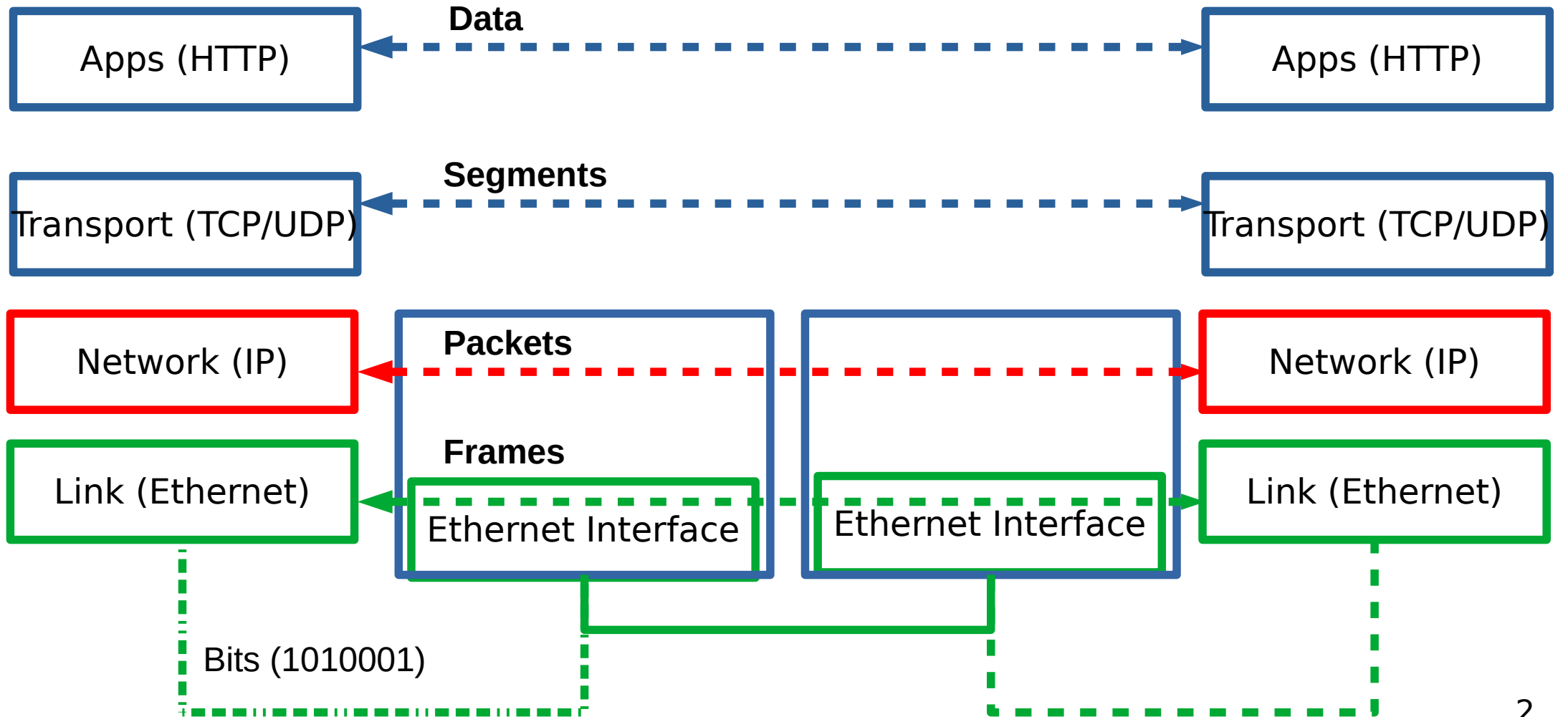


CSC4200/5200 – COMPUTER NETWORKING

Instructor: Susmit Shannigrahi
ARP AND DHCP

sshannigrahi@tntech.edu

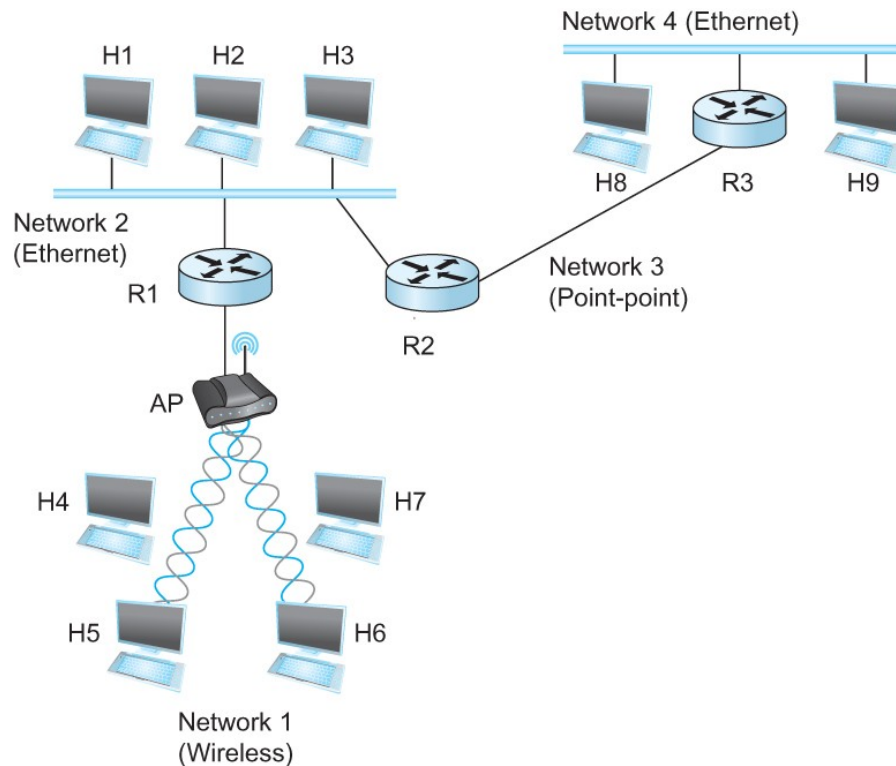


So far...

- We now know how to address hosts and networks!
- Subnetting for scale

Internetworking Protocol (IP)

- What is an internetwork?
 - An arbitrary collection of networks
 - provide some sort of host-host to packet delivery service



Global Address in IP – Each node has an unique address

- A 32 bit number in quad-dot notation
- Identifies an **Interface**
 - **A host might have several interfaces!!!**

- **129.82.138.254**

10000001.01010010.10001010.11111111



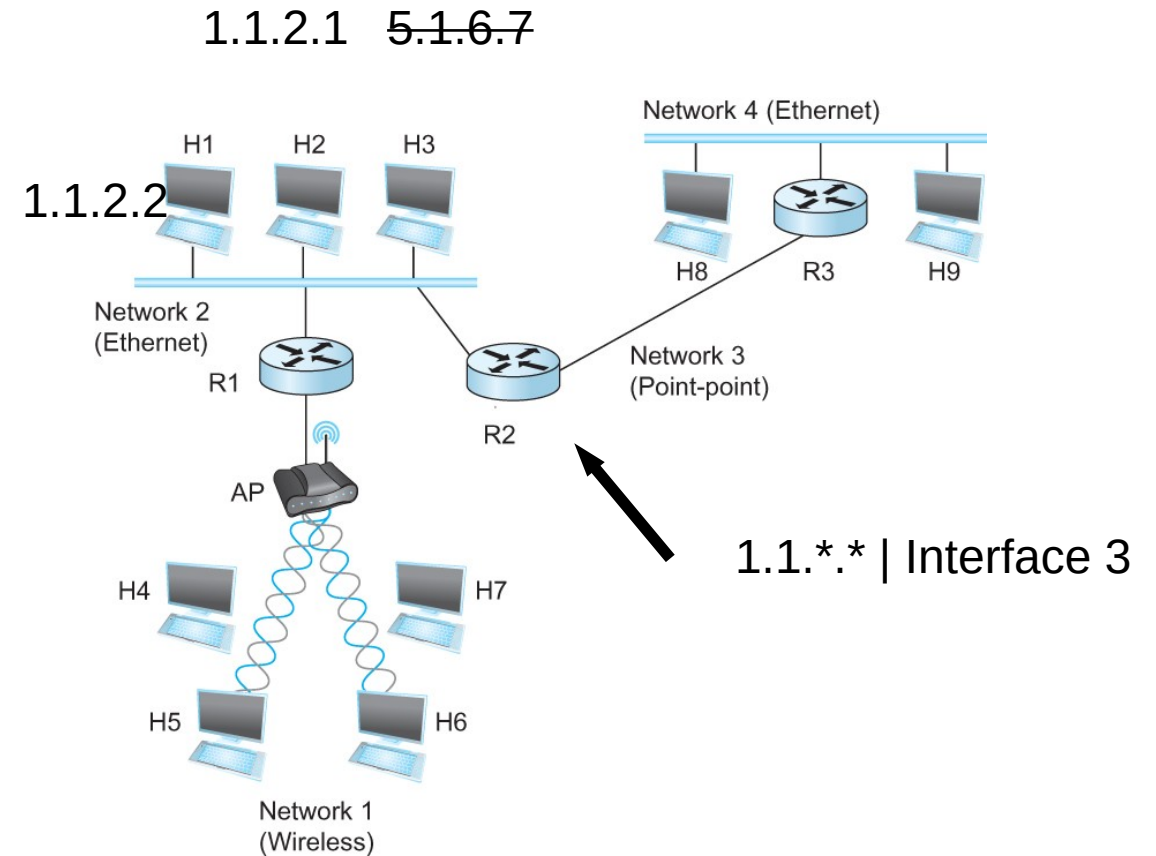
IP addresses are in Network + Host

- 1.1.2.1 →
 - 1.1 → Network part
 - 2.1 → host part
- Each octet can range from 1- 255
- Hierarchical address

