



UNIVERSITY OF
WATERLOO

What is a computer network, and why learn about it?

CS 456/656, Fall 2026

Mina Tahmasbi Arashloo

Territorial acknowledgement

The University of Waterloo acknowledges that much of our work takes place on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. Our main campus is situated on the Haldimand Tract, the land granted to the Six Nations that includes six miles on each side of the Grand River. Our active work toward reconciliation takes place across our campuses through research, learning, teaching, and community building, and is centralized within the Office of Indigenous Relations.

About the instructor

Mina Tahmasbi Arashloo

- I do research on computer networks
- Princeton (PhD) → Cornell (Post Doc) → Waterloo (Assistant Professor)
- mina.arashloo.net

About the instructor (cont.)

My focus is making sure networks are correct, fast, and evolvable:

- Testing and verification tools
- High-level languages to describe what a networked system is supposed to do, and compilers that can generate fast implementations
- Infrastructure-level platforms that are fast, with testing and programmability as first-class goals

Research is a big part of this job

- A major part of my job is doing research on computer networks
- Undergraduates can and do take part in it
 - **URA** (Undergraduate Research Assistantship): part-time, 10 weeks, CS
 - **URF** (Undergraduate Research Fellowship): full-time, four-month term, CS
 - **MURA** (Mathematics Undergraduate Research Award): full-time, four-month term, Math
 - **EREP / UR2PhD (CS399)**: part-time, 12 weeks, for a first research experience, CS + CRA
 - **DRP** (Directed Reading & Research Programs): part-time, one term, paired with a graduate mentor, Math + Women in Mathematics
 - Other opportunities too
- Come to office hours if you want to talk about any of it

Today

- Where to find things (two minutes, the rest of the logistics is at the end)
- Poll: why are you taking this course?
- What is a computer network?
- What we are doing for the next twelve weeks
- Why I care about them, and why you might
- Back to your reasons
- The rest of the course logistics

Where to find things

- **Course webpage:** mina.arashloo.net/courses/CS456-F26
 - Outline, schedule, slides, policies, references
- **LEARN:** announcements, slides, quizzes, assignments
- **Piazza:** piazza.com/uwaterloo.ca/fall2026/cs456cs656
 - Access code: [a9q9zyvy43t](#)
- **Office hours:** Tuesdays, 5:00 to 6:00 PM

Why are you taking this course?



vevox.app/491270692

Or open **vevox.app** and enter session ID
491270692

- **Pick all that apply**
- Anonymous. I cannot see who answered what.

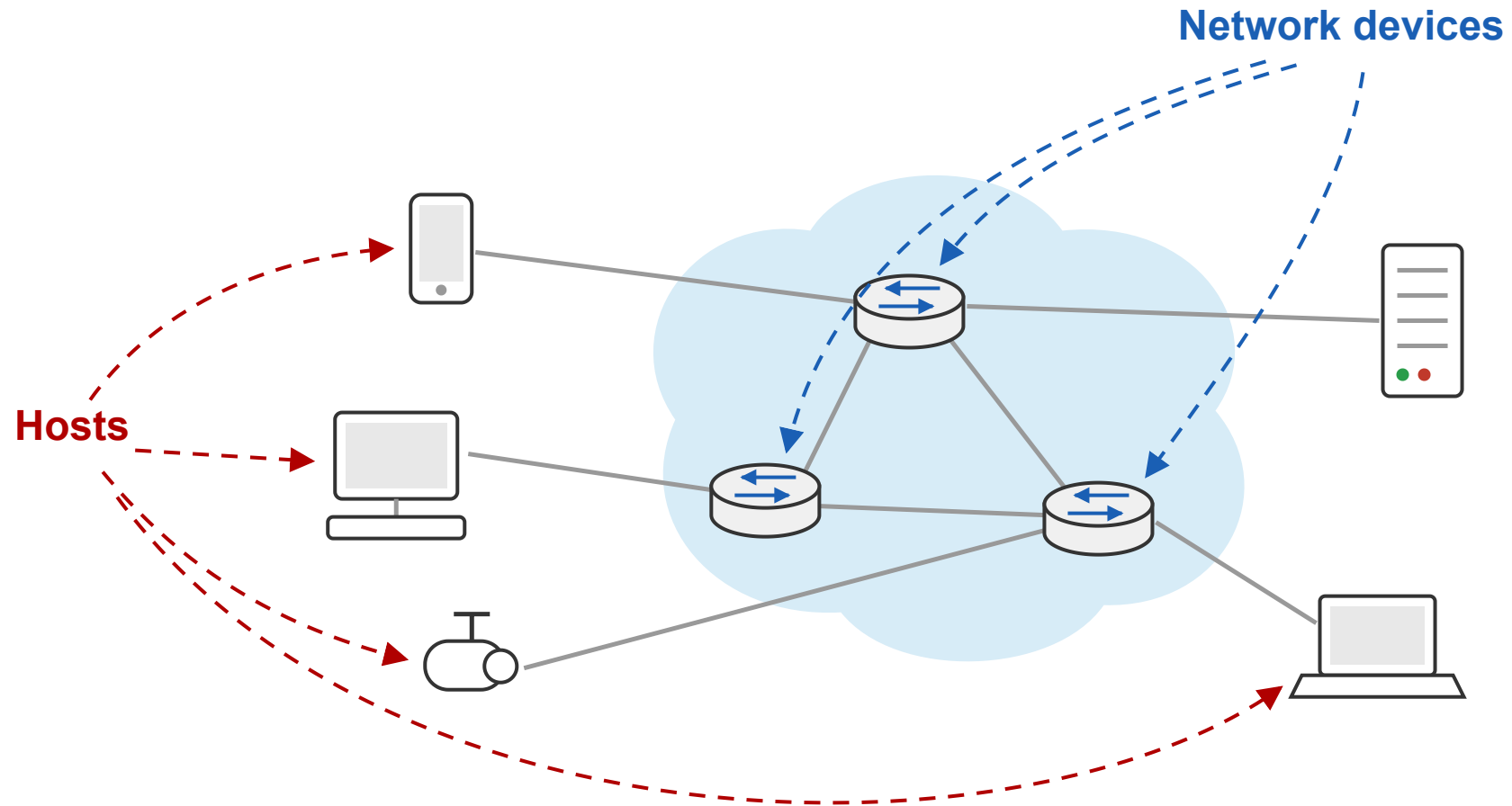
What you said

[live results]

We will come back to this.

