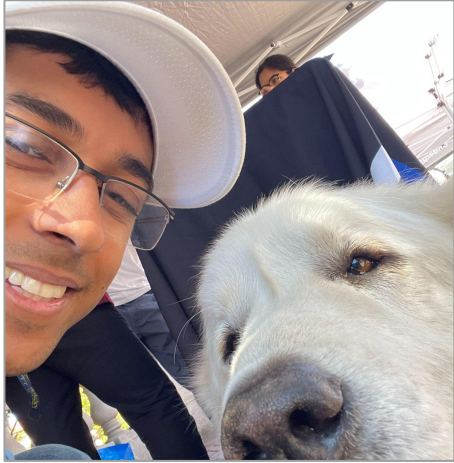# CS168: Discussion 1

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Intro to the Internet I
Fall 2024

Agenda

- Introductions
- Terms
- Poking the Internet
- Intro to Project Traceroute

Light discussion today

About Me - Arjun (He/Him)

I'm a 4th year undergrad student studying CS and Applied Mathematics

I'm from LA (lowkey actually from Simi Valley which is a lot less interesting), and like climbing, photography, sleeping, yapping, and walking doggs.

Disclaimer: I have NOT taken this class

My office hours (Soda 411), VERY subject to change:
- Fri: 2-4 PM
- Tu: 4-5 PM

My email: arjundamerla@berkeley.edu (Edstem is faster)

About Me - Anita (She/Her)

I'm a 4th year undergrad student studying CS.

I'm from the East Bay. I like snowboarding, playing the guitar, and CTFs.

My office hours: Monday 2-5 pm @ Soda 411
My email: anitading556@berkeley.edu (Edstem is faster though)

About Me - Ian

I'm a 4th year undergrad student studying CS and DS.

I'm from the East Bay. I like playing basketball, tennis, and exploring new restaurants

My office hours: Tuesday 2-5 pm @ Soda 411
My email: ihdong@berkeley.edu
(Edstem is faster though)

About Me - Jaewon (He/Him)

I'm a 4th year undergrad student studying EECS and ORMS.

I'm from South Bay. I like playing tennis, hiking, and urban exploration!

My office hours (Soda 411):
- Mon, Wed, Fri: 2-3 PM
- Tu, Th: 1-3 PM

My email: jaewon.lee@berkeley.edu (please include "[CS 168]" in the header; Edstem is faster though)

Deadlines

Project 1A: Basic Traceroute
- Deadline: Tuesday 09/10

Project 1B: Traceroute Error Handling (there are a few hard tests)
- Deadline: Friday 09/20

Additional Information
- File to modify: traceroute.py
- Grade: 15%
- One partner allowed

Terms

Terms

- **Routers/Switches:** Devices that forward packets arriving on one link to another link. We make no distinction between routers/switches at this point

- **End-host:** a device attached to the network that sends or receives packets.
 - Examples: mobile phone, laptop, security camera, smart fridge
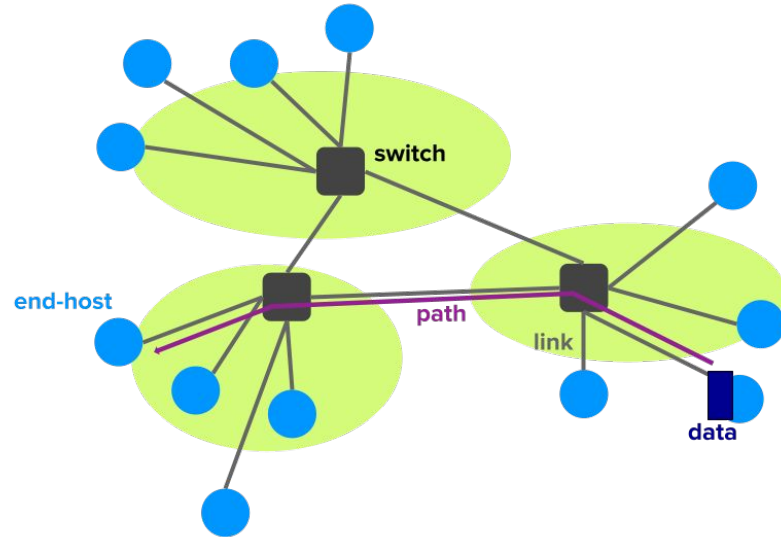
Terms

- **Packets:** A Bags of bits with a
  - *Header*-- info for network and network stack to make decisions
  - *Body*-- contains a payload. Ex. A file, image, an application header
    - The network doesn't really care about what's in the payload.