129.82.138.254

10000001.01010010.10001010.11111110

Network part (24 bits). Host part(8 bits)



Calculate the first and the last IP address of a subnet

129.82.138.254/27

First host - host bits 0

10000001.01010010.10001010.11111110
11111111.11111111.11111111.11100000 (LOGICAL AND)

10000001.01010010.10001010.11100000 → 129.82.138.224

Last host – host bits 1

10000001.01010010.10001010.11111110
11111111.11111111.11111111.11111111 (LOGICAL AND)

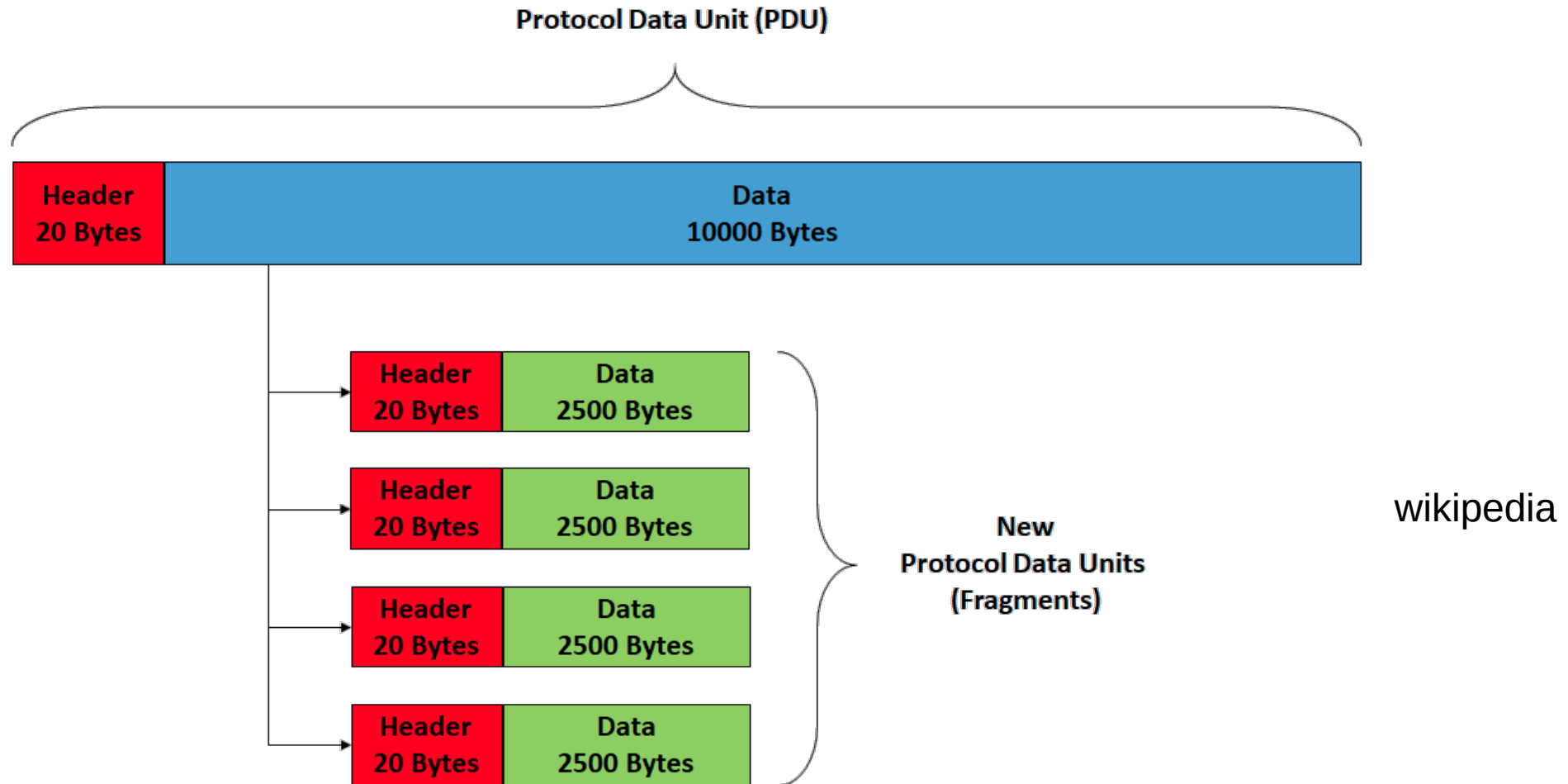
10000001.01010010.10001010.11111110 → 129.82.138.255

Perform logical AND to get the network part = 129.82.138.224

Available addresses – 129.82.138.225-129.82.138.254

Broadcast address – 129.82.138.255

IP Fragmentation and Reassembly



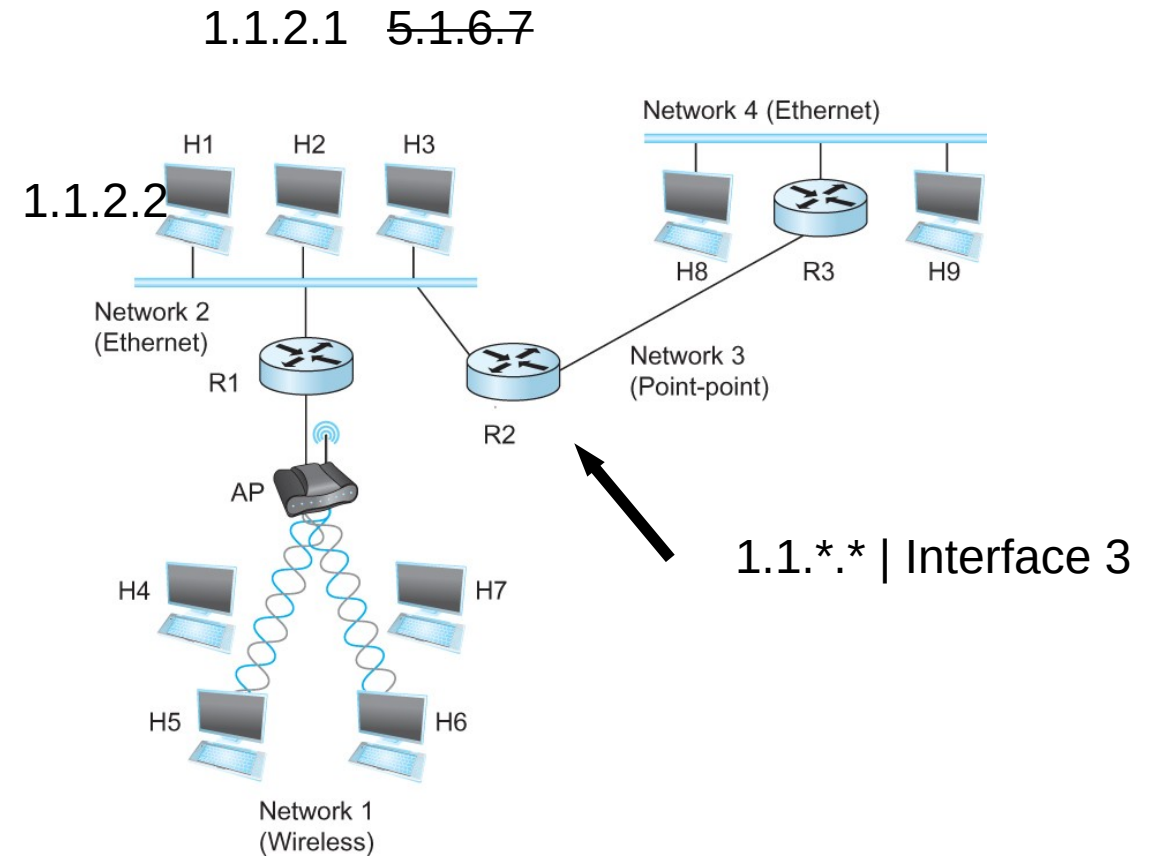
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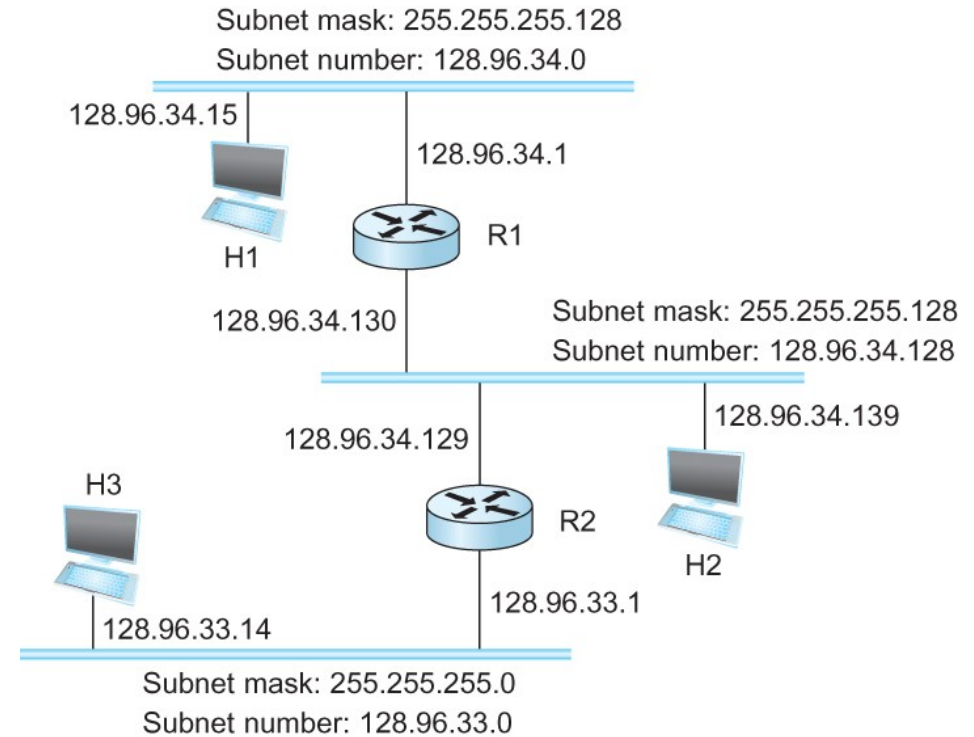
129.82.138.254

