CS 352
Internet Technology

Lecture 1.1: Introduction

http://www.cs.rutgers.edu/~sn624/352

Srinivas Narayana

RUTGERS
UNIVERSITY | NEW BRUNSWICK

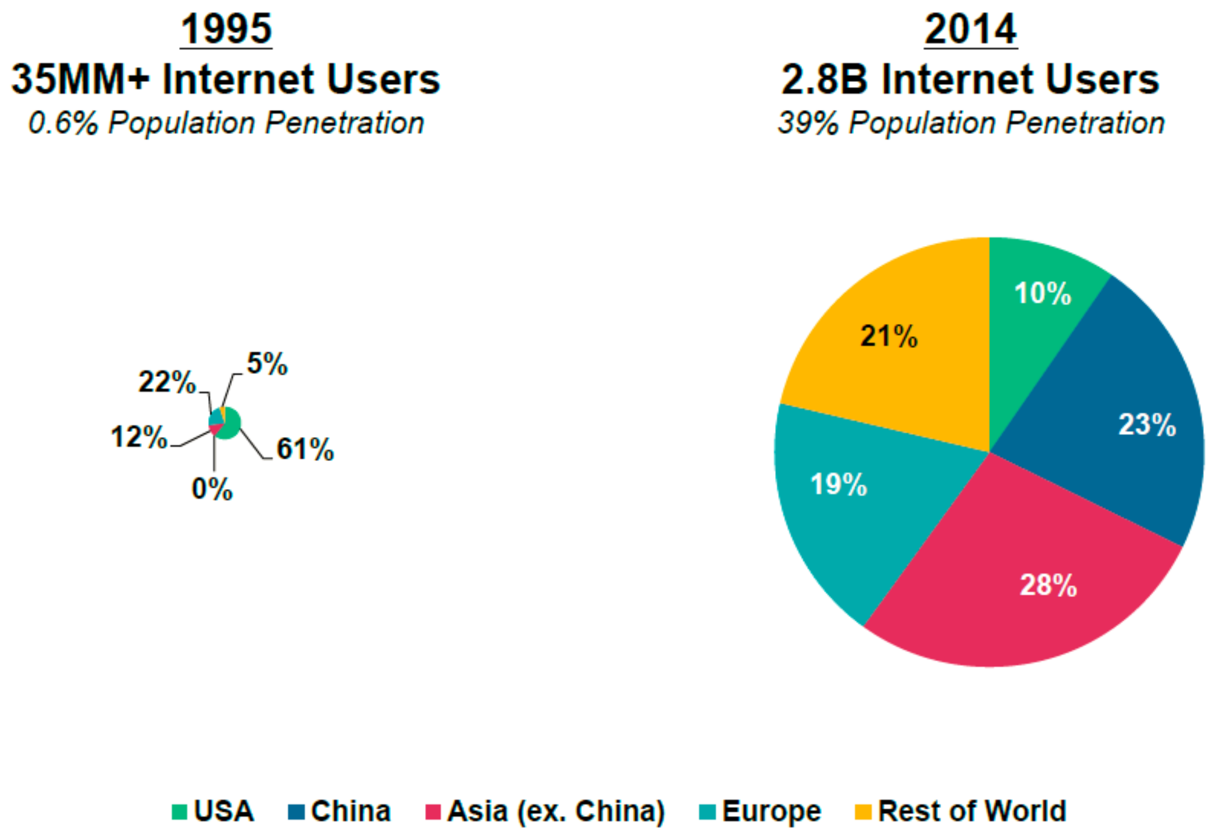
The Internet is an exciting place

The Internet has transformed everything

- How we communicate with other humans
- How we learn what’s going on in the world
- How we learn and acquire knowledge
- How we transact and do business
- How we entertain ourselves
- How espionage and war is conducted

- In short how we live, especially through a pandemic.