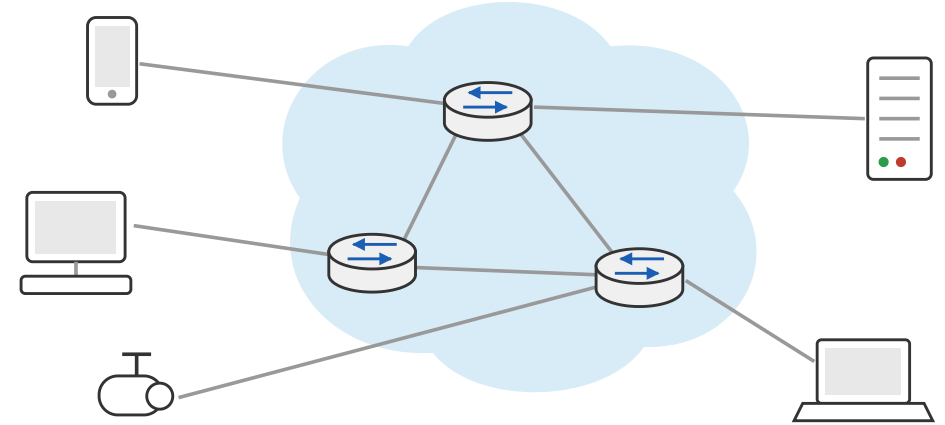
What is a computer network?

- A system that enables computers to exchange information



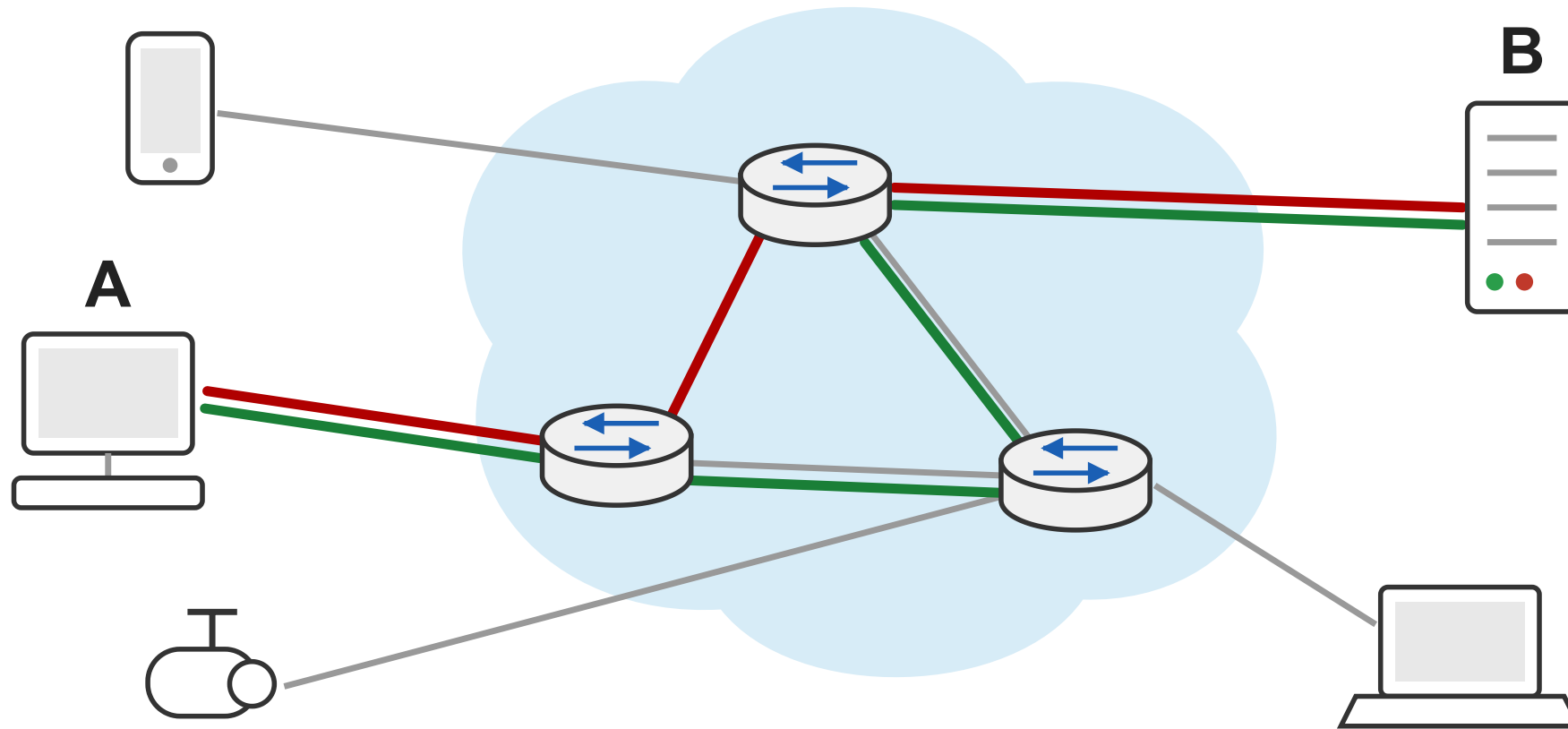
Where do you encounter computer networks?

- Everywhere!
 - Loading a webpage
 - Sending a message
 - Pushing to a repo
 - Tapping your bank/bus/train cards
 - Smart lights, locks, and thermostats
 - ...



Remember the Rogers outage in July 2022?

Designing, operating, and using networks is tricky



A wants a file from B. Which parts of this picture does A control?