10000001.01010010.10001010.11111110

Network part (24 bits). Host part(8 bits)



Subnetting



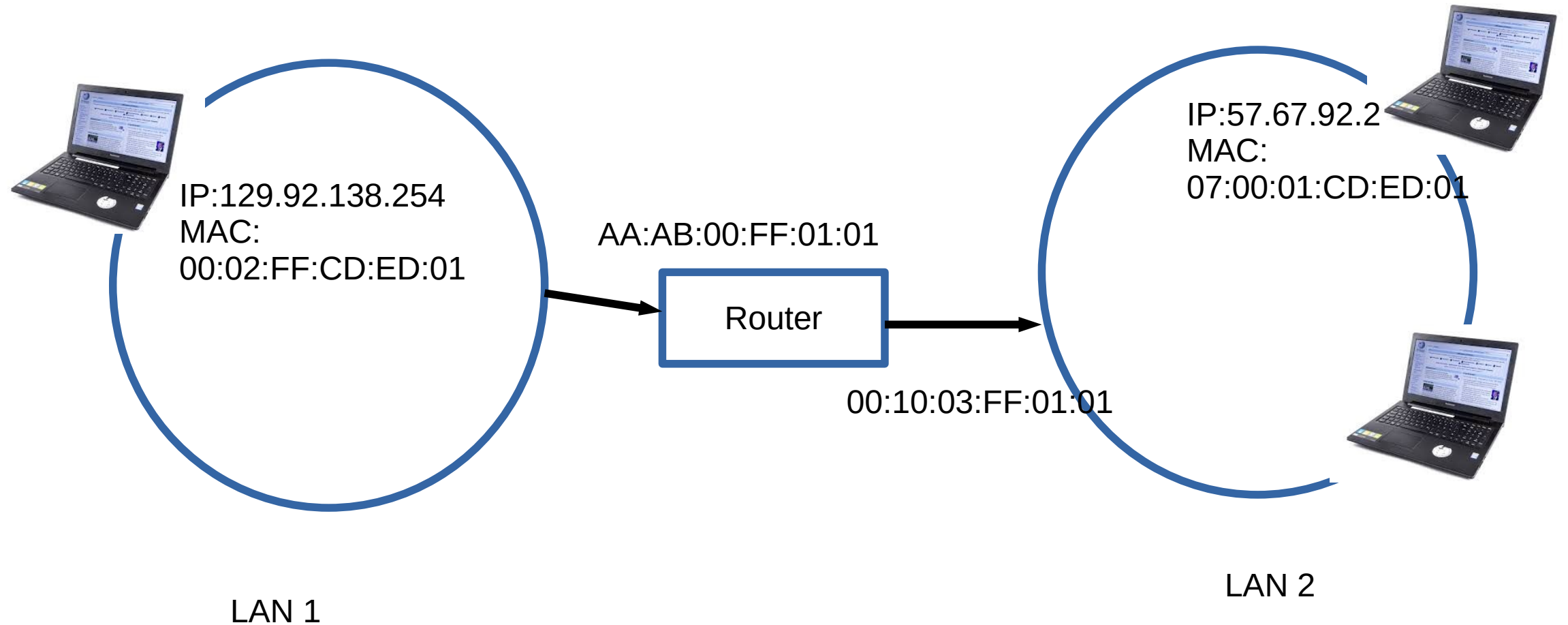
Forwarding Table at Router R1

SubnetNumber	SubnetMask	NextHop
128.96.34.0	255.255.255.128	Interface 0
128.96.34.128	255.255.255.128	Interface 1
128.96.33.0	255.255.255.0	R2

Now let's map that to MAC address

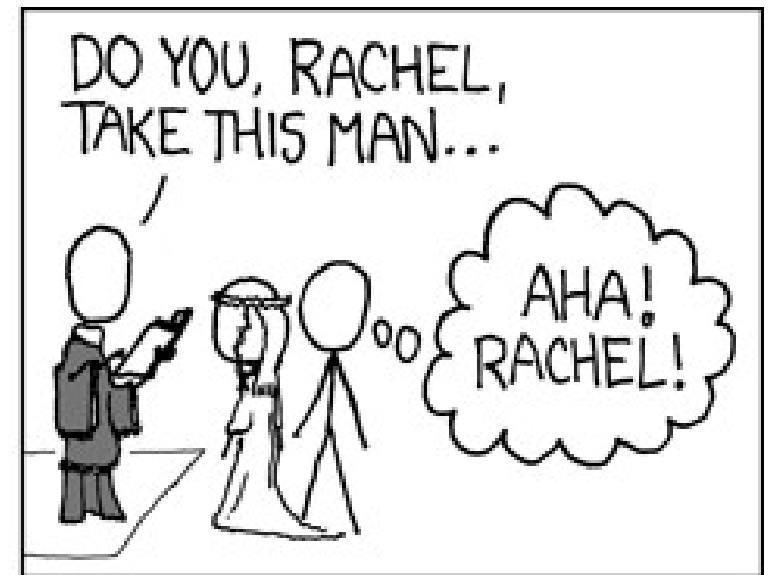
- Adaptors only understand MAC addresses
- Source: 129.82.138.254, Destination: 129.82.138.5
- Your machine does not know what that means:
 - Routers for getting you to the room
 - In the room, you still need to use the MAC address
- Put IP packet in a frame → **Encapsulation**

IP ↔ MAC mapping: Address Resolution Protocol (ARP)



IP ↔ MAC mapping: Address Resolution Protocol (ARP)

- Important concept → Broadcast
 - Shout in the room → Who here is Rachel?



ARP table

- Important concept → Broadcast
 - Shout in the room → Who here is Rachel?



Ethernet address for 129.82.138.254?
Send to : FF-FF-FF-FF-FF-FF
Everyone receives it!!