Internet growth



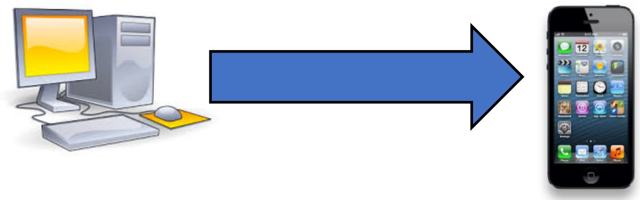
2020

4.8B users

(61% of the world's population)

https://www.broadbandsearch.net/blog/internet-statistics

Evolution of Internet applications



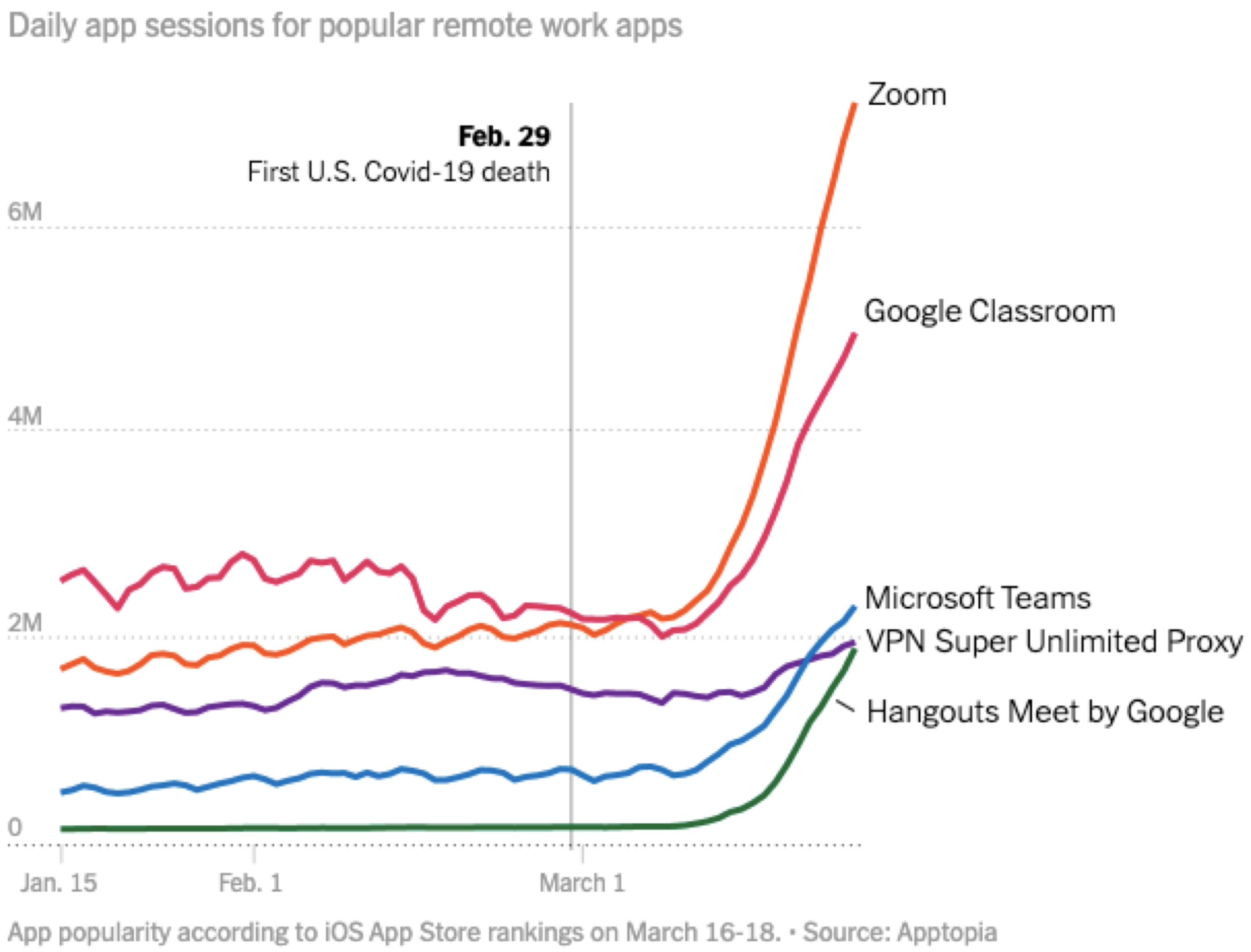
1992	1996	2000	2004	2008	2010-now
ftp Web email	chat Games IM Yahoo!	news Blog Search	Music itunes Games search	Wikipedia Craiglist Youtube	

