Lecture 3: Naming

CS 356: Introduction to Computer Networks

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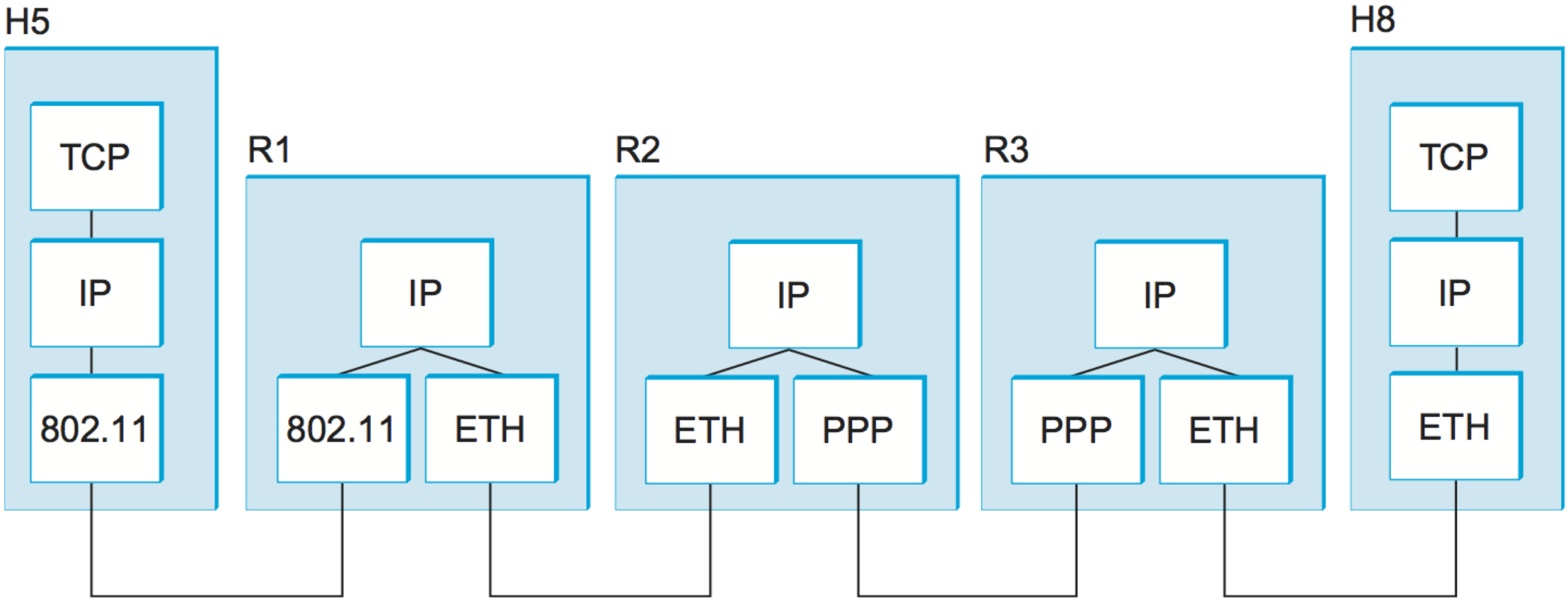
P&D Chapter 3.3

Borrows some images from “Computer Networks: A Systems Approach” by Peterson and Davie

Recap: Layers



Recap: Sockets

- Server listens on a given IP address and port. The port number is usually standardized (e.g. 80 for HTTP)
  - For example, it could pick 93.184.215.14:80 (format is IP:port), which was the address for example.com when I looked it up
- Client picks a random source port. The source IP is simply the IP address of the interface it uses to send the packet from.
  - Suppose it picks 128.62.124.2:3168 (address from my office)
  - The first packet is {source: 128.62.124.3:3168, dest: 93.184.215.14:80, protocol: TCP}.
  - The same fields are used for every packet sent by the client to this server on this connection.
- Upon receiving this packet, the server creates a new socket identified by the fields in the packet listed above.
  - When the server sends a packet to this client on this socket, it uses the following fields: {source: 93.184.215.14:80, dest: 128.62.124.3:3168, protocol: TCP}
- This way a server can have multiple sockets to communicate with multiple clients. In fact, it can have multiple sockets to talk to the same client if the client picks a different source port for each.