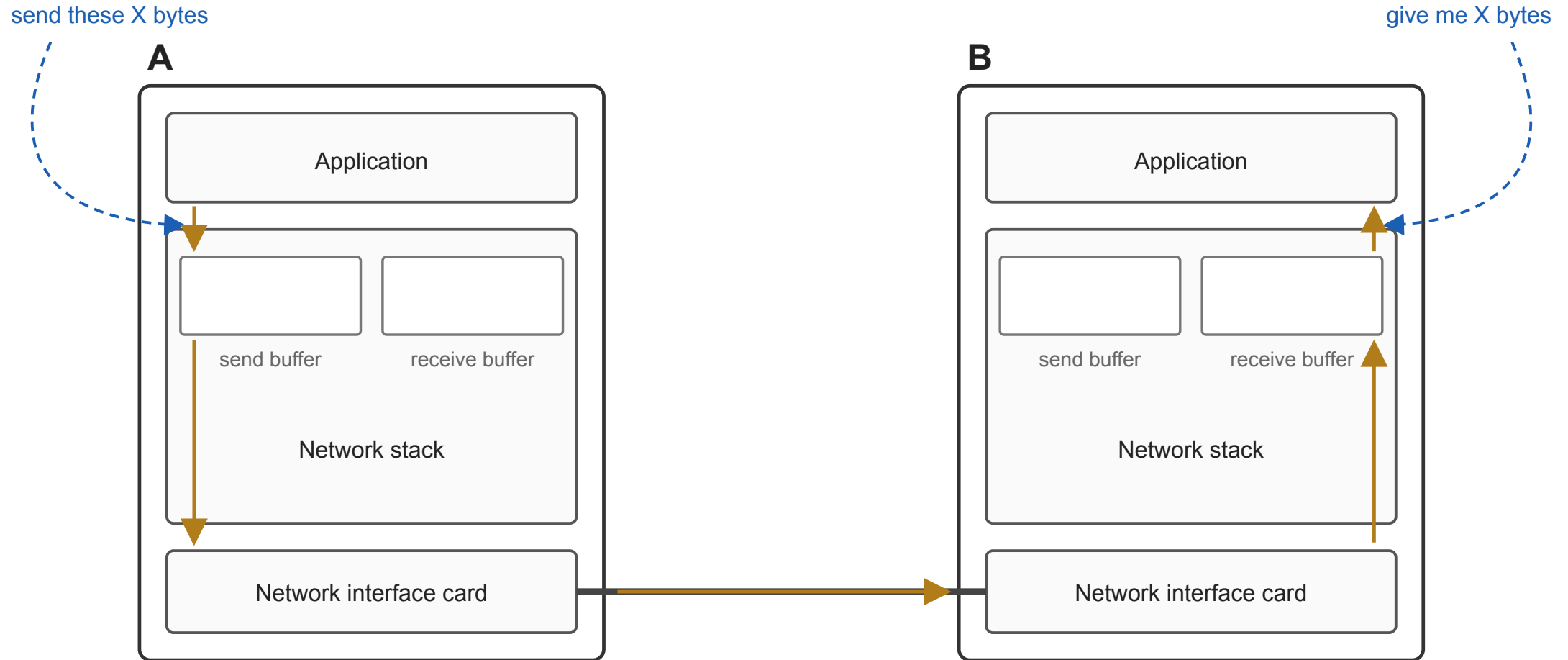
It is a distributed system

- Many independent machines, interacting only through messages
- Messages can be delayed, dropped, and re-ordered
- Machines and links between them can fail

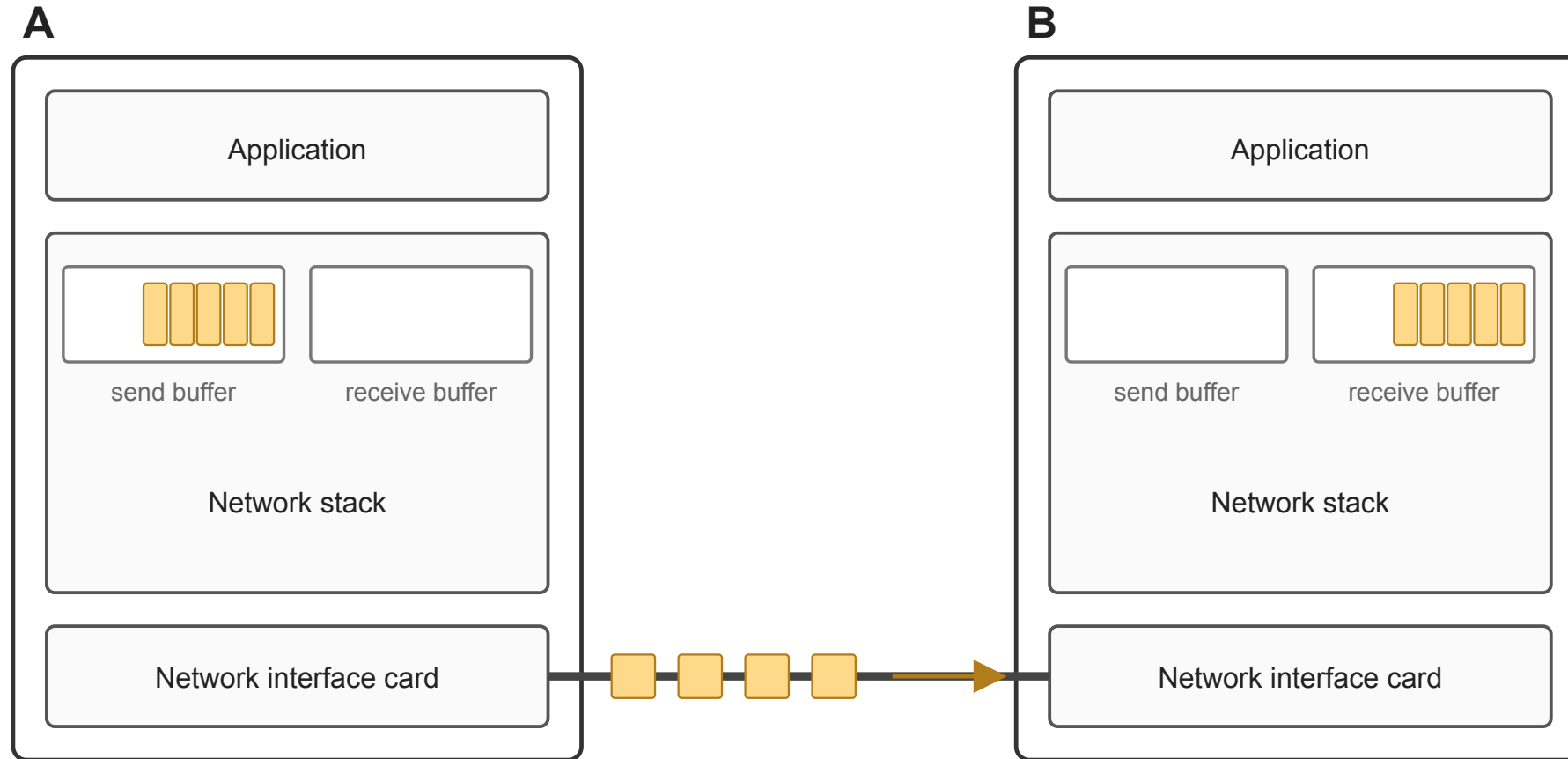
All the usual distributed systems problems: availability, handling failures, sharing one infrastructure to serve independent concurrent users, doing all of it efficiently.