Text-heavy

Multimodal media

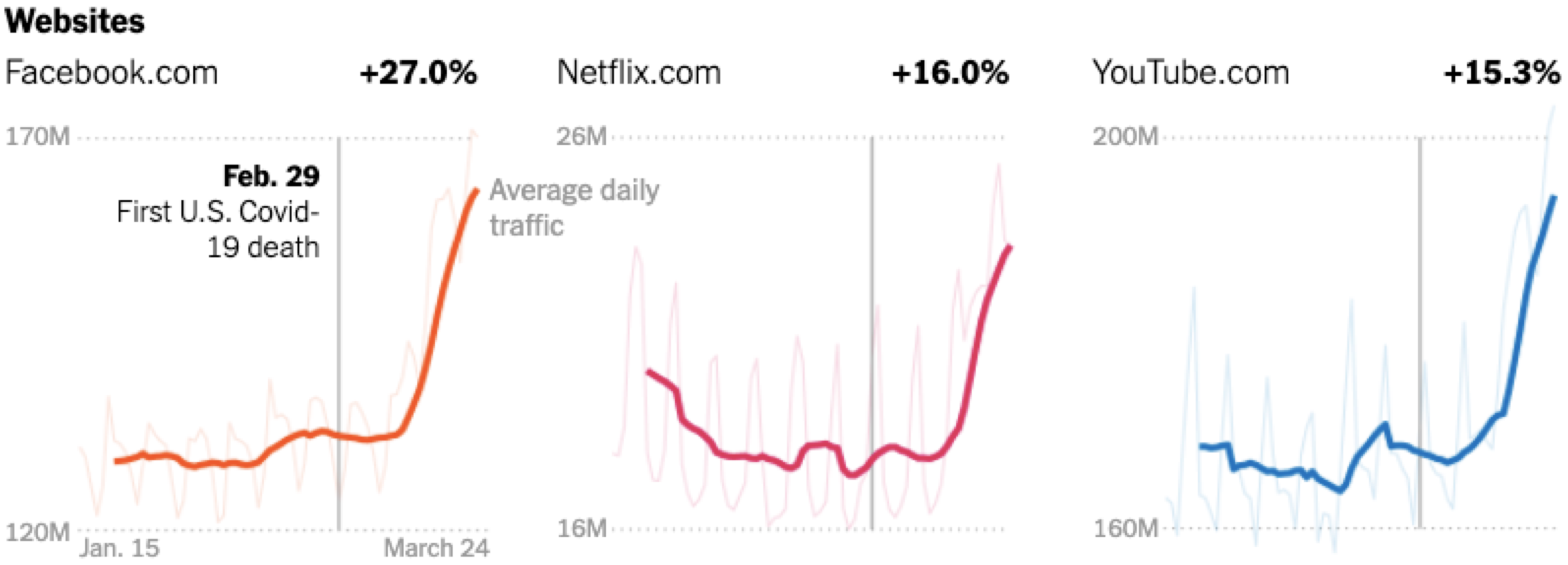
Augment physical world

We relied on the Internet to work



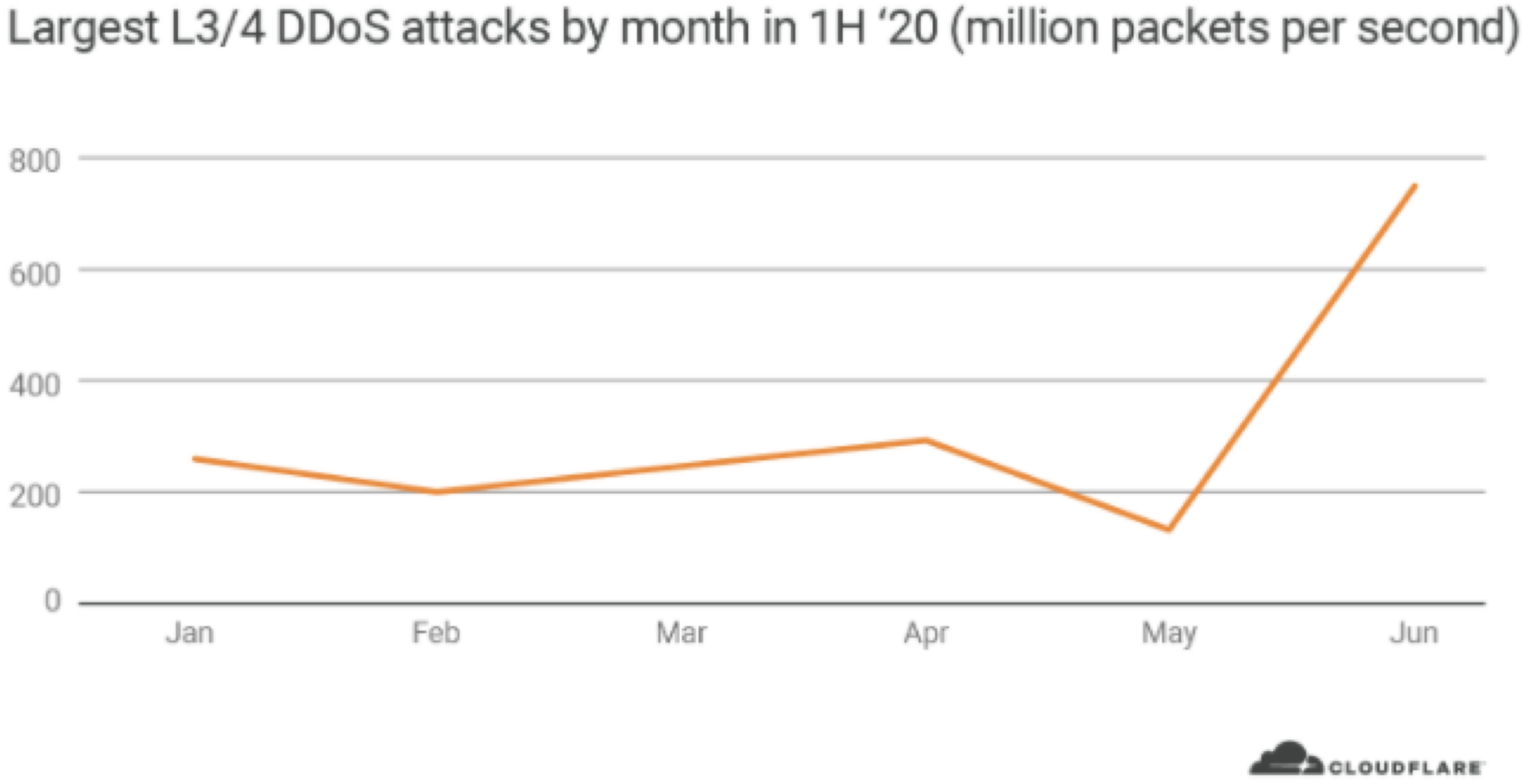
Data shows number of daily sessions in the US over a period in 2020. Source: nytimes

We relied on the Internet to “play”!



Data shows number of daily sessions in the US over a period in 2020. Source: nytimes

Threats on the Internet are growing, too



Source: CloudFlare blog

Internet Technology: This course

- The study of how the Internet (and other large networks) are designed.

- We will study the principles that make the Internet as successful an artifact as it is.

