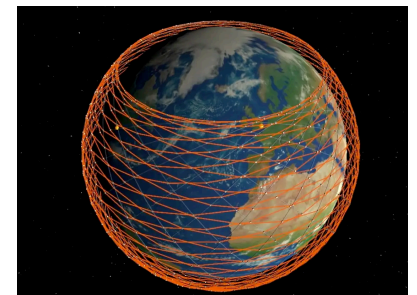
- **Internet**
- **Telephone network**
- **Transportation networks**
- **Etc.**

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 4 billion users
 - Tomorrow: more users, computers, things, ...
- **Near-constant innovation**
 - Apps: Web, social networks, Bitcoin, blockchain, ...
 - Links: optics, WiFi, cellular, satellite, ...

Starlink



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**

- Zoom, 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

● ● ● car navigator

● heart pacemaker

end-system



● Linux server



Windows PC

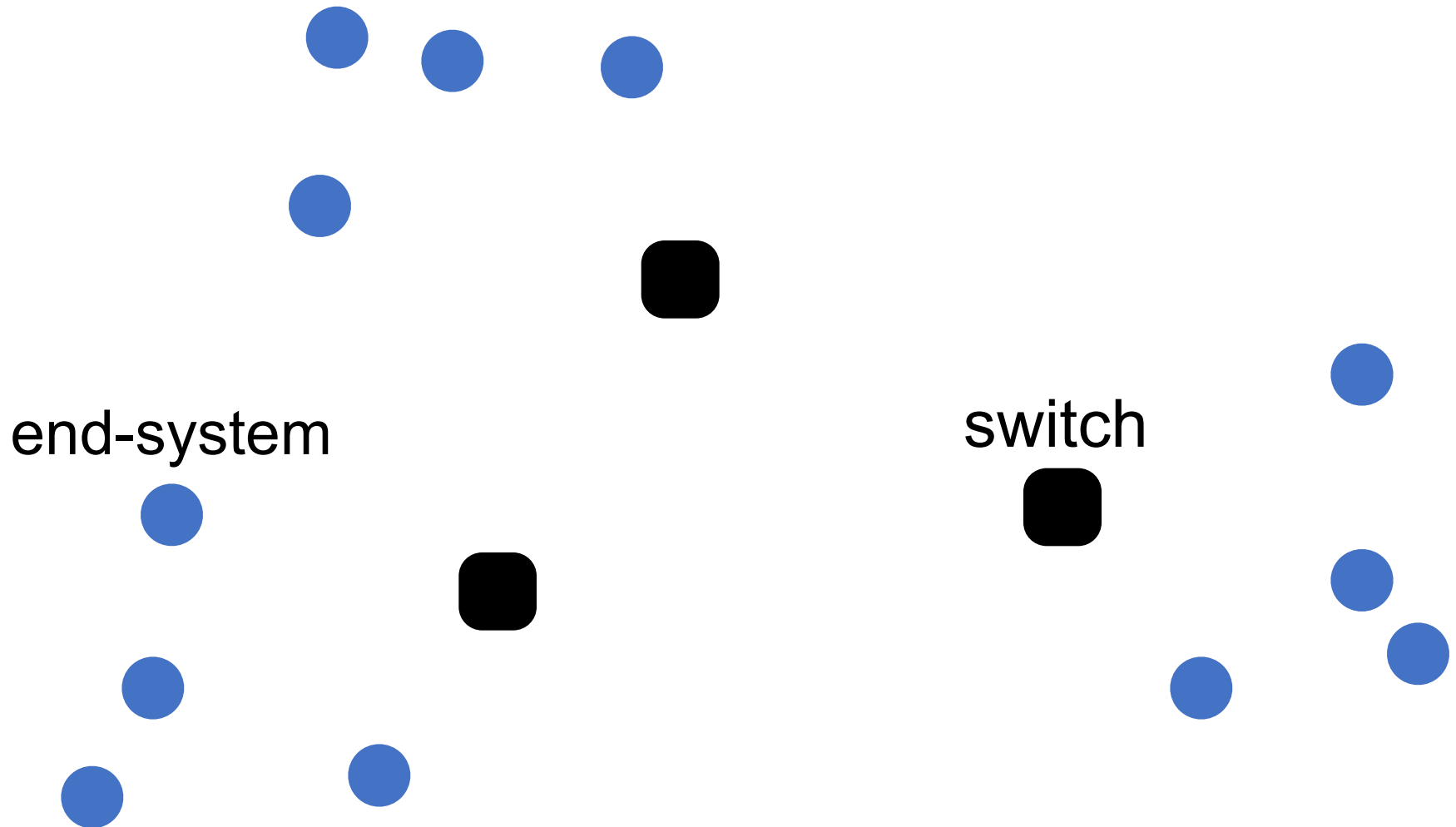
smartphone ●

iPad ●

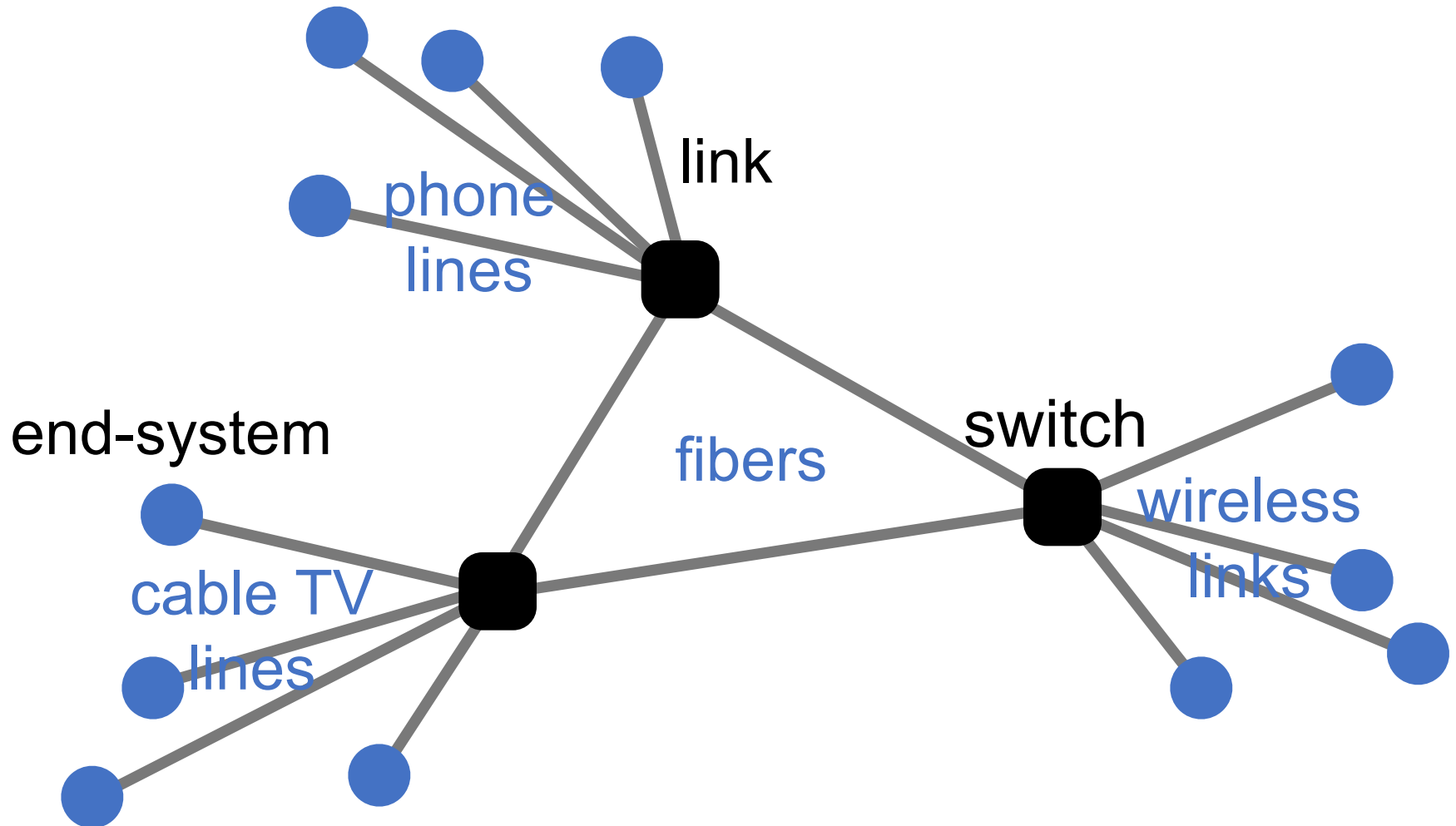
MAC laptop ●



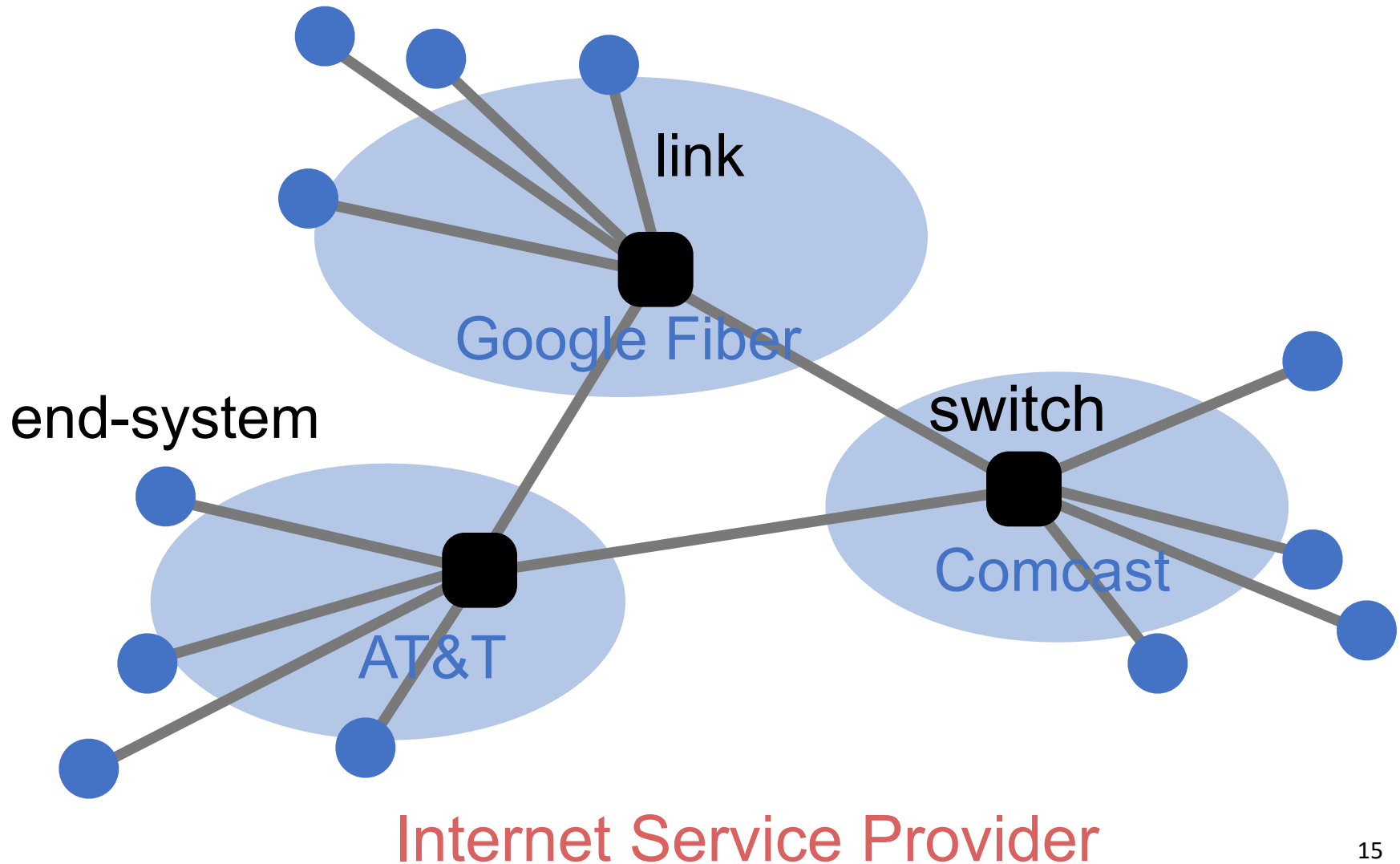
Connected by switches



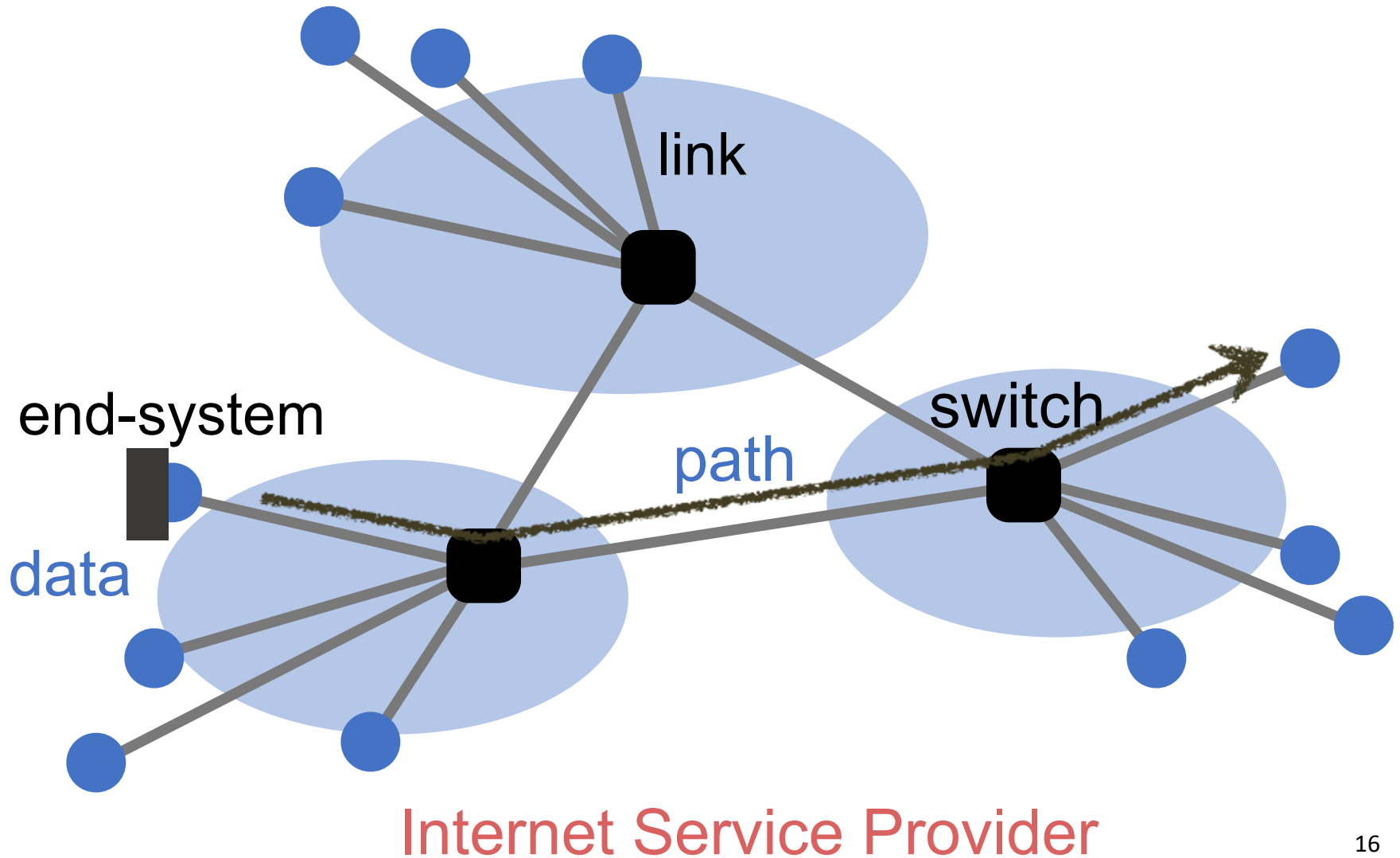
And links



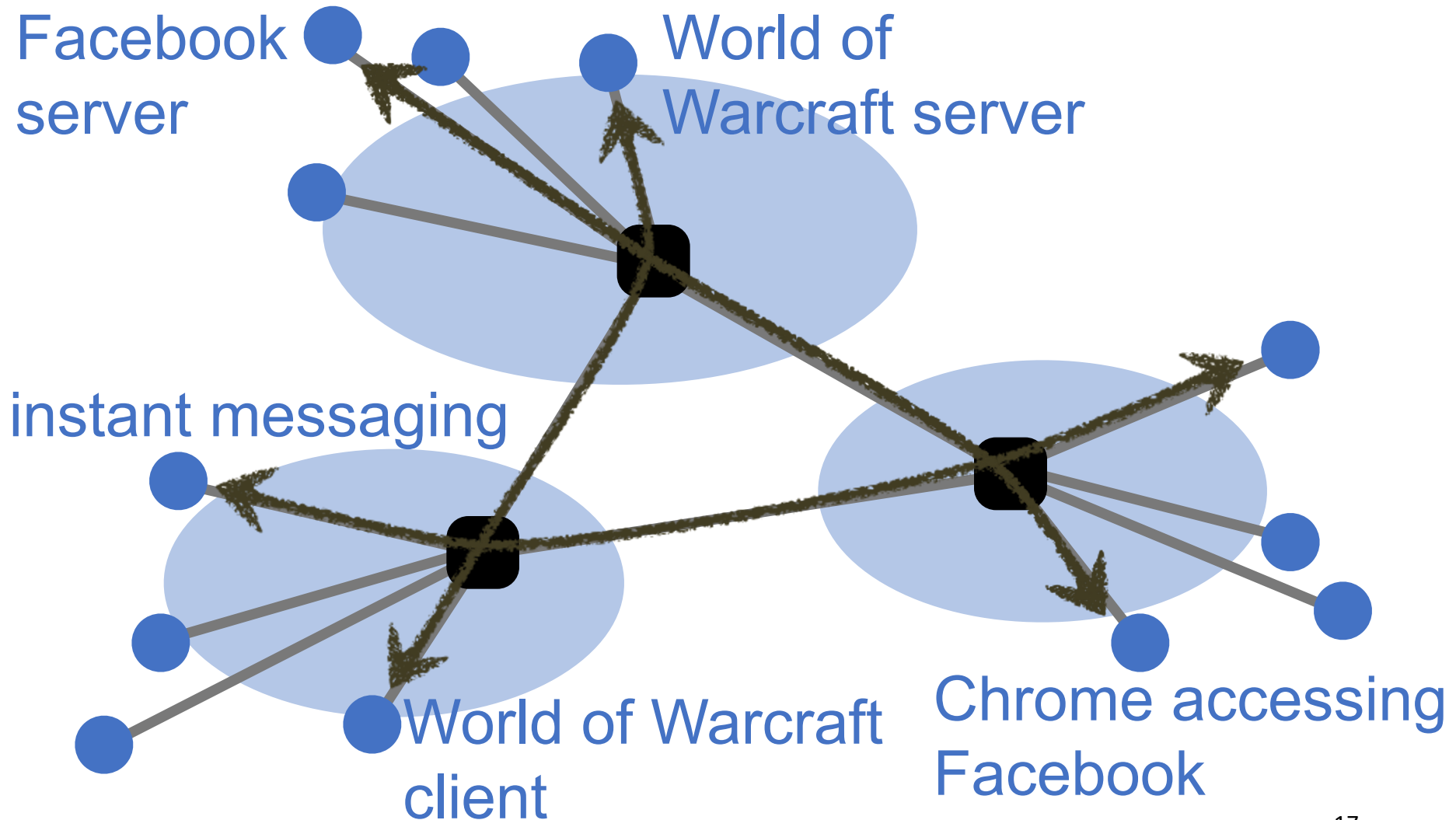
Managed by many parties



Transfers data

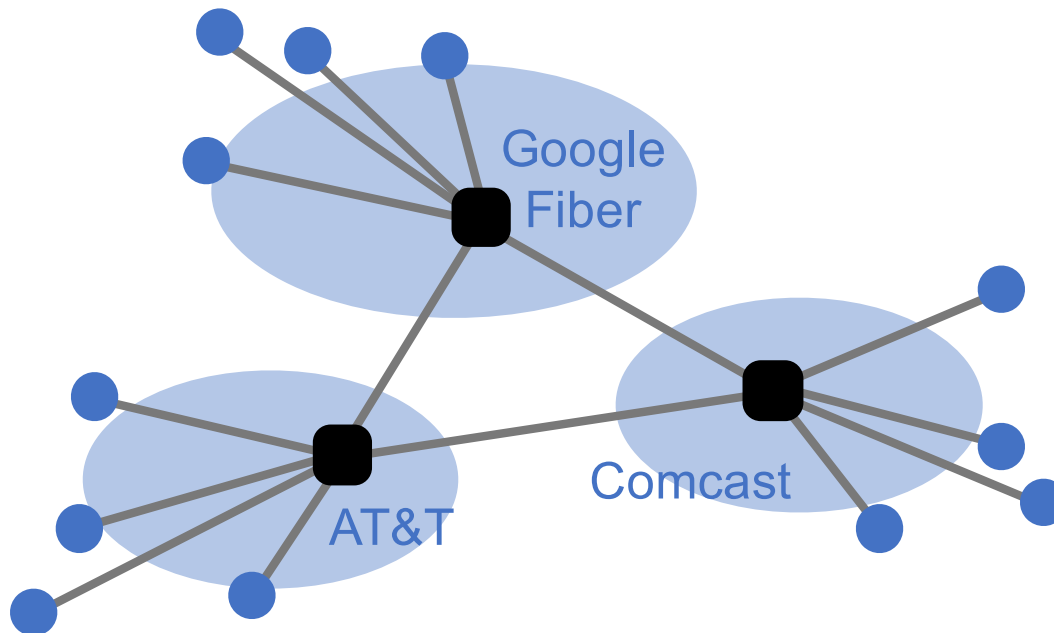


Shared among many services



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

- **4.47 Billion** users (59% of world population)
- **1 Trillion** websites