Today’s topic: naming

- A name can have two qualities
  - A: Fixed length, hierarchical name that is easy for machines to process
  - B: Names with words that humans can easily read and remember

- The internet has three types of names
  - Ethernet addresses: neither A nor B
  - IP addresses: only A
  - Domains names: only B + a little bit of A

Ethernet Addresses

- Completely “flat” 48-bit number

- For example: 00:40:05:1c:0e:9f
  - Q: What is your machine’s ethernet address? Assignment 1 will lead you to it
  - Set by manufacturer, which means it is great for uniqueness. Each manufacturer is given a 24-bit prefix. They assign the rest at their discretion
  - Useless for global routing: every router will have to remember exactly where every other machine is in the world
    - Q: is this infeasible with modern hardware?

- Useful when first connecting to a network, and within a local network

IP Addresses (P&D 3.3.3)

- 32-bit address. For example: 93.184.215.14
  - Each number is between 0-255 and represents 8-bits
  - Q. How many addresses can you have? Is this enough?
  - No. Sometimes, you will see larger 128-bit addresses. This is called an IPv6 address.
  - Example: *2001:0db8:85a3:0000:0000:8a2e:0370:7334*

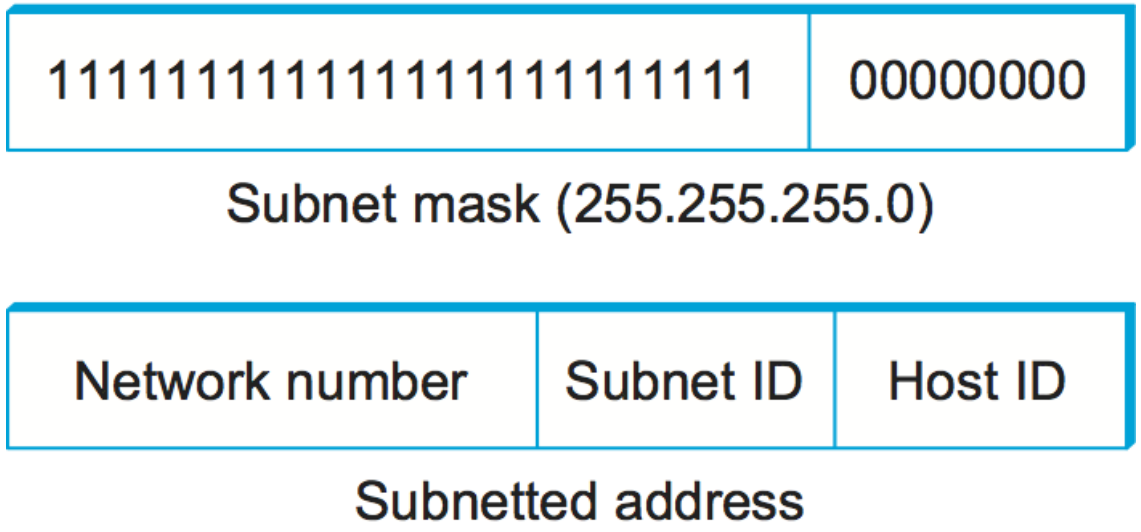
- Allows for hierarchical addressing. Each **subnetwork** has a prefix. It can assign internally per its discretion (often by creating smaller subnetworks)