- The Internet is an example of a computer network

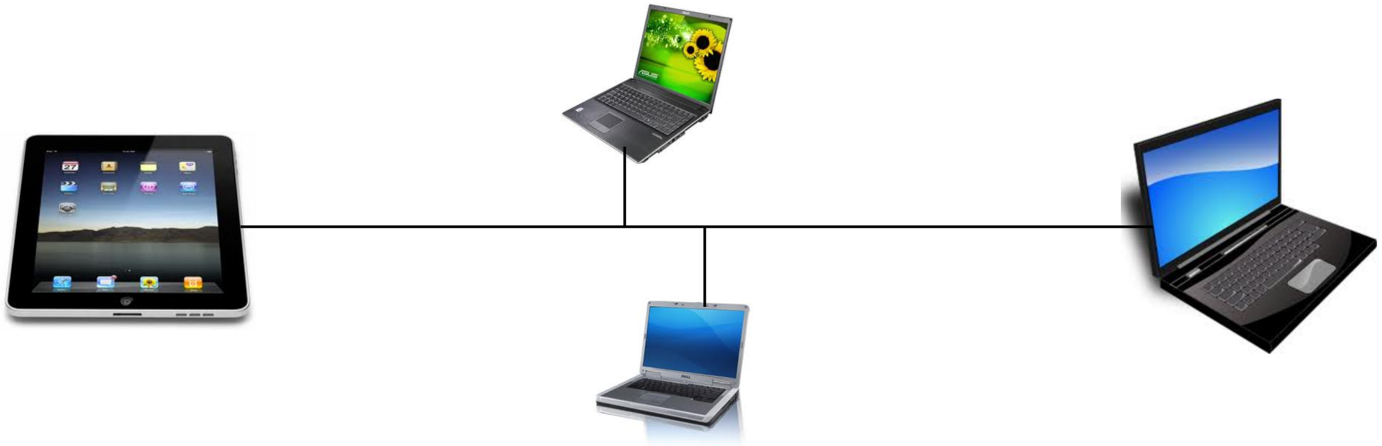
What is a network?

- Carrier of information between two or more entities

- Entities may be hosts/endpoints (used interchangeably)
  - your laptop, cell phone, etc.

- Entities may also be devices in the middle of the network
  - For example, your WiFi router
- The interconnection between entities is any physical medium capable of carrying information: we call physical media links
  - copper wire, lasers (over optic fibre), microwave, cable (coax), satellite link, wireless link (cellular, 802.11, bluetooth)