- **200 Billion** emails sent per day
- **2.5 Billion** smartphones
- **2.7 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, Berkeley 168)

- **New EXCITING materials (updated from last year)**

- Programmable networks, software defined networking (SDN)
- Frontiers of networking research in the age of AI and ML
- Big network data, cloud computing, Blockchain, Bitcoin

Class workload

- **In-class participation**
 - Group discussion in Zoom breakout zooms
- **Four programming assignments**
- **Two exams: midterm exam and final exam**

Grading

- **Class participation: 20%**
 - Group discussion in class
- **Programming assignments: 40%**
 - 10% for each assignment
- **Midterm exam: 20%**
- **Final exam: 20%**
- Purpose: The grading policy is refined to enhance participation and reduce pressure of exams for online course

Programming assignments

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

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

Participation

- **Group discussion in Zoom breakout rooms**
 - NEW this semester to enhance participation and improve learning experience of online course
- **Format**
 - Discuss questions related to the lecture in groups at the end of each class
 - Pick a leader to summarize the discussion
 - Post a short summary on Piazza (including the student names that contribute to the discussion)

Recording and Privacy

- **Lectures**

- The lectures will be recorded and posted on Blackboard (only viewable by enrolled students)
- Post your questions in the Zoom chat window if you do not want to be part of the recording

- **Group discussions**

- The group discussions will NOT be recorded. Zoom recording will be turned OFF for this part.
- Feel free to ask questions and present your answers

First Group Discussion

- **Topic: network performance of Internet applications/services**
 - What is your favorite Internet application/service?
 - What do you dislike about it?
 - Is there a quantitative metric to measure it?
 - What network technologies can potentially help?
- **Everyone participates this time**
 - Everyone first introduces yourself to the class, so your classmates and I will know you!

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