**But, a special kind of distributed system
with unique challenges**

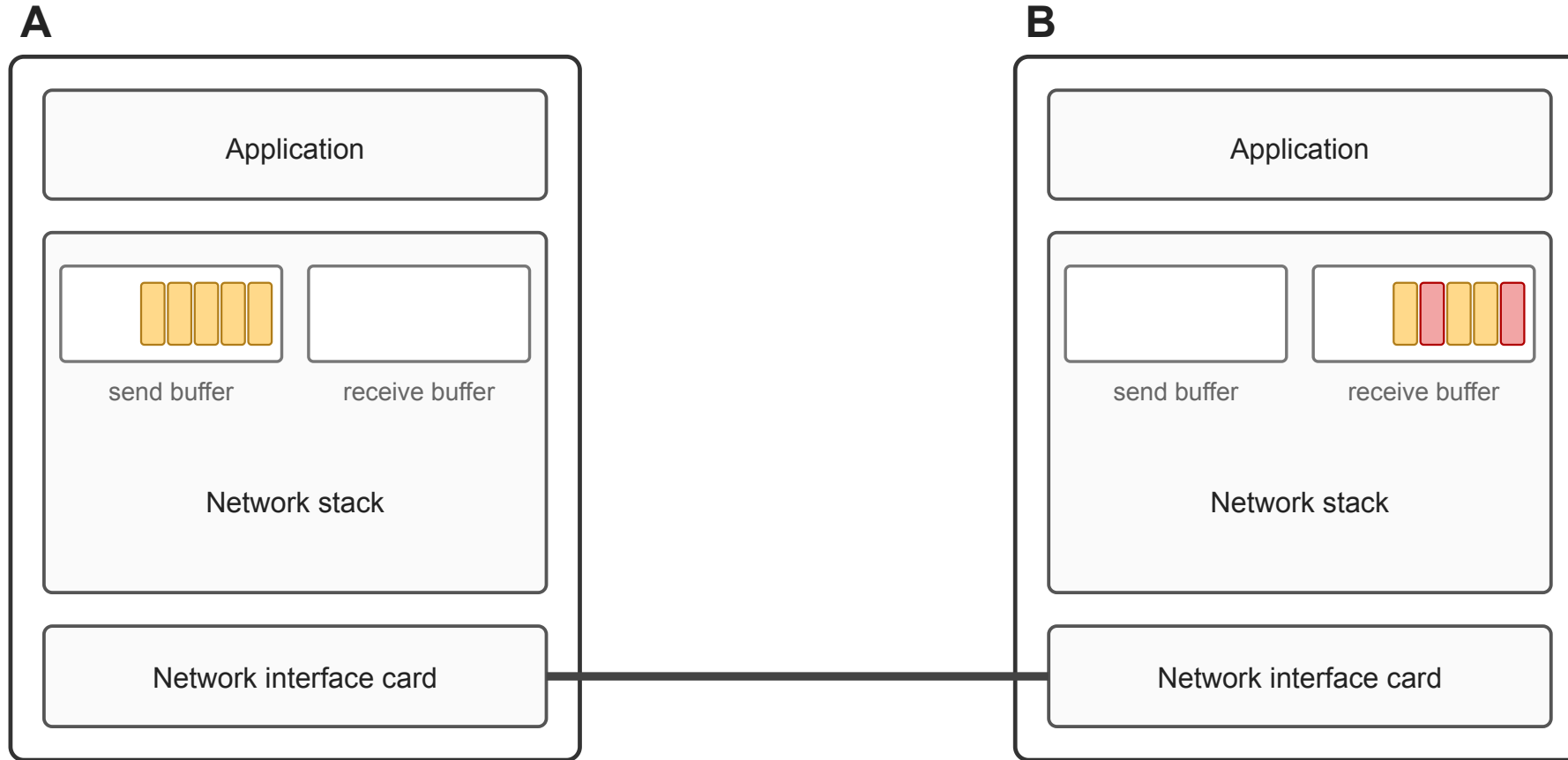
A wants to send data to B



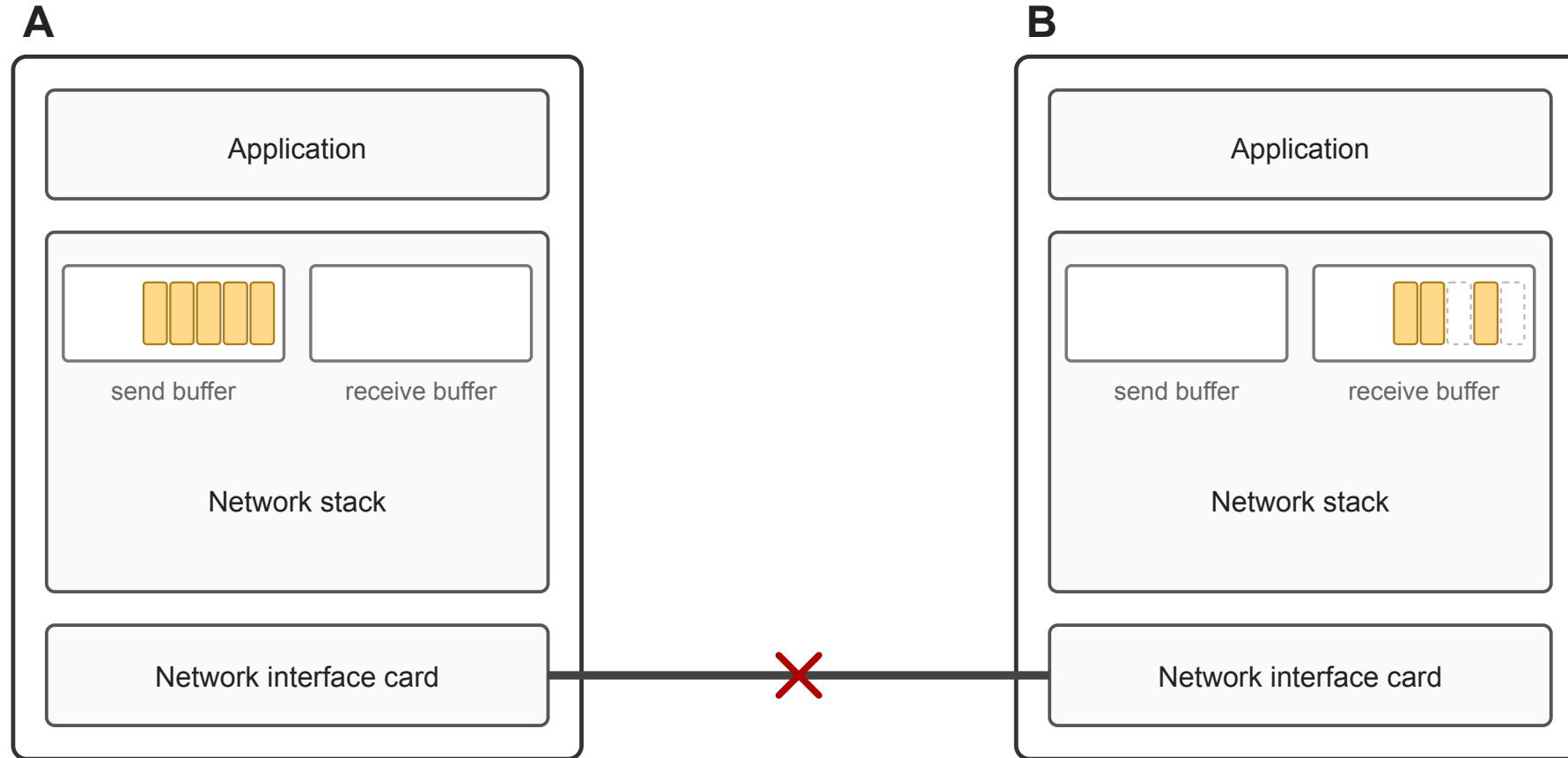