"Go Bears"

Body	Header
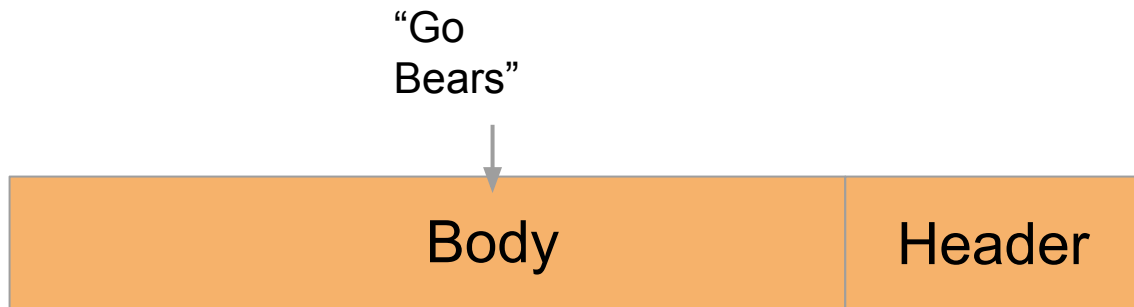
Terms

- **Naming:**
  - Network name: which host it is
  - Network address: where host is located
  - When you move a server to a new building, its name does not change but its address does

Name: mywebsite.com
Addr: 142.250.72.206

Name:
**mywebsite.com**
Addr: 208.117.236.69
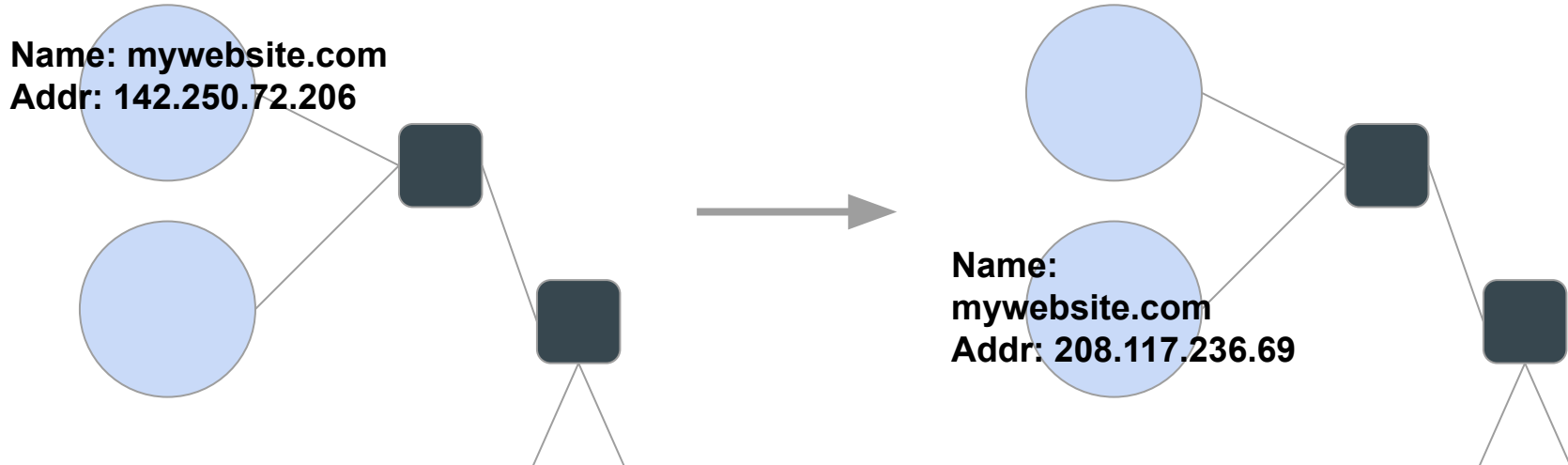
Terms