Hierarchical addressing in IP

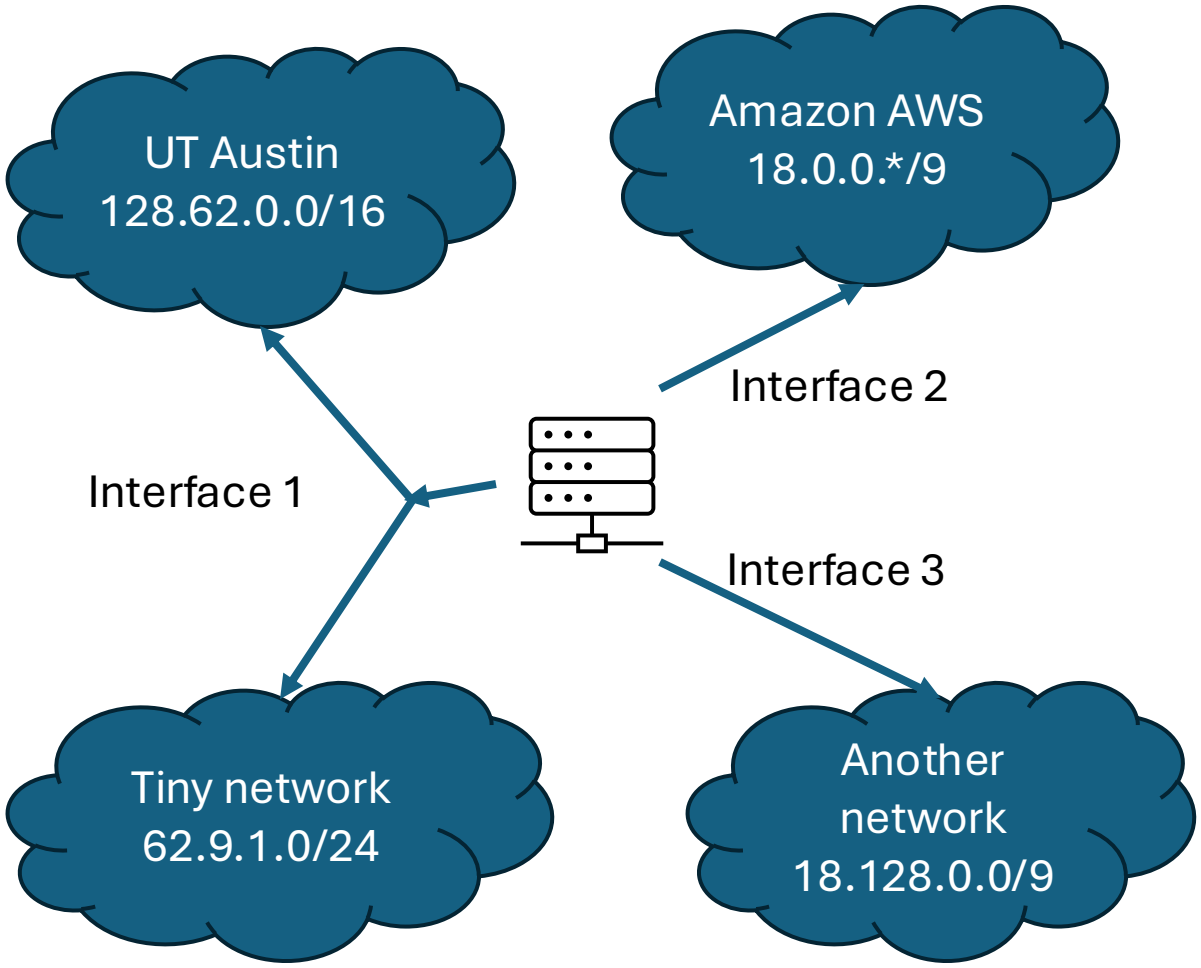
- For example, UT could be given a prefix: 128.62.*.*
- All computers on campus will then be given addresses that begin with 128.62
- Routers outside UT only need to know how to forward things that begin with 128.62.*.* Everything else is internal business
- This prefix could be a part of a larger prefix from UT's ISP. It is likely subdivided further
- We will discuss how these tables are generated later

128.63.*.* is sometimes represented as 128.63.0.0/16

This means only the first 16 bits should be considered when making a routing decision