Data is transferred in packets



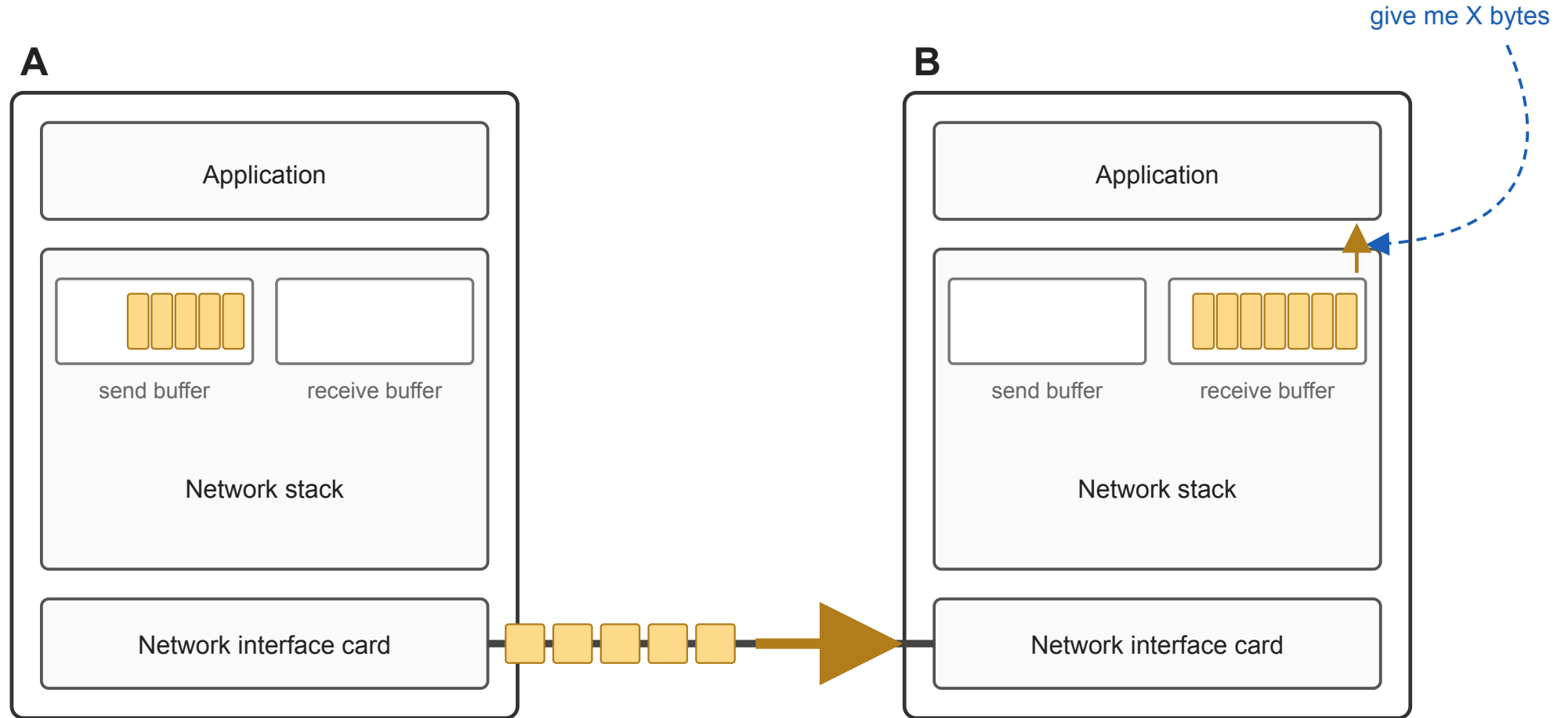
What if some bits arrive flipped?



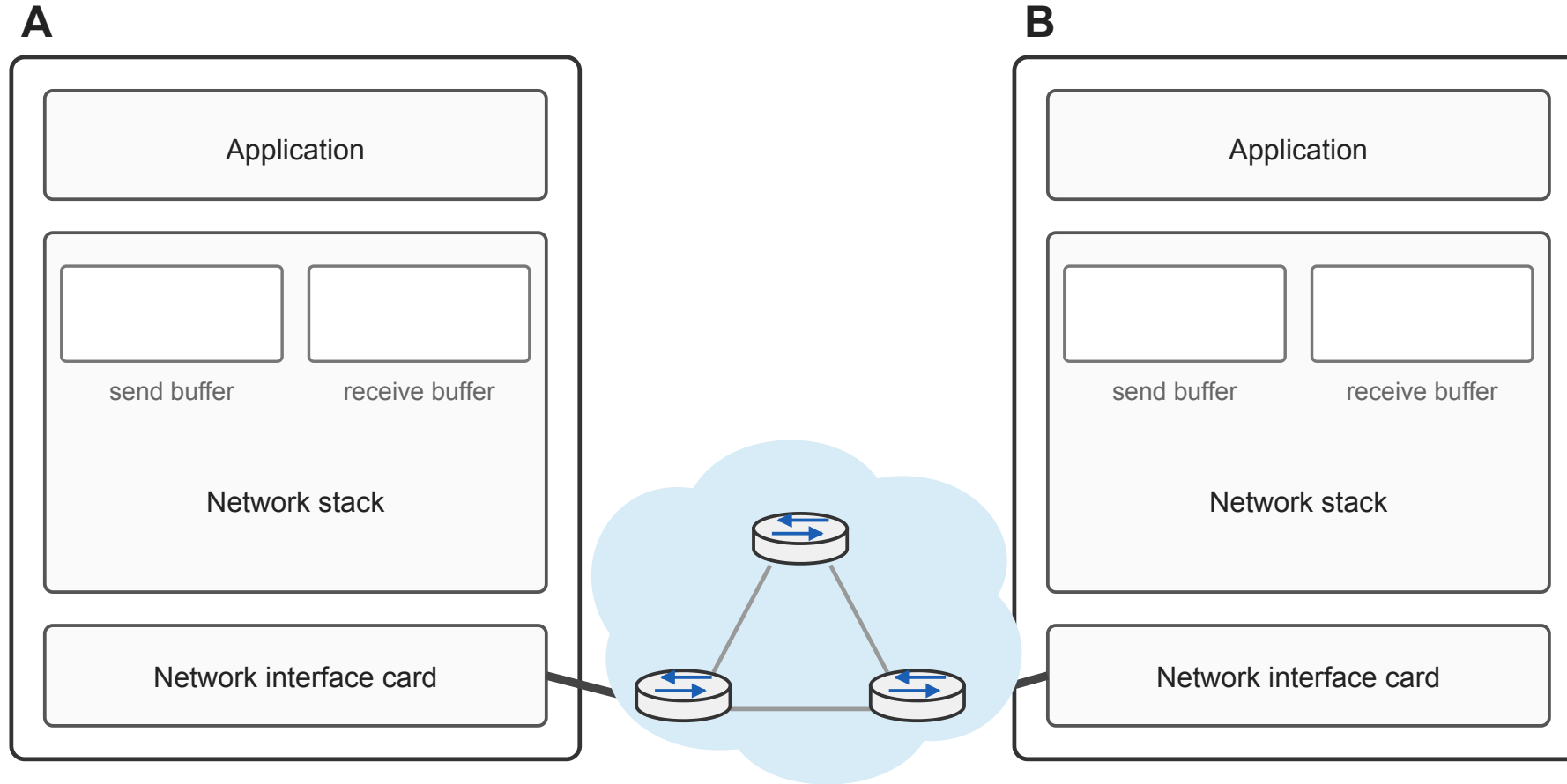
What if some of it never arrives?