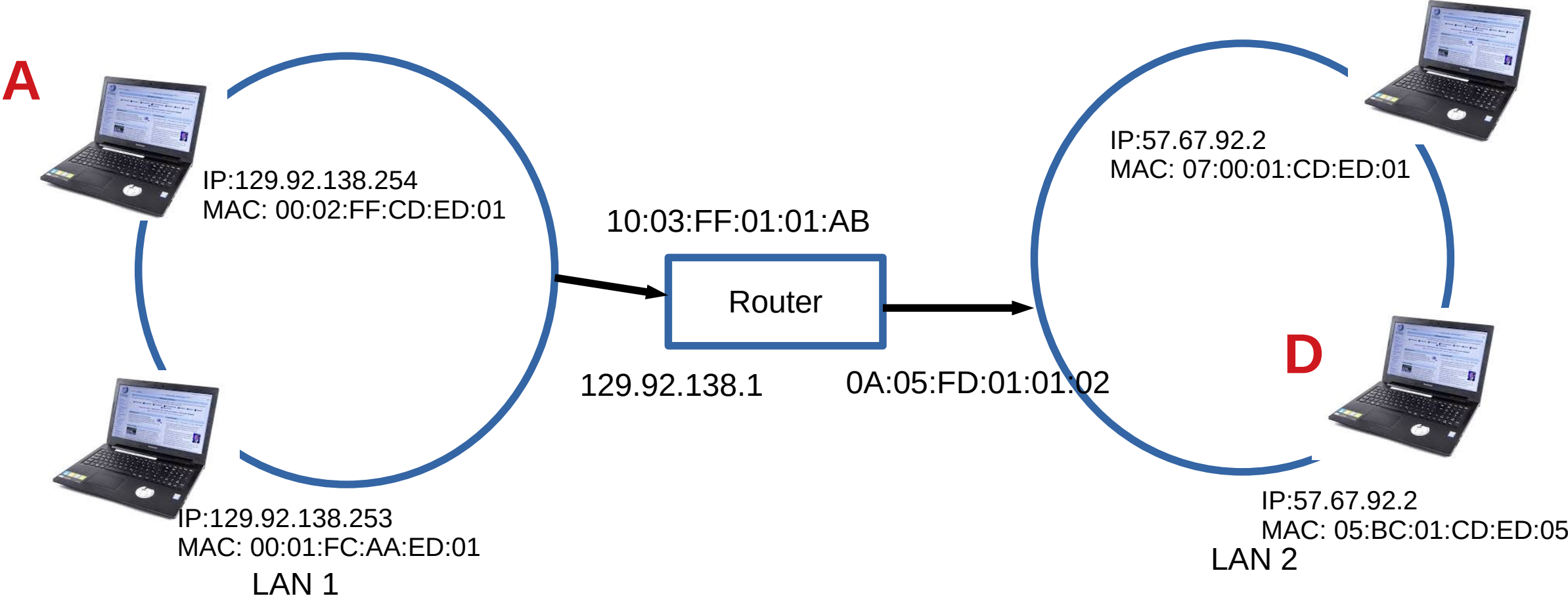
It's me, my MAC is 00:00:22:33:01:21



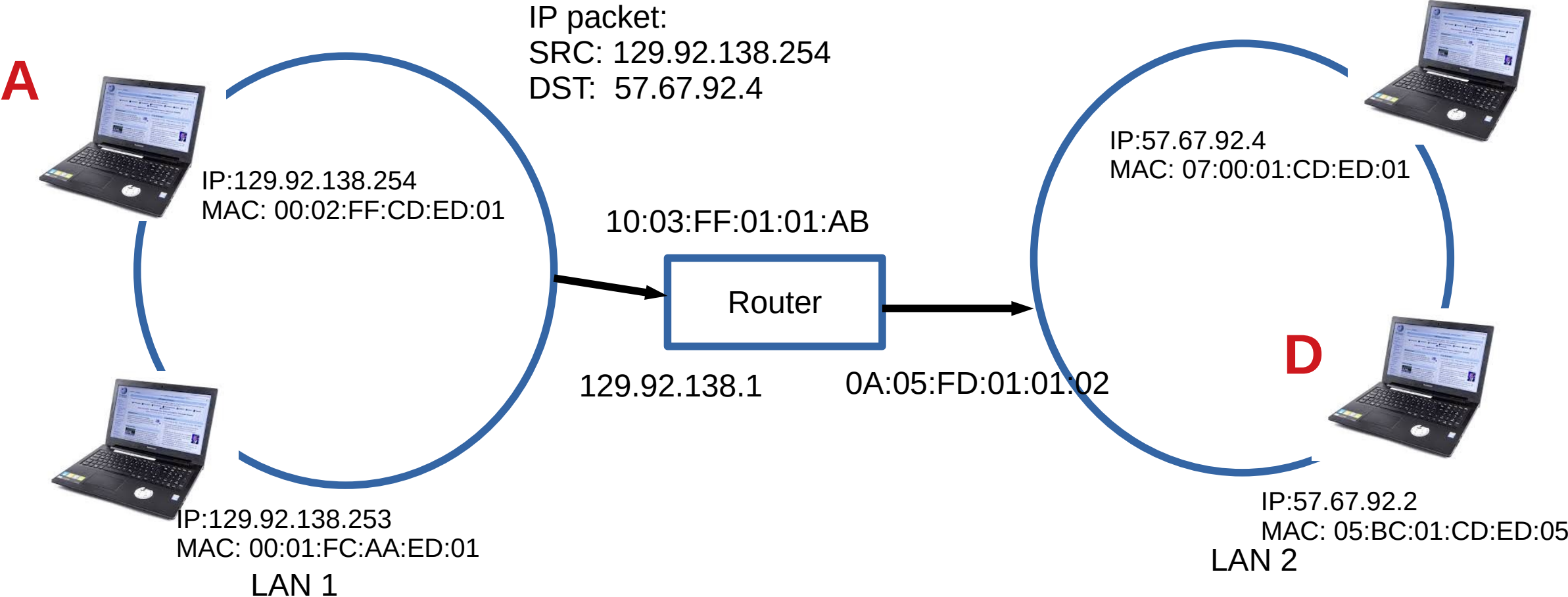
IP ↔ MAC mapping: Address Resolution Protocol (ARP)

- Every node maintains an ARP table
 - <MAC, IP> mapping
- Consult this table when sending IP packets
- Encapsulate with the MAC address, send it the address
- If address is not known, broadcast!
- Cache the response for some time, and eventually forget
 - **Why not broadcast the IP packet?**

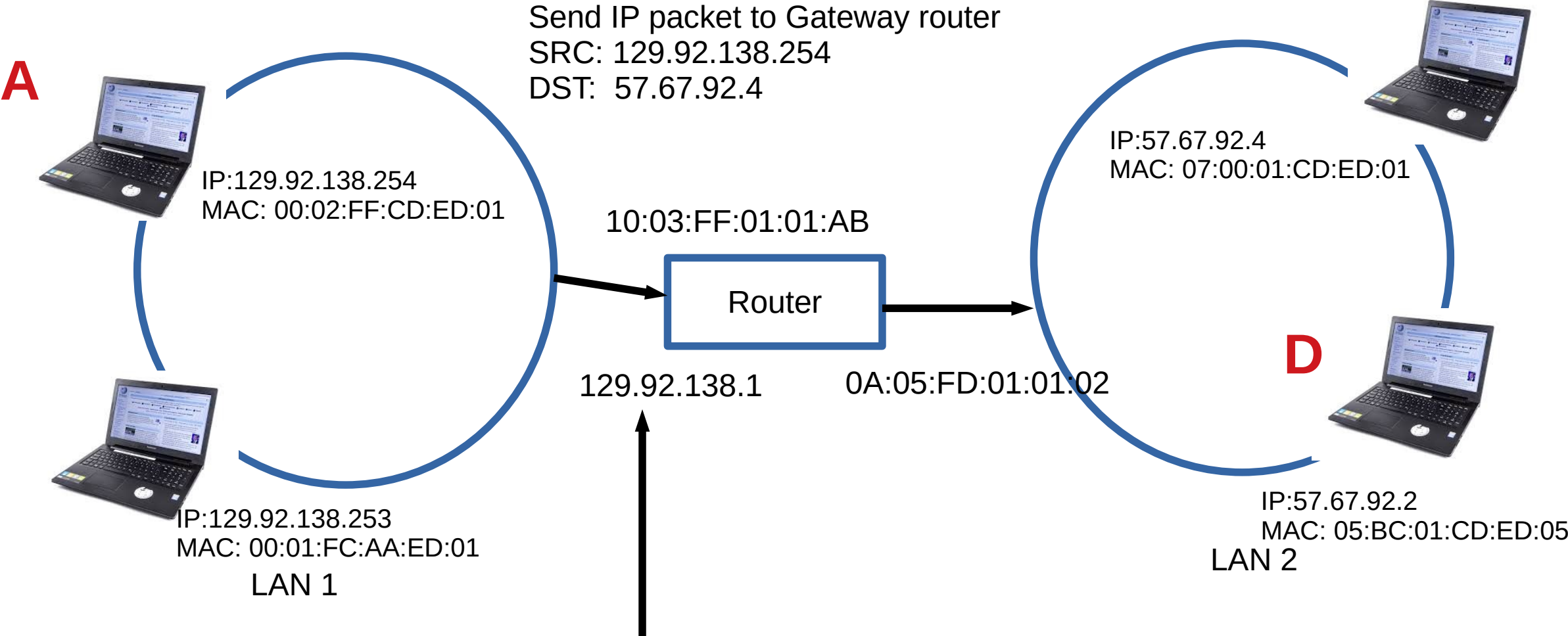
How does A talk to D?