A single link multiple access network

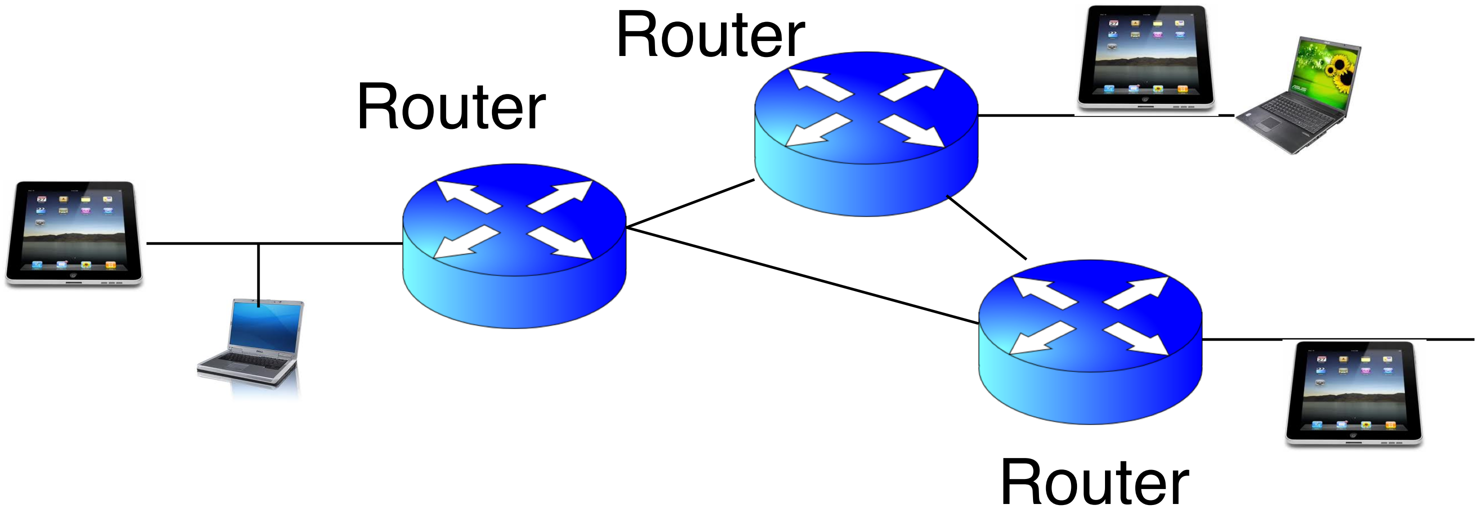


- Send bits of data in packets or frames
- How do we differentiate among many receivers?
- Every endpoint as a link level address: also called a *MAC* address
- Packets have a destination address on them
- However, can't have every computer in the world on the same link!
    - Physical limits on power / distance over which info travels over a single link

A single link multiple access network

- Even on a single link, you need to worry about a few things:
- Converting digital data to physical signals over the medium (encode/decode)
- How do we decide who speaks? (medium access control problem)
- Detecting and correcting errors

A multi-link network



- Connect multiple links via routers
- Need to figure out how to move packets from one host to another host, e.g., how to reach google.com from your laptop
- Known as the routing problem
- Key Q: How should packets be moved from A to reach B?

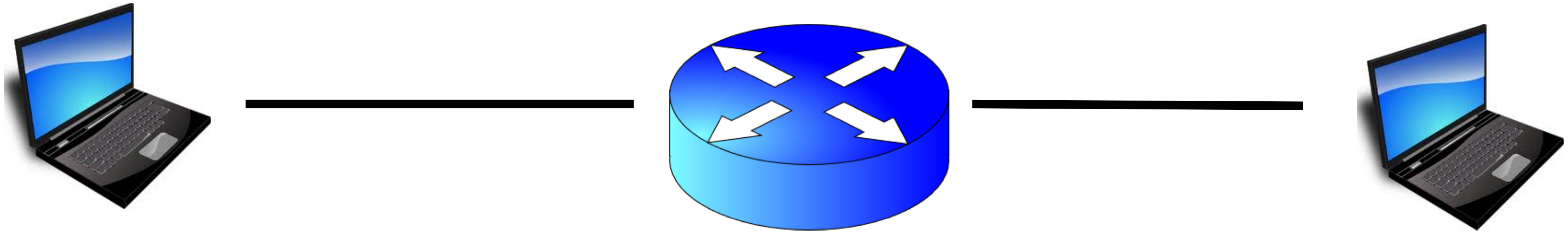
In general, networks give no guarantees

- Packets may be lost, corrupted, reordered, on the way to the destination
  - Best effort delivery

- Advantage: The network becomes very simple to build
  - Don’t have to make it reliable
  - Don’t need to implement any performance guarantees
  - Don’t need to maintain packet ordering
  - Almost any medium can deliver individual packets
    - RFC 1149: “IP Datagrams over Avian Carriers”
- The early Internet thrived since (transient) disruptions are okay