Hierarchical addressing in IP



Example of a CIDR routing table

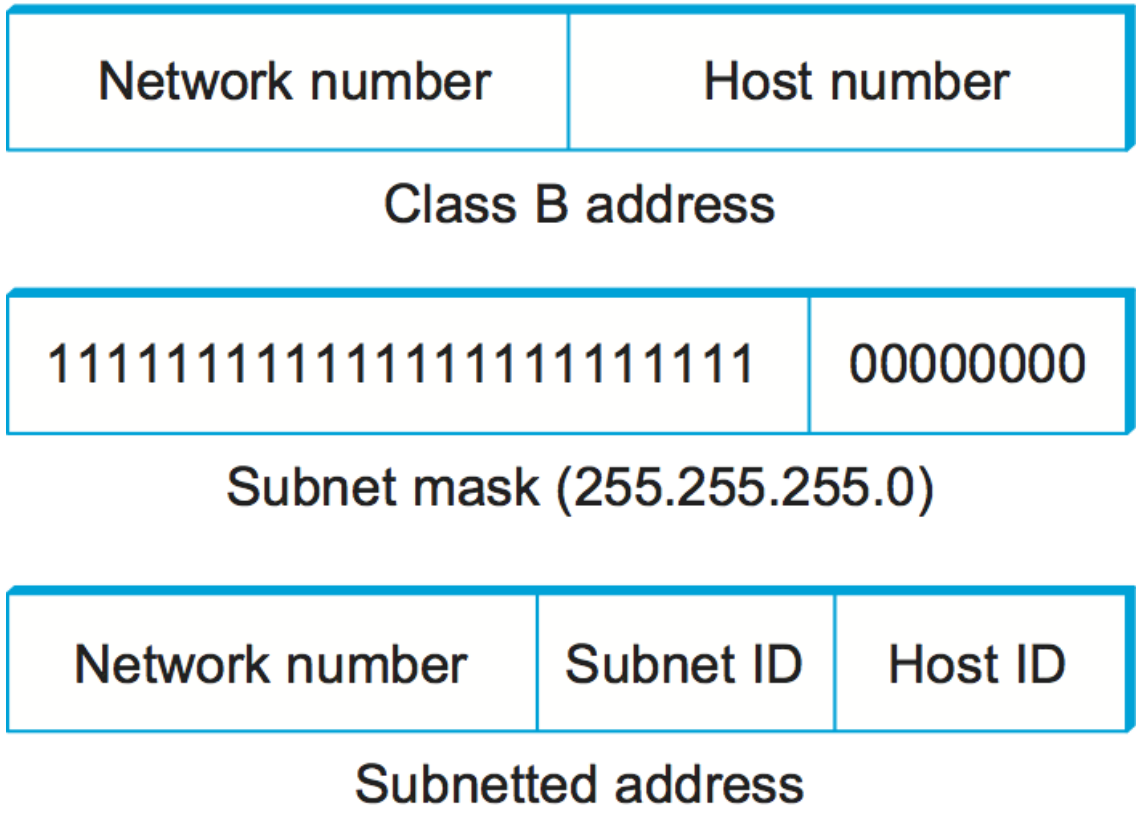
(Book discusses the history of how we got to CIDR)

IP Address	Mask	Next Hop
128.62.0.0/16	255.255.0.0	Interface 1
18.0.0.0/9	255.128.0.0	Interface 2
18.128.0.0/9	255.128.0.0	Interface 3
162.9.1.0/24	255.255.255.0	Interface 1