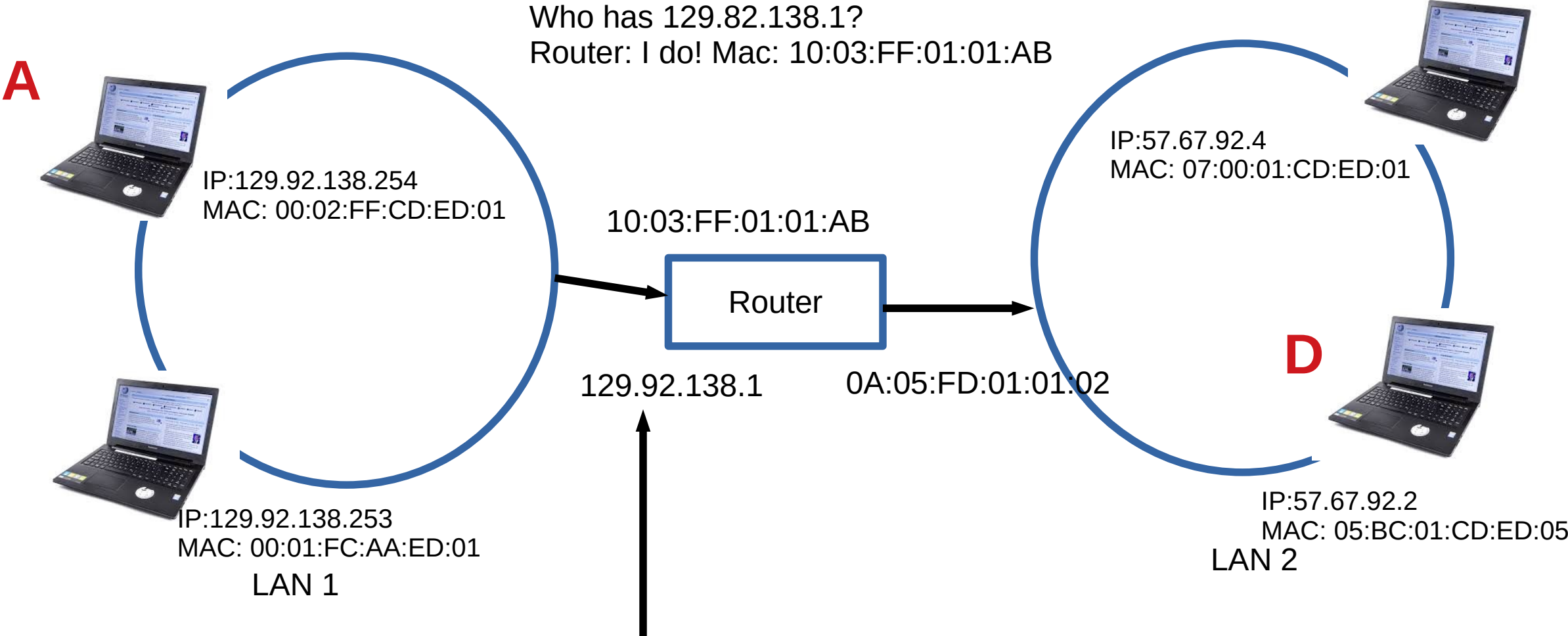
How does A talk to D?



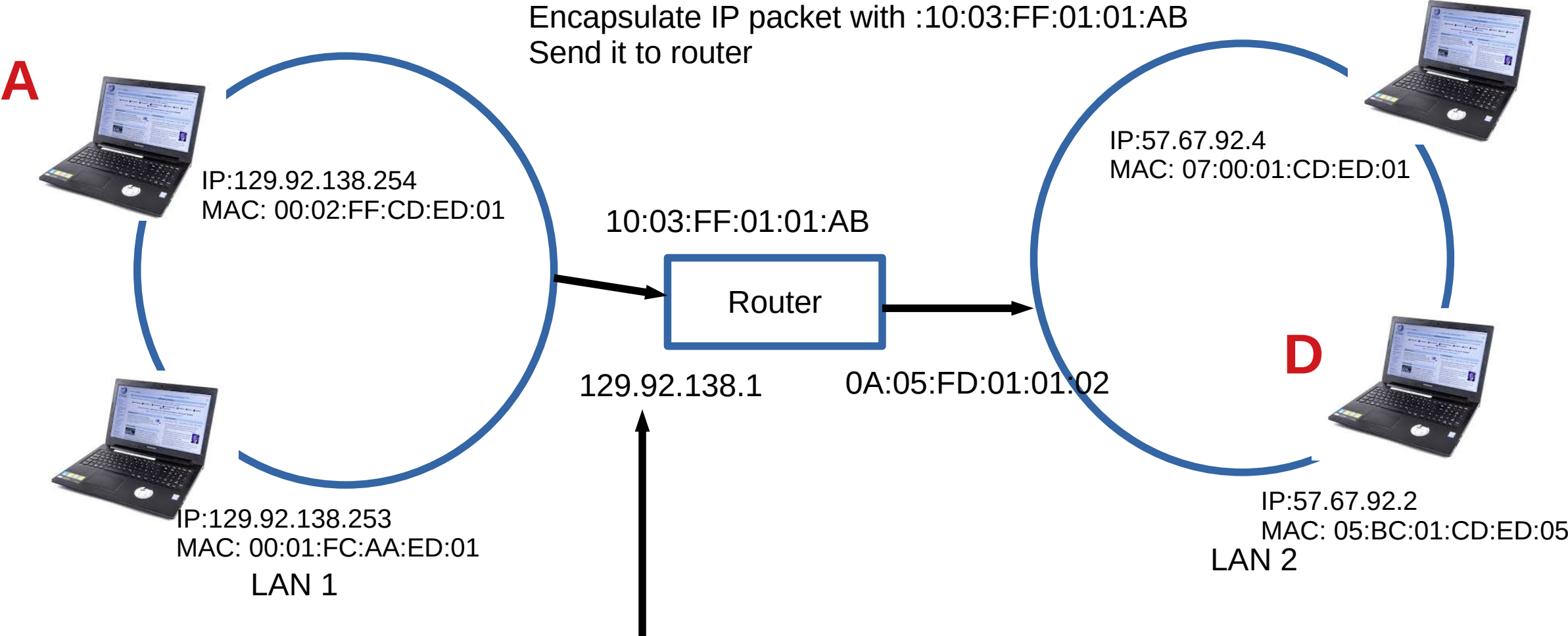
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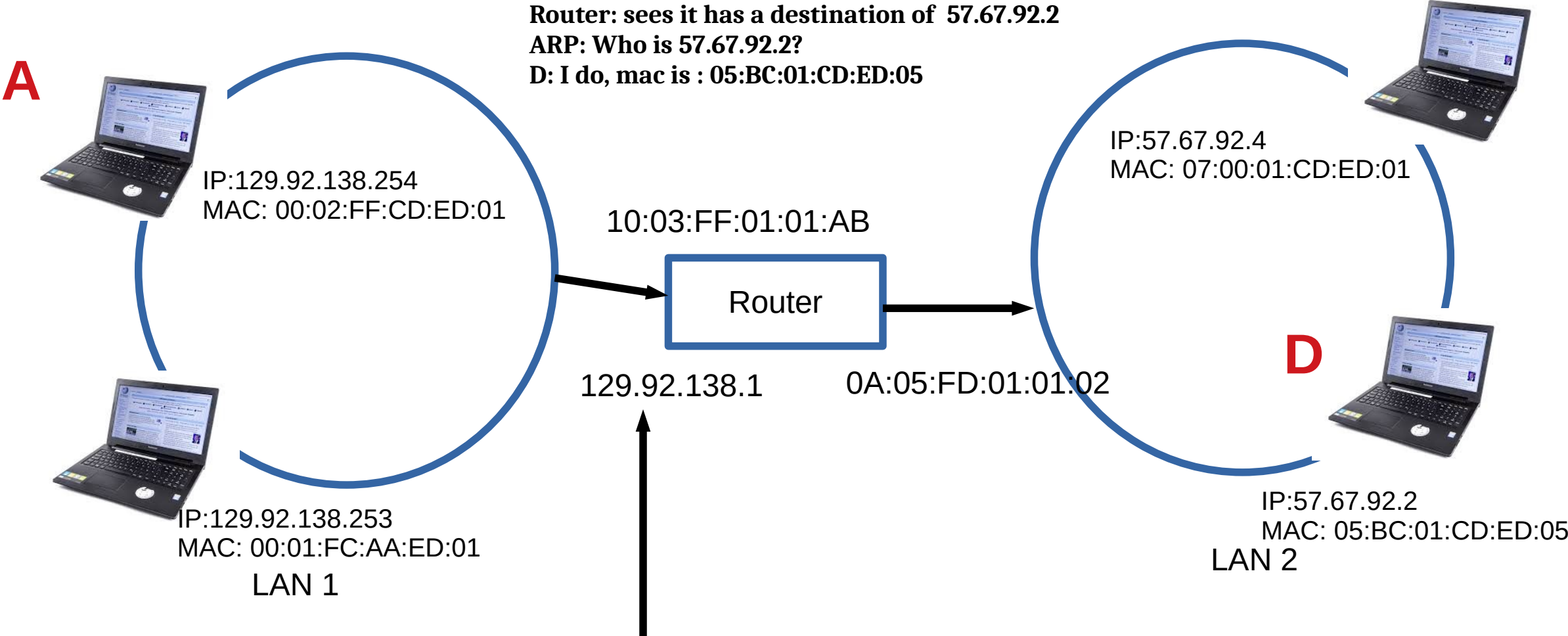
How does A talk to D?