Guarantees for applications

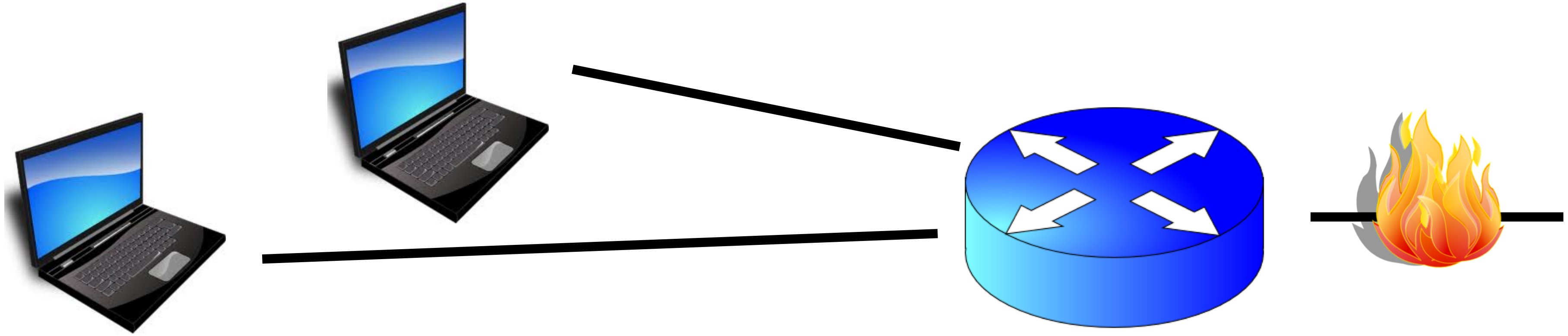
- How should endpoints provide guarantees to applications?



- Transport software on the endpoint oversees implementing guarantees on top of an unreliable network
- Need to solve the reliable data delivery problem
- For some applications, also need ordered delivery

Sending data into a multi-link network

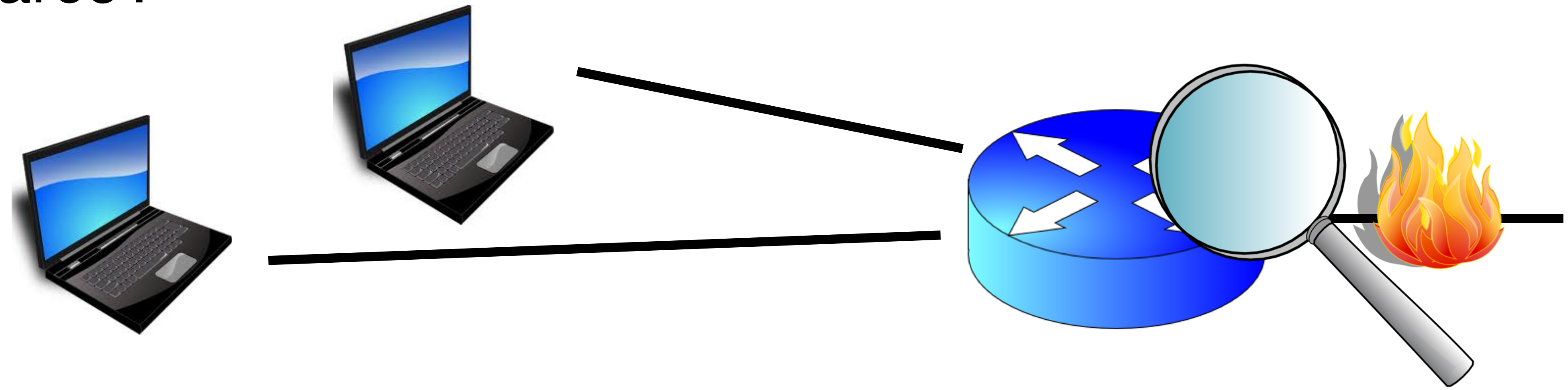
- How quickly should endpoints send data into a network?



- Known as the congestion control problem
- Congestion control algorithms at source endpoints react to remote network congestion. Part of the transport sw/hw stack.
- Key question: How to vary the sending rate based on network signals?

Sending data into a multi-link network

- How should a router transmit packets when network resources are scarce?