Hierarchical addressing in IP

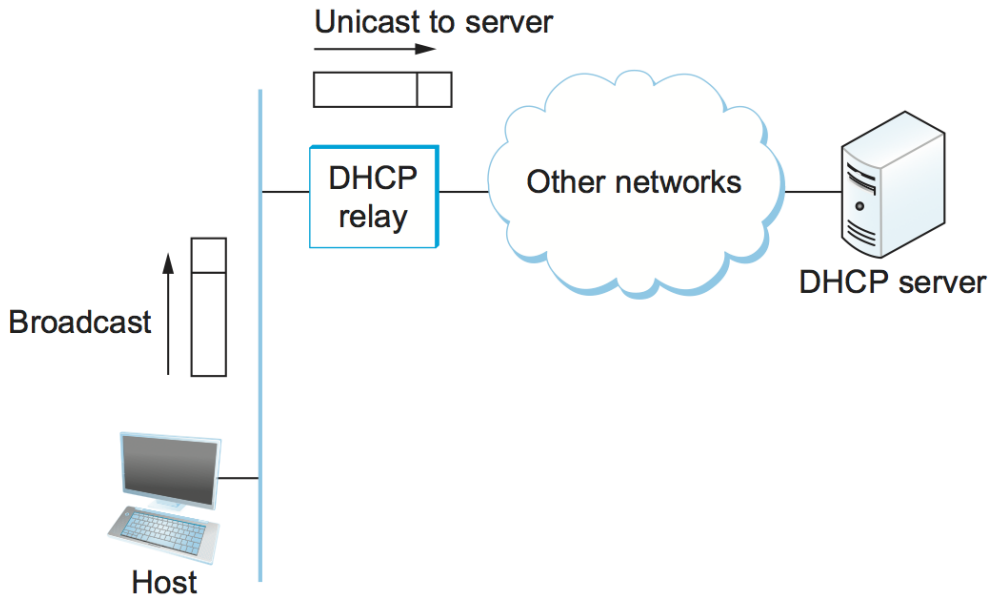
Historical naming convention

- Class A: First 8 bits are important (largest class with 2^24 Addresses)
- Class B: First 16 bits are important (2^16 addresses)
- Class C: First 8 bits are important (only 2^8 addresses)



DHCP: How do I get my IP address? (P&D 3.3.7)

- New host: “Hello *everyone*, my ethernet address is 00:40:05:1c:0e:9f. Can someone give me an IP address please?”
- DHCP server (to everyone): “Hello 00:40:05:1c:0e:9f, use this one: 182.16.2.14”
- New host: “Ok”
- DHCP server: “Ok”



- The DHCP server has a block of addresses from which it allocates. It is managed by the network operator
- This is sent over UDP to a special broadcast IP address (255.255.255.255) and DHCP port 68/67

ARP: Routing within the local network (P&D 3.3.6)

- New host: “Hello everyone, I’m 00:40:05:1c:0e:9f and my IP address is 182.16.2.14”