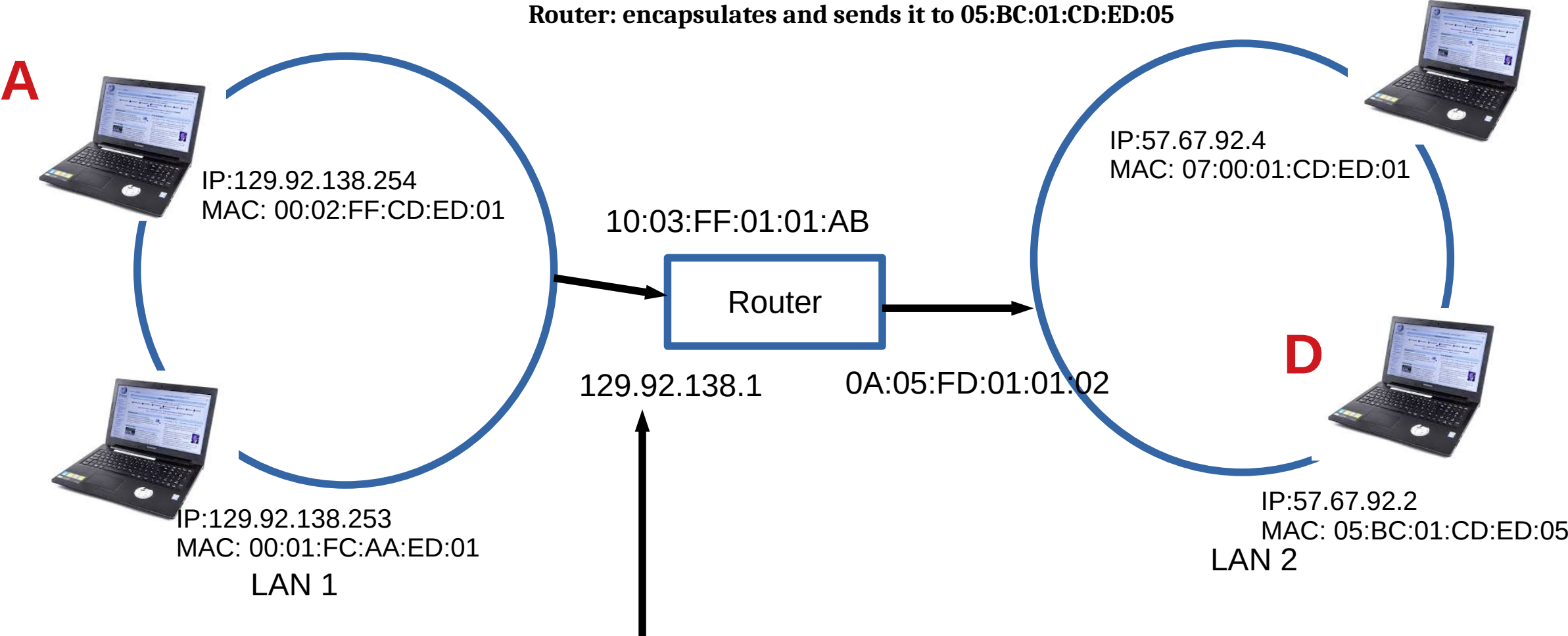
How does A talk to D?



How does A talk to D?



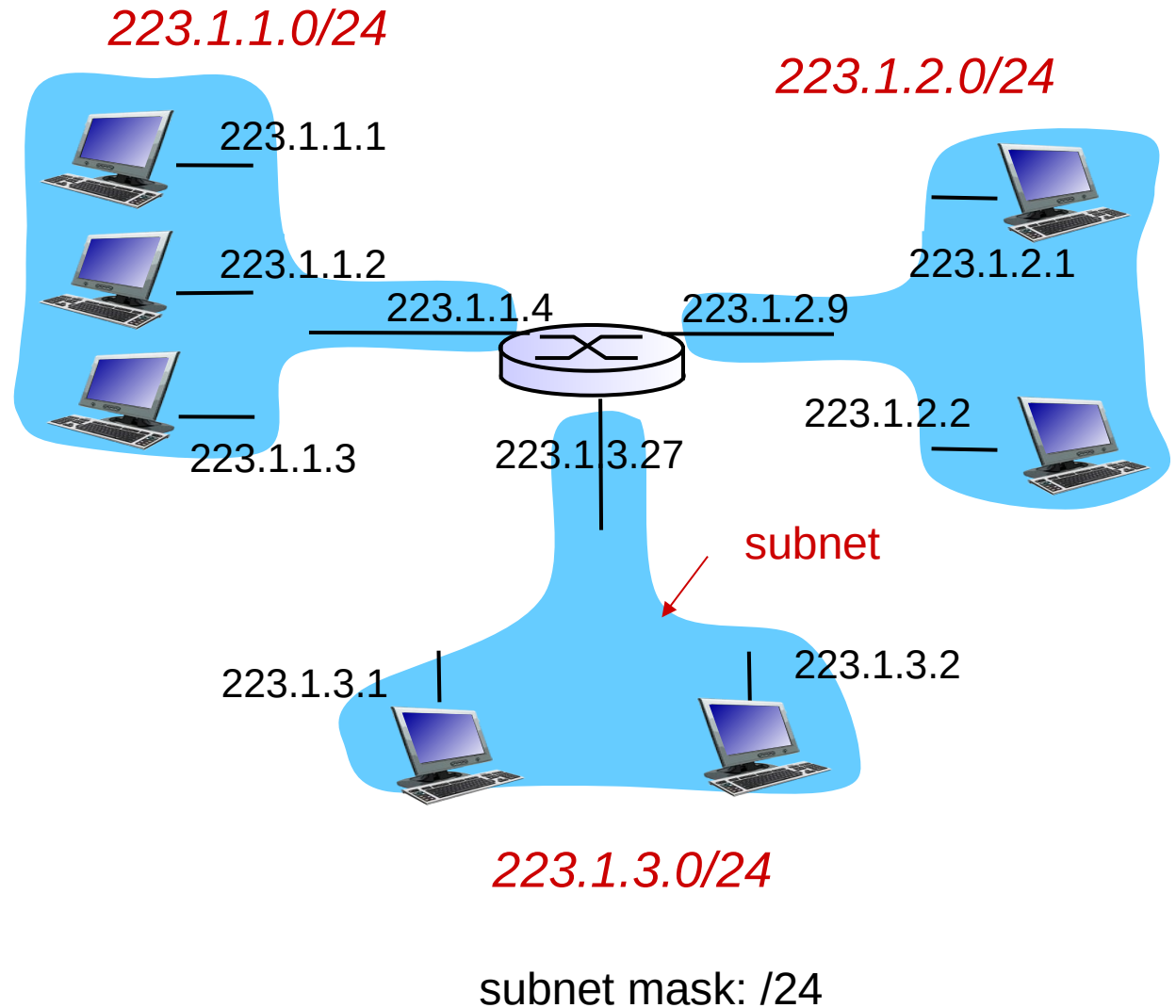
How does A talk to D?