- Known as the packet scheduling problem
- Key question: which packet to transmit over a constrained network link, and when?
  - Related: the buffer management problem

Components of a network: Review

- Link
  - Communication links for transmission
- Host/Endpoint
  - Computer running applications of end user
- Router
  - Computer for routing packets from input link to another output link
- Network
  - A group of hosts, links, routers capable of sending packets among its members

CS 352
Course Logistics

Lecture 1.2

http://www.cs.rutgers.edu/~sn624/352

Srinivas Narayana

RUTGERS
UNIVERSITY | NEW BRUNSWICK

About us: Management

- Faculty Instructor: Srinivas Narayana
  - http://www.cs.rutgers.edu/~sn624
  - sn624@rutgers.edu
  - Office hours on Zoom (link on Canvas) Mondays and Thursdays at 9 am ET or by appointment
  - Class is fully remote and asynchronous. Lectures every Mon+Thu
- Recitation sections 1 (Shuxin Zhong) and 2 (Ari Hayes)
  - Recitations are also fully remote and asynchronous
  - TA office hours to be announced; recitation
- Course info
  - http://www.cs.rutgers.edu/~sn624/352/
- This course uses Canvas and Piazza (linked from Canvas)

Class philosophy

- We want you to learn and to be successful
- Ask questions on Piazza
- Attend office hours regularly to clarify material
  - 6 hours of office each week among all 3 instructors put together
- In summary, be proactive. Interact with us and with your fellow students and support each other

Goals

- Understand the basic design principles of computer networks
- Understand how the Internet works
  - Principles, architecture, protocols
- Text: “Computer networking, a top-down approach,” by James Kurose and Keith Ross

Course Assessments

- 30% programming projects
- 30% weekly quizzes
- 20% mid-terms (2 of 10% each)
- 20% final exam

- Full schedule of assessments available at https://www.cs.rutgers.edu/~sn624/352/syllabus.html

Programming projects (30%)

- Three programming projects (3 * 10%)
- Work in the same group of two students throughout semester
  - Only change groups with the discretion of instructor
- Programs and short write-up required
- Background needed to get started
  - Python (211, 214 level)
    - Get comfortable using data structures (tuples, arrays, dictionaries)
  - Unix (login, permissions, gcc)

Programming projects (30%)

- Hand-in programming projects via Canvas
  - Please get them in on time

- Failure to meet the due date will result in maximum 20% credit for that project for both team members.

- You must turn in all programming projects, even if they are delayed, to pass this course. Not turning in a project automatically implies a failing grade for all team members.

Weekly quizzes (30%)

- 8 weekly quizzes over the semester.
- Take them on Canvas any 40-min period over a week
- Quizzes will be announced when available
- Quizzes are closed book. Calculators are allowed

- No make-ups. You can drop 2 of the lowest scores among the 8

- Quiz schedule at https://www.cs.rutgers.edu/~sn624/352/syllabus.html

Mid-Terms (2 * 10%) and Final (20%)

- Two mid-terms (1.5 hours each) and a final exam (2.5 hours)
- Take any time over a window of 3 and 5 days (resp.). You can find the exam windows in the schedule
- Open-book: but only use lectures, textbook, and your own notes.
- No collaboration
- No looking for answers on the Internet.
- You must notify me at least 2 weeks before the final if you need to take a makeup

24/7 Grading Policy

- You may not dispute a grade or request a regrade before 24 hours or after 7 days of receiving it

- You may contact us if you have a legitimate regrading request…

- After 24 hours of receiving the grade: Please take the time to review your case before contacting the instructors

- Before 7 days have elapsed since you received the grade: we don’t want to forget what the test was all about!

Academic integrity

- I encourage you to study and prepare in groups
  - Share materials: it’s helpful for everyone
- All written & programmed work you turn in must be your own
- Please, no cheating on projects and exams
  - We reserve the right to…
    - Run code similarity detectors on the projects & code review
    - Scrutinize exams for copying
- It’s much easier to just do the right thing
- Read the course academic integrity policy at https://www.cs.rutgers.edu/~sn624/352/index.html#academic-integrity

Help, Accommodations, etc.

- We'll be happy to try and accommodate any requests that better support your learning

- Don't hesitate to contact the course staff with any requests.

- sn624@cs.rutgers.edu