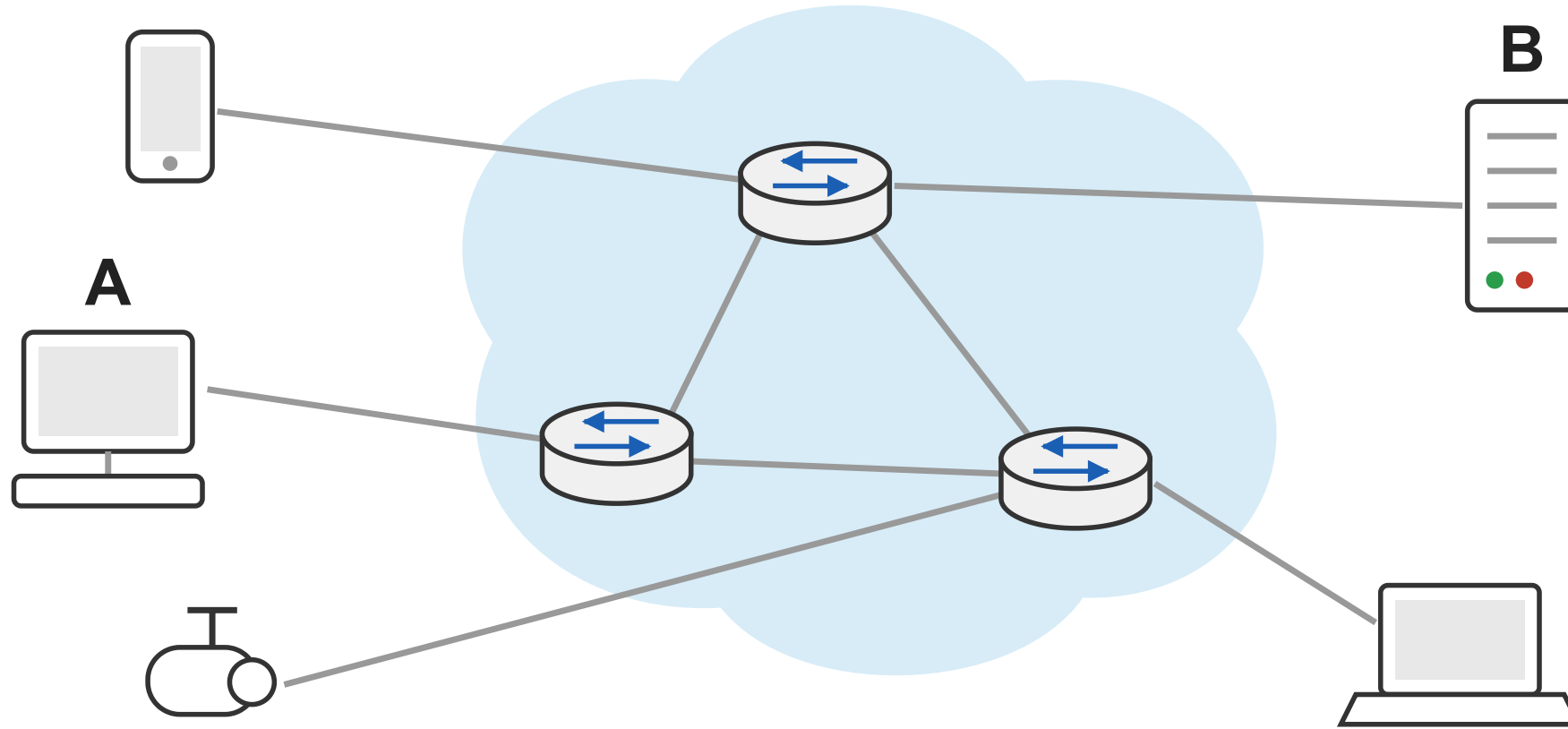
What if it arrives faster than B can take it?