- **Network "Stack":** Networking Software on host.
  - Replicates some router/switch functionality and adds some additional functionality before passing the body of packets to the application
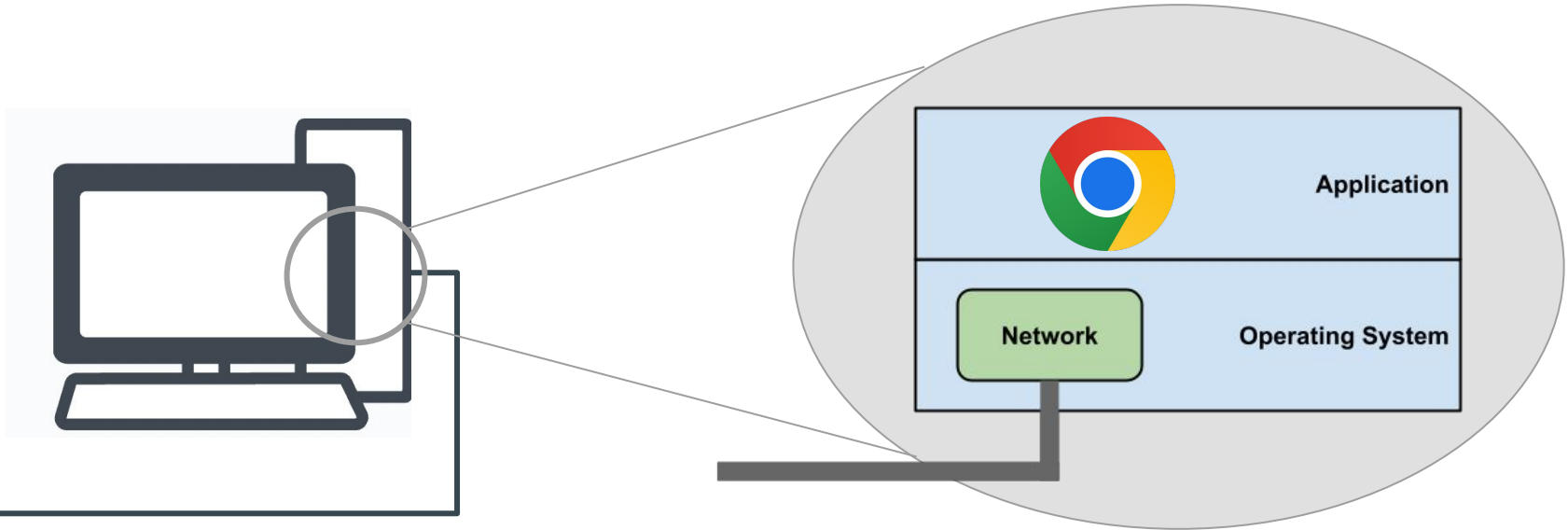
Terms (cont'd)

- **ISP (Internet Service Provider):** A network of packet switches and links that provide network access (i.e. Comcast, ATT, Sonic)
- **ASes (Autonomous Systems):** Groups of routers under the same control
  - Usually each ISP has one AS, but may have multiple ASes
  - Routers within the same AS will have information about each other
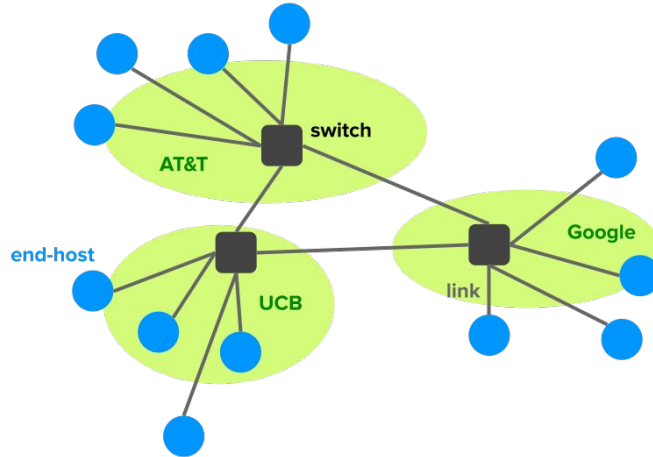
Poking the Internet

Ping, Traceroute

- Internet is large and complex. Network engineers and researchers have built some handy tools to get some insight into what is going on inside and across the internet.
- We're going to play around with them a little bit

Think of this as a "tinker discussion" - you aren't expected to know any of these concepts yet. We'll learn about them throughout the semester.

Ping, Traceroute

- Simple utility that lets you "poke" a website and see if it moves (spoiler: most do!)
- You say hi and see if the server says hi back
  - This by itself is not super interesting
- Ping also tells you <u>how long</u> the reply took to come back
  - This is more interesting!
- Let's try out a few websites.