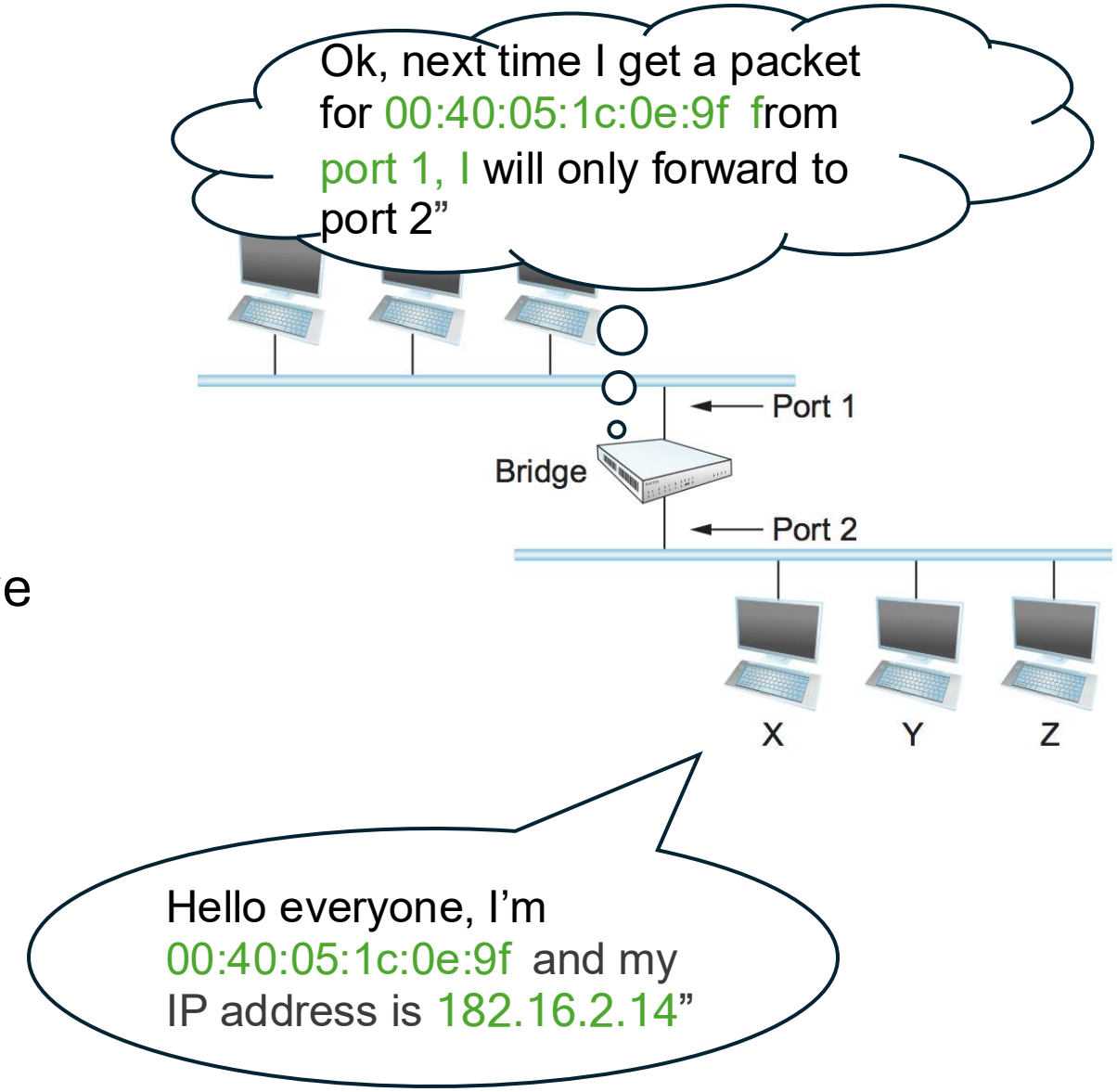
OR

- Existing host: “I got a message for 182.16.2.14. Who is it?”

- Host: “It’s me! I’m 00:40:05:1c:0e:9f”

ARP: Routing within the local network (P&D 3.3.6)

- Originally, ethernet was a broadcast medium
- Bridge can cut the chatter a little
- Can you spot a problem with this approach? We will discuss how to solve it in the next class
- Does not scale to the entire internet because everybody would have to remember where everyone is. Remember, this is why we invented hierarchical addressing



DNS: Global, human readable, names

- You pay money to buy a domain name like “google.com” or “chess.com”
- This lets you to get the Domain Name System (DNS) to respond with an IP address of *your choice* whenever someone asks for that domain name
- When a client wants to connect to “google.com”, they ask for an IP address. DNS returns with an IP address picked by google (usually, to a server close to you). Client connects to IP address for the rest of the business
- Assignment 1 asks you to make this query using the tool “nslookup”
- We will discuss more details later

How do I connect to DNS

- IP address of the DNS server is configured either manually or by DHCP
- 8.8.8.8 and 8.8.4.4 are addresses managed by Google. Anyone can use it for “free”
- You can send a packet to the DNS IP address asking “what is the IP address of example.com?” It will send a packet back saying “example.com is 23.192.228.80”

Up Next: Routing

Problem: Switches get packets with destination addresses. Somehow, they need to know which port to forward it to

- How do they figure it out?
- How do they do it in a self-organizing manner?
- How well can they adapt to changes (new links are made, existing links fail, new machines are added etc)?
- How do we manage economic and policy-based decisions?