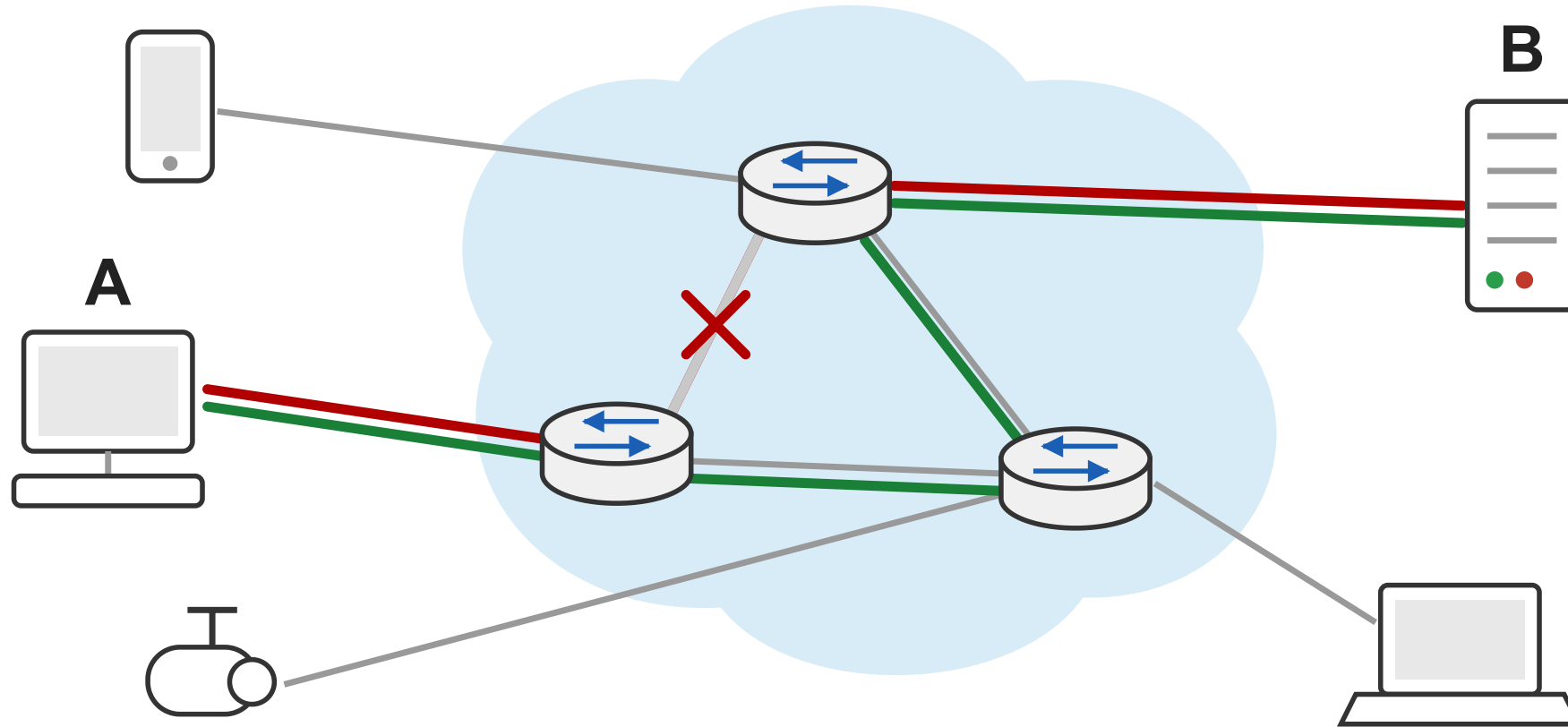
The link is actually a network



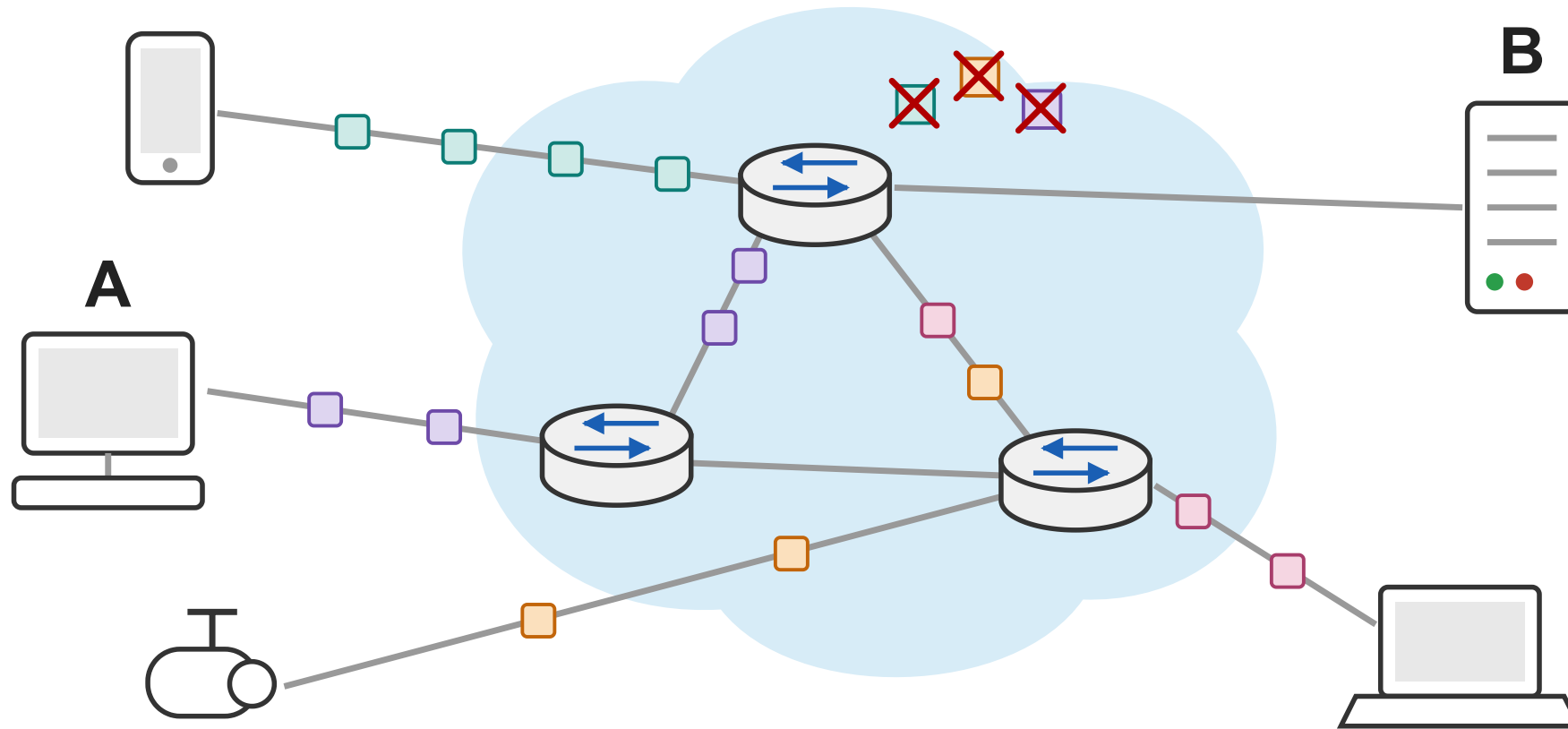
It is a shared infrastructure



Which way should the packets go?



What if everyone sends at once?