Ping, Traceroute

```
ping berkeley.edu -c 3
PING berkeley.edu (141.193.213.21): 56 data bytes
64 bytes from 141.193.213.21: icmp_seq=0 ttl=50 time=14.142 ms
64 bytes from 141.193.213.21: icmp_seq=1 ttl=50 time=20.024 ms
64 bytes from 141.193.213.21: icmp_seq=2 ttl=50 time=17.540 ms

--- berkeley.edu ping statistics ---
3 packets transmitted, 3 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 14.142/17.235/20.024/2.411 ms

ping csail.mit.edu -c 3
PING csail.mit.edu (128.52.132.19): 56 data bytes
64 bytes from 128.52.132.19: icmp_seq=0 ttl=32 time=108.253 ms
64 bytes from 128.52.132.19: icmp_seq=1 ttl=32 time=109.574 ms
64 bytes from 128.52.132.19: icmp_seq=2 ttl=32 time=98.613 ms

--- csail.mit.edu ping statistics ---
3 packets transmitted, 3 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 98.613/105.480/109.574/4.886 ms
```

Ping: A prediction

- We've pinged a couple websites and seen pretty significant differences in *latency*.
  - **Latency** is the time between when a request is sent and when the response is heard.
- What about differences in latency for the same website, but in different regions?
- We've pinged google.com and seen its latency.
  - How many times longer will it take for a ping to google.co.uk to come back?

Ping, **Traceroute**

- Tool to *trace* the *route* that packets take from your computer to the destination.
  - Specifically lets you see the routers/switches that are forwarding your packets.
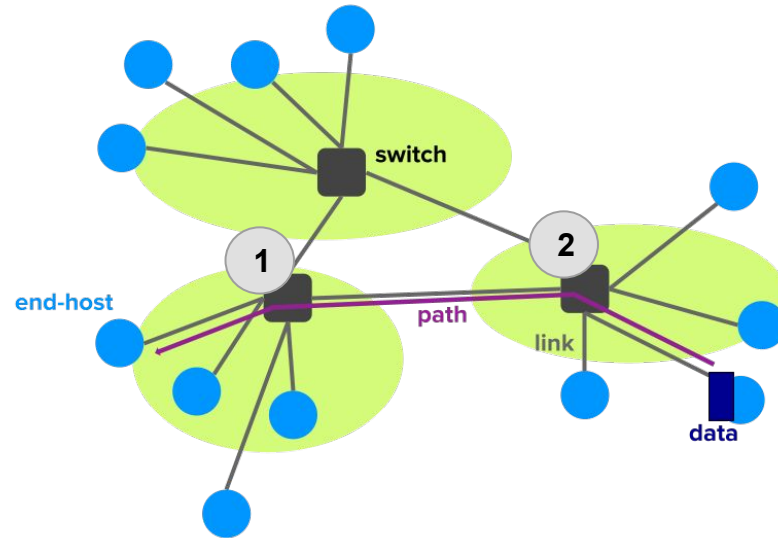
```
traceroute berkeley.edu
traceroute: Warning: berkeley.edu has multiple addresses; using 141.193.213.20
traceroute to berkeley.edu (141.193.213.20), 64 hops max, 40 byte packets
 1  sut-mdc-sr9--ae0-558.net.berkeley.edu (10.40.232.2)  6.154 ms  10.428 ms  7.135 ms
 2  sut-mdc-cr1--xe-2-1-13.net.berkeley.edu (128.32.255.96)  16.284 ms  19.354 ms  7.312 ms
 3  reccev-cev-cr2--et-0-2-8.net.berkeley.edu (128.32.255.177)  5.652 ms
       sut-mdc-cr2--et-0-2-8.net.berkeley.edu (128.32.255.41)  10.454 ms *
 4  * * *
 5  * sut-mdc-fw9--xe-0-0-1-3.net.berkeley.edu (128.32.255.143)  6.366 ms  5.512 ms
 6  reccev-cev-sr1--xe-0-1-1-0-2.net.berkeley.edu (128.32.255.140)  5.309 ms  4.949 ms  5.388 ms
 7  reccev-cev-sr1--lt-0-1-0-0.net.berkeley.edu (128.32.255.166)  4.160 ms  5.037 ms  4.338 ms
 8  reccev-cev-cr2--et-0-0-0-3.net.berkeley.edu (128.32.255.74)  5.742 ms  9.072 ms  7.551 ms
 9  sut-mdc-cr1--et-0-1-0.net.berkeley.edu (128.32.255.40)  7.412 ms
       sut-mdc-cr1--et-0-1-5.net.berkeley.edu (128.32.255.176)  5.063 ms
       reccev-cev-cr1--et-0-1-0.net.berkeley.edu (128.32.255.174)  6.135 ms
10  reccev-cev-br1--et-1-1-1.net.berkeley.edu (128.32.0.38)  4.994 ms  5.771 ms
       reccev-cev-br1--et-1-1-0.net.berkeley.edu (128.32.0.36)  5.349 ms
11  emvl1-agg-01--ucb--100g.cenic.net (137.164.3.26)  9.055 ms  5.400 ms  5.872 ms
12  svl-agg10--emvl1-agg-01--400g--01.cenic.net (137.164.11.94)  9.312 ms  9.272 ms  8.780 ms
13  198.32.251.193 (198.32.251.193)  18.352 ms *  33.886 ms
14  172.68.188.80 (172.68.188.80)  10.743 ms
       172.68.188.94 (172.68.188.94)  10.407 ms
       172.68.188.80 (172.68.188.80)  26.217 ms
15  141.193.213.20 (141.193.213.20)  8.597 ms  9.852 ms  8.677 ms
```