Subnets Revisited

recipe

- to determine the subnets, detach each interface from its host or router, creating islands of isolated networks
- each isolated network is called a *subnet*



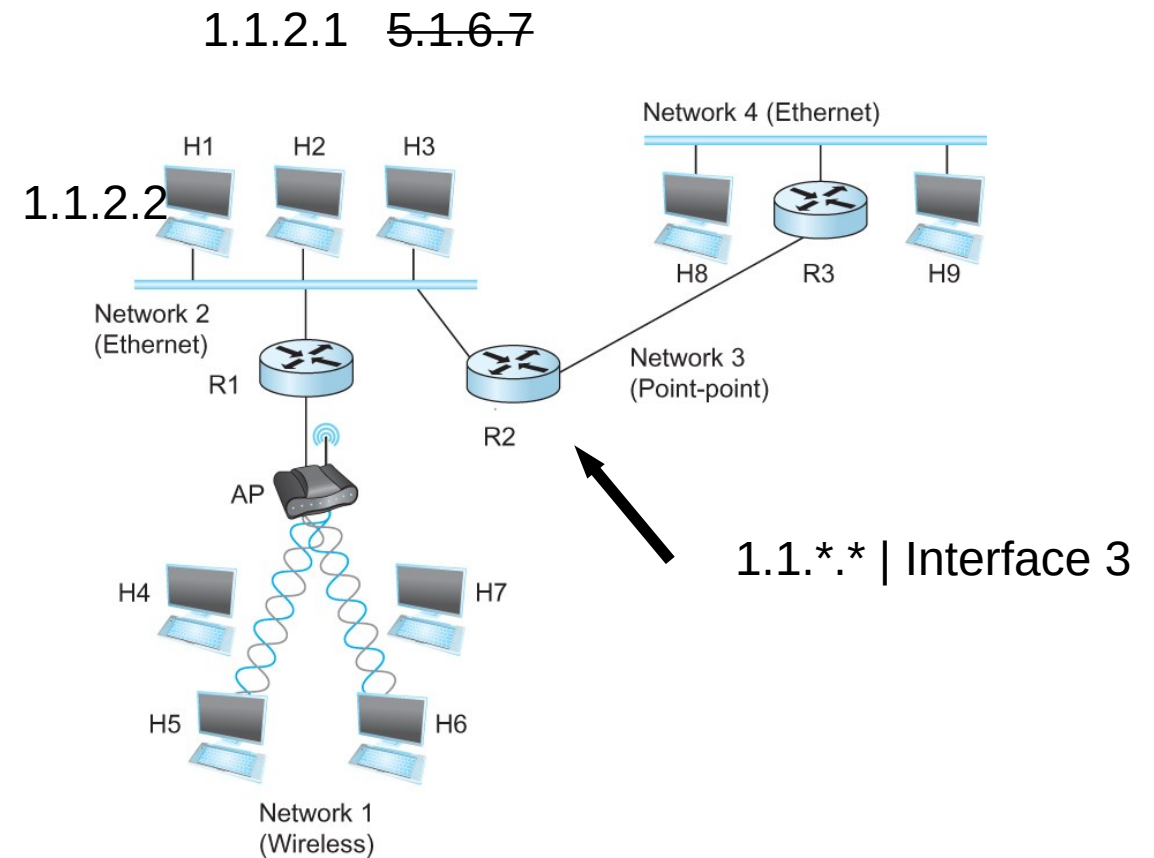
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Perform logical AND to get the network part = 129.82.138.224

Available addresses – 129.82.138.225-129.82.138.254

Broadcast address – 129.82.138.255

Problem

You have an address block:
192.168.123.0/24

- CSC needs 50 addresses
- Library needs 50
- Math needs 50
- ME needs 50

They can not overlap!

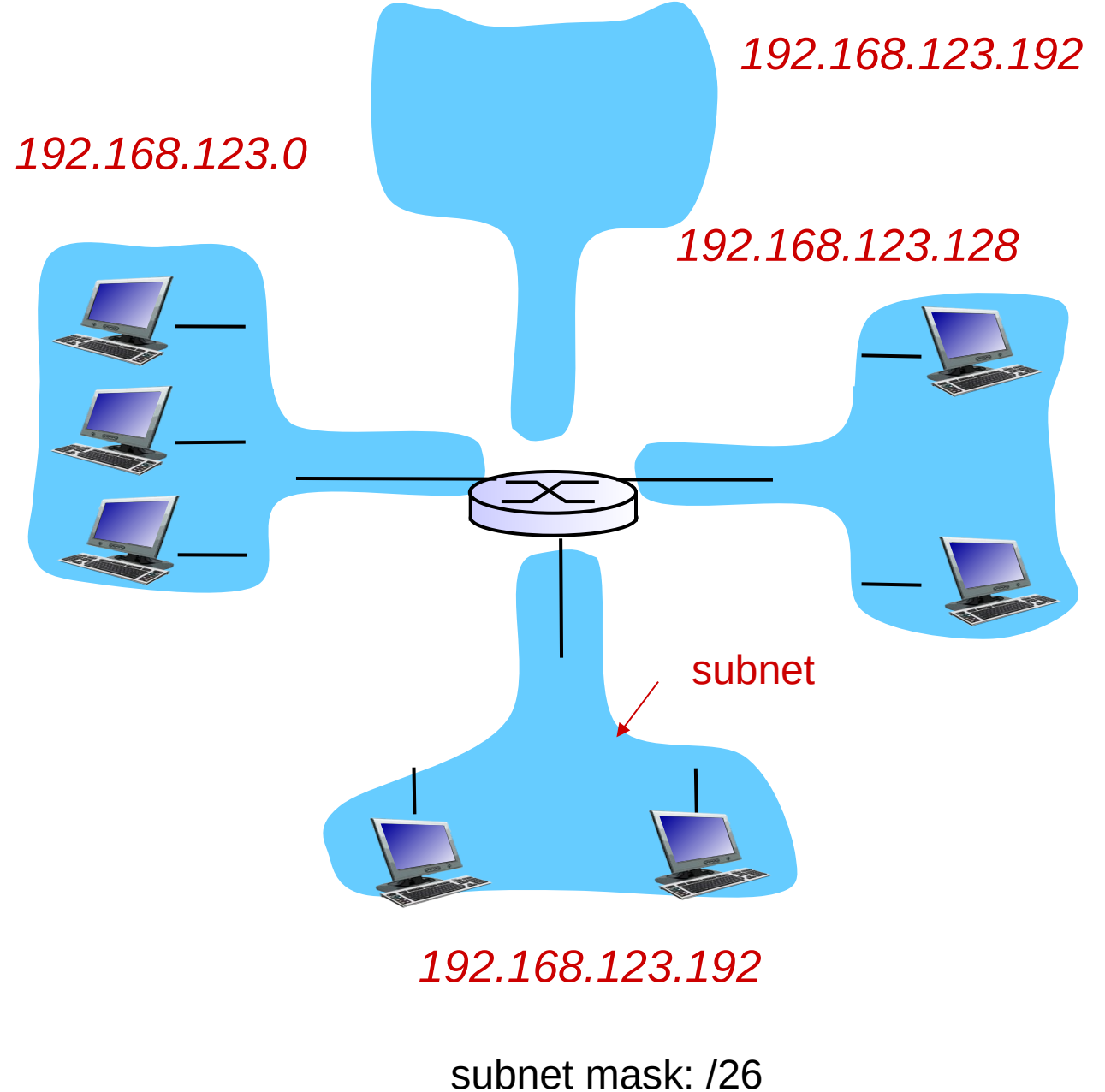
Borrow some bits from the host part.