Now imagine this is the whole planet

- More than **20 billion** connected endpoints
- **Hundreds of thousands to millions** of network devices
 - Nobody has an exact count. We cannot see it all.
- About **79,000** organizations, each managing a piece of it

Networks in the wild

- **Datacenters and AI.** Many servers work together by exchanging data to respond to one request. The network is crucial in determining how fast that collective computation is done.
- **Wireless.** There is no cable. Everything in range shares the same medium, and how much you can send depends on interference and on distance.
- **Satellites in low orbit.** The network devices are on satellites that move, so which ones you can reach changes every few minutes.
- **Failures at scale.** With this many components, something is always broken. It is often hard to tell which component failed, and you cannot take the network offline to fix it.

**A special kind of distributed system with
unique challenges**

The answer to most of these is: it depends

This is a new syllabus

- CS 456 has usually been taught based on the book *Computer Networking: A Top-Down Approach*
- This term is built around the progression you just saw
- Slides, assignments and exams from previous terms will not necessarily line up with ours

Why I care about computer networks

- **It is broad.** Networking cuts across distributed systems and applications, operating systems, and lower-level infrastructure.
- **The problems are hard, and they are fun.** We talked about some of them, we'll talk about more.
- **It is not going away.** Computation keeps getting more distributed. Whatever gets built on top, something underneath still has to move the bytes reliably and efficiently.

Why you might care about computer networks

- **All the above?**
- **Also, you will build distributed systems and applications.** Almost every non-trivial system has a network in the middle.
 - Its availability and performance depend on
 - the properties of the network that carries its data
 - how it interacts with that network
 - ...
 - Learning about networks gives you the foundation to reason about it

Back to your reasons

[live results]

Course logistics: where to get what

- **Course webpage:** mina.arashloo.net/courses/CS456-F26
 - Outline, tentative schedule, slides, policies, references
- **UWaterloo outline:** outline and policies
- **LEARN:** announcements, slides, quizzes, assignments
- **Piazza:** piazza.com/uwaterloo.ca/fall2026/cs456cs656
 - Access code: [a9q9zyvy43t](#)

Course logistics: the teaching team

- **Instructor:** Mina Tahmasbi Arashloo
- **Teaching assistants**
 - Nesa Abbasimoghaddamniasar
 - Amaan Ahmed
 - Kimiya Mohammadtaheri
 - Muhammad Sulaiman
 - Mohammad Zangooei
- Email addresses are on the course webpage. Please use Piazza first.

Course logistics: lectures and office hours

- Lectures: Mondays and Wednesdays, 4:00 to 5:20 PM
- Instructor office hours: Tuesdays, 5:00 to 6:00 PM
 - September only, the new time goes on the webpage
 - For the lectures, and for computer networks in general
- TA office hours: time and location on LEARN
 - For the assignments

Course logistics: assessment

	CS 456	CS 656
Quizzes	10%	10%
Programming assignments	30%	15%
Project	n/a	15%
Midterm	25%	25%
Final	35%	35%

Course logistics: quizzes

- Posted on LEARN every week we have lectures, **Thursday at 8 PM**
- Due **Sunday at 11:59 PM**, unless stated otherwise
- **Quizzes start next week.** There is no quiz this week.
- Multiple choice, on the material covered in class that week
- **Unlimited attempts.** They are there to help you check your understanding, and to show me what needs more time in class.
- A missed quiz cannot be retaken, and a doctor's note is not accepted
- You can miss **two** without it affecting your grade

Course logistics: programming assignments

- **CS 456**: two assignments, 15% each
- **CS 656**: one of the two, 15%. The project takes the place of the other, and it is your choice which one you skip.
- Specifications posted on LEARN, submitted to the LEARN Dropbox
- Completed individually
- Assignment 1: released Monday October 5, due Tuesday October 27
- Assignment 2: released Friday November 6, due Thursday December 3

Course logistics: project, CS 656 only

- Worked on individually, based on a published networking paper
- Reproduce one of the paper's claims from the authors' artifact, evaluate the solution under settings the paper did not try, then report and analyze what you find
- A list of papers with working artifacts goes on LEARN
- No artifact? You can reimplement from the paper's description instead, with instructor approval
- The paper choice and the extension both need instructor approval

Course logistics: project deliverables

- **Paper choice**, Friday September 25
- **Baseline and extension proposal**, Monday October 19
- **Progress report**, Friday November 13
- **Final report and demo**, Monday December 7

The grade comes from the final report and the demo. The first three are not graded on quality, but missing one takes **3%** off your final grade.

Course logistics: late policy (does not apply to quizzes)

- **Four late days for the whole term**, for assignments and project deliverables
- Self-declared absences through Quest come out of the same four days
- No questions asked. They are for whatever comes up.
- When they run out there are no extensions
- Nothing can be submitted after **Monday December 7**, no matter how many are left. University policy.

Course logistics: how late days are counted

- Counted **daily, not hourly**, rounded up, from the LEARN records
 - One hour late costs one day
 - One day and 20 hours late costs two days
- The four days are for the whole term, not per assignment
 - If you use two on assignment 1, you have two left for everything else
- If you submit late with no days left, you get no points for that assignment

Course logistics: exams

- **Midterm:** Tuesday November 3, 7:00 to 8:50 PM
- **Final:** date, time and location from the Registrar's Office
- Based only on what we cover in class
- Closed book, apart from a limited set of notes you can bring in
- Midterm and final have to be passed in the aggregate to pass the course
 - $(\text{Midterm} \times 25 + \text{Final} \times 35) / 60 \geq 50\%$
- If you miss the midterm with a filed short-term absence, its weight moves to the final, and you need at least 50% on the final to pass

Course logistics: asking questions

- Post on **Piazza** rather than emailing the teaching team
- Check the outline, the assignment FAQs, and Piazza first. We may not be able to answer duplicates.
- Allow **up to two business days** for a reply, and plan around that
- We may not get to last-minute questions right before a deadline

Course logistics: attendance and readings

- Attendance is not mandatory, but I would encourage you to come
- The slides are teaching aids, not lecture notes. They do not have everything we discuss.
- Optional books, papers, blog posts and platforms are listed on the course webpage, and I will add to that list through the term

Course logistics: generative AI

- **Use AI responsibly**
 - What does that mean?
- You are accountable for the content and accuracy of everything you submit, including anything a generative model helped with
- Pointers to the university guidelines are on the course webpage

Also in the outline

- Mental health support, on and off campus
- AccessAbility Services and academic accommodations
- Academic integrity, grievances, discipline, and appeals
- ...

Final remarks

- Eighty minutes of one-way conversation is no fun for either of us
- **There are no wrong questions here.** If something does not make sense, say so. Someone else is almost certainly stuck on the same thing.
- Ask in class, on Piazza, or in office hours
- Computer networks hold up most of what you do every day, and I am looking forward to going through how they work with you this term.