Traceroute: Notice anything?

- Traceroute gives us a lot more interesting feedback than ping.
  - Latency to *every* step along the way.
    - Can see a breakdown of latencies!
  - Router names.
    - Often have locations in them (i.e. city name)
    - Can roughly trace packet path on a map!
  - Weird stars
    - Some routers just don't respond ¯_(ツ)_/¯

Traceroute

- Traceroute gives you the path of routers and switches your packets take.
- How?
  - Takes advantage of something called a **TTL** in the packet IP header.
  - TTL denotes how many times a packet should be forwarded before it is discarded.
    - Why does this exist?
      - To stop the internet from collapsing! (We'll cover this when we get to routing)
  - Sets the TTL to 1, 2, 3, etc
  - When packets are dropped because of TTL expiring, most routers send back a message telling us.
  - Use the source of this notification to identify the routers along the packet's path.

Visualizing Traceroute
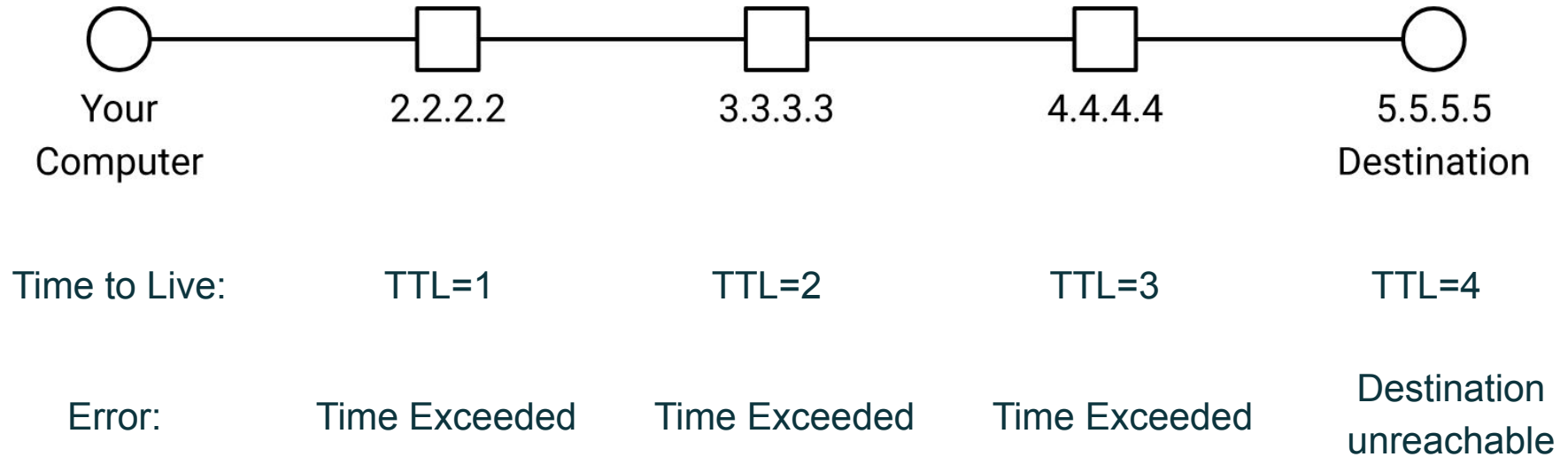
Traceroute

How many bytes are the headers for IP, ICMP, and UDP packets?

What are the fields in each protocol header?

What ICMP error messages are relevant to traceroute?

Hint 1: What's included in the ICMP response packets?

Hint 2: Check out some of the professional traceroute implementations.

Hint 3: Implement logging in your code to track the receipt and handling of each packet.

Questions?

Feedback Form:
https://tinyurl.com/cs168-disc-fa24