24 bits - 1111111.11111111.1111111.00000000

2 bits for network –

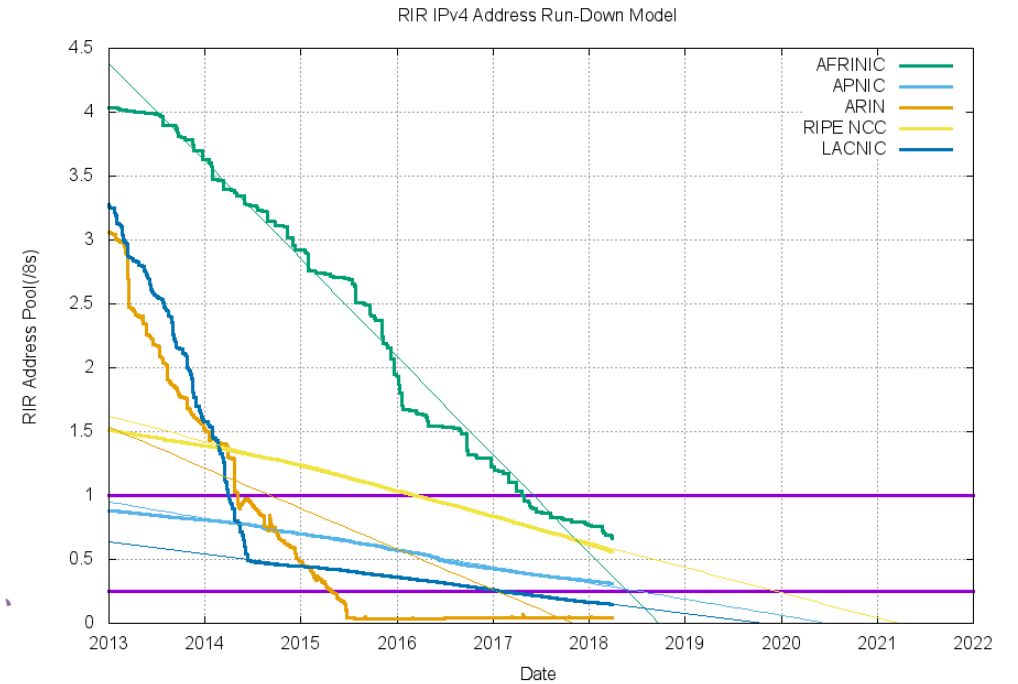
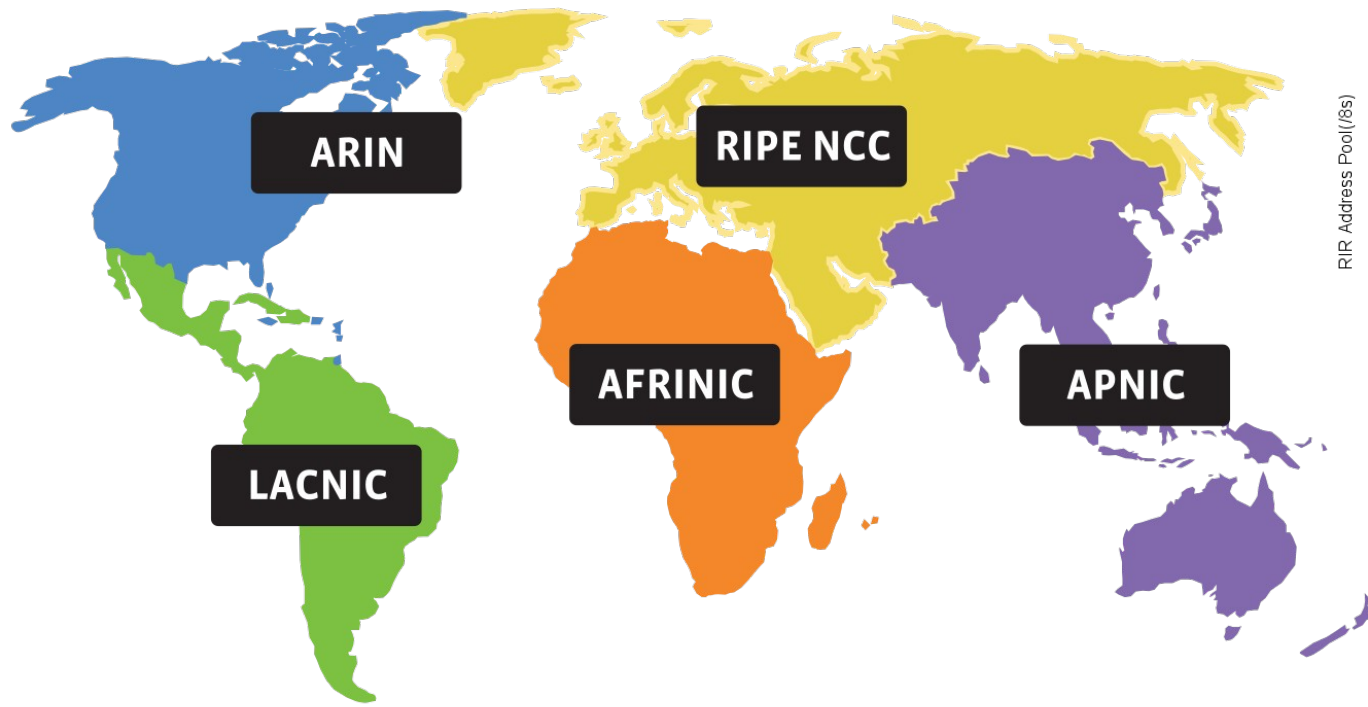
1111111.11111111.1111111.11000000

- How many networks?
- How many hosts in each of these networks?



Address shortage

- IPv4 – 32 bits – Around 4 billion



Solution?

[Home](#) > [WAN](#) > [Internet](#)



BUZZBLOG

By [Paul McNamara](#), News Editor, Network World | APR 21, 2017 8:29 AM PDT

About

In addition to my editing duties, I have written Buzzblog since January, 2006. Feel free to e-mail me at buzz@nww.com.

MIT selling 8 million coveted IPv4 addresses; Amazon a buyer



MIT is selling half of its 16 million valuable IPv4 addresses – an increasingly scarce stash it has held since the birth of the Internet. While details of the sale have not been made public, at least some of those addresses have already been [transferred](#) to Amazon.

sell ipv4 addresses



[auctions.ipv4.global](#) :

[IPv4 Address Auctions - Buy and Sell IP Addresses | IPv4.Global](#)

IPv4.Global's online auction platform is an intuitive way to buy and sell blocks of IPv4 addresses. Register for the platform today to buy and **sell IP addresses** ...

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[www.cfo.com](#) > [it-value](#) > [2017/07](#) > [got-extra-ip-adre...](#) :

[Got Extra IP Addresses? You Can Sell Them - CFO](#)

Jul 19, 2017 — Whatever you call it, any company that possesses unused internet **addresses** — that is, internet protocol version 4 (**IPv4**) **addresses** — can very likely **sell** them at a high profit margin. That's because **IPv4** numbers were distributed for free by the Internet Assigned Numbers Authority and its five regional registries.

[ipv4marketgroup.com](#) > [Broker Services](#) :

[IPv4 Address Space for Sale | IPv4 Market Group](#)

Sell IP Addresses with IPv4 Market Group. Now is a great time to **sell IPv4 address** blocks because they're in high demand due to their limited availability and the ...

[ipv4marketgroup.com](#) > [sell-ipv4-addresses-ipv4-group](#) :

[Sell Your IPv4 Addresses with IPv4 Group - IPv4 Market Group](#)

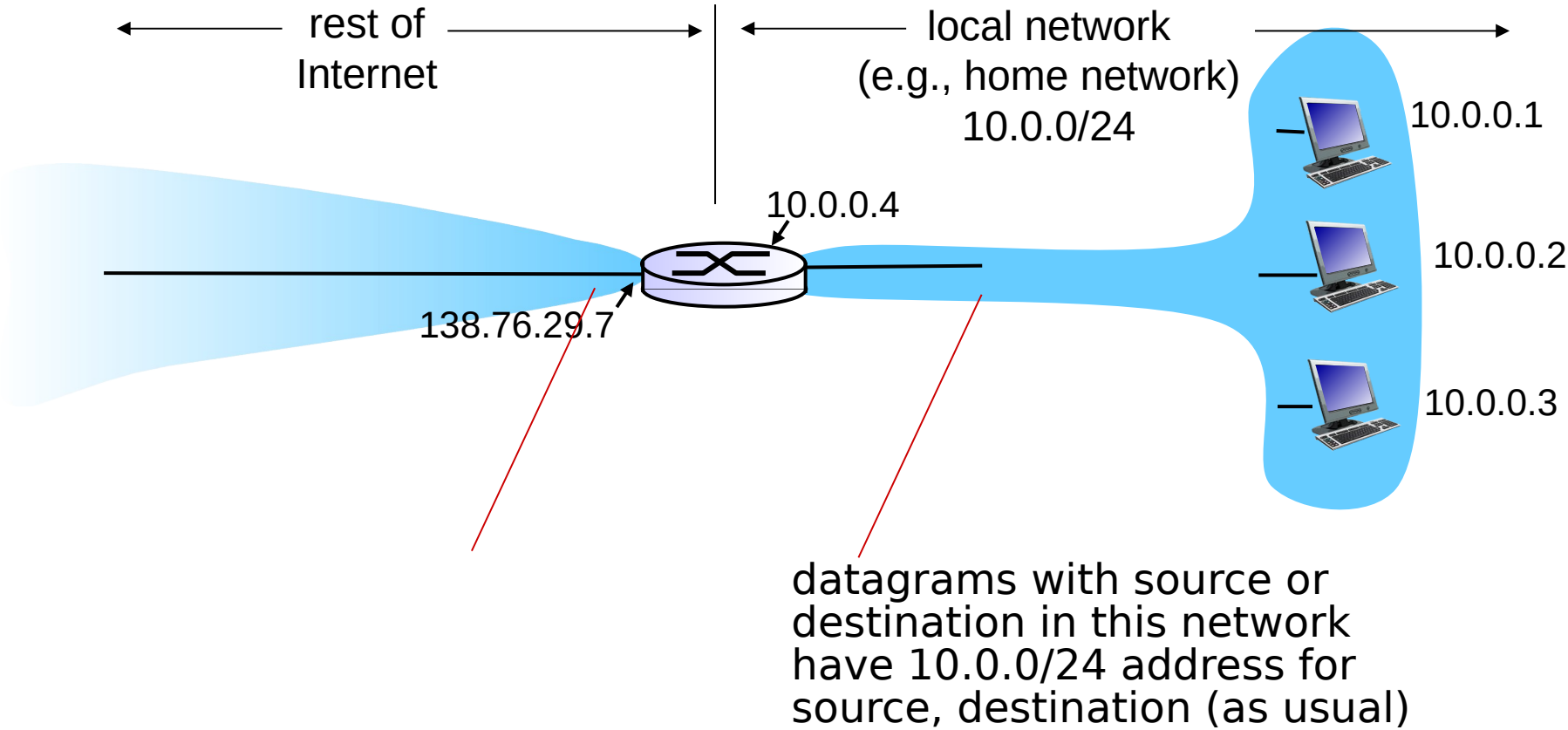
Oct 5, 2017 — The IPv4 Transfer Market is an after-market IPv4 transfer mechanism. It creates financial incentive for entities to **sell** their unused **IPv4 addresses**, ...

[ipv4connect.com](#) > [sell-ipv4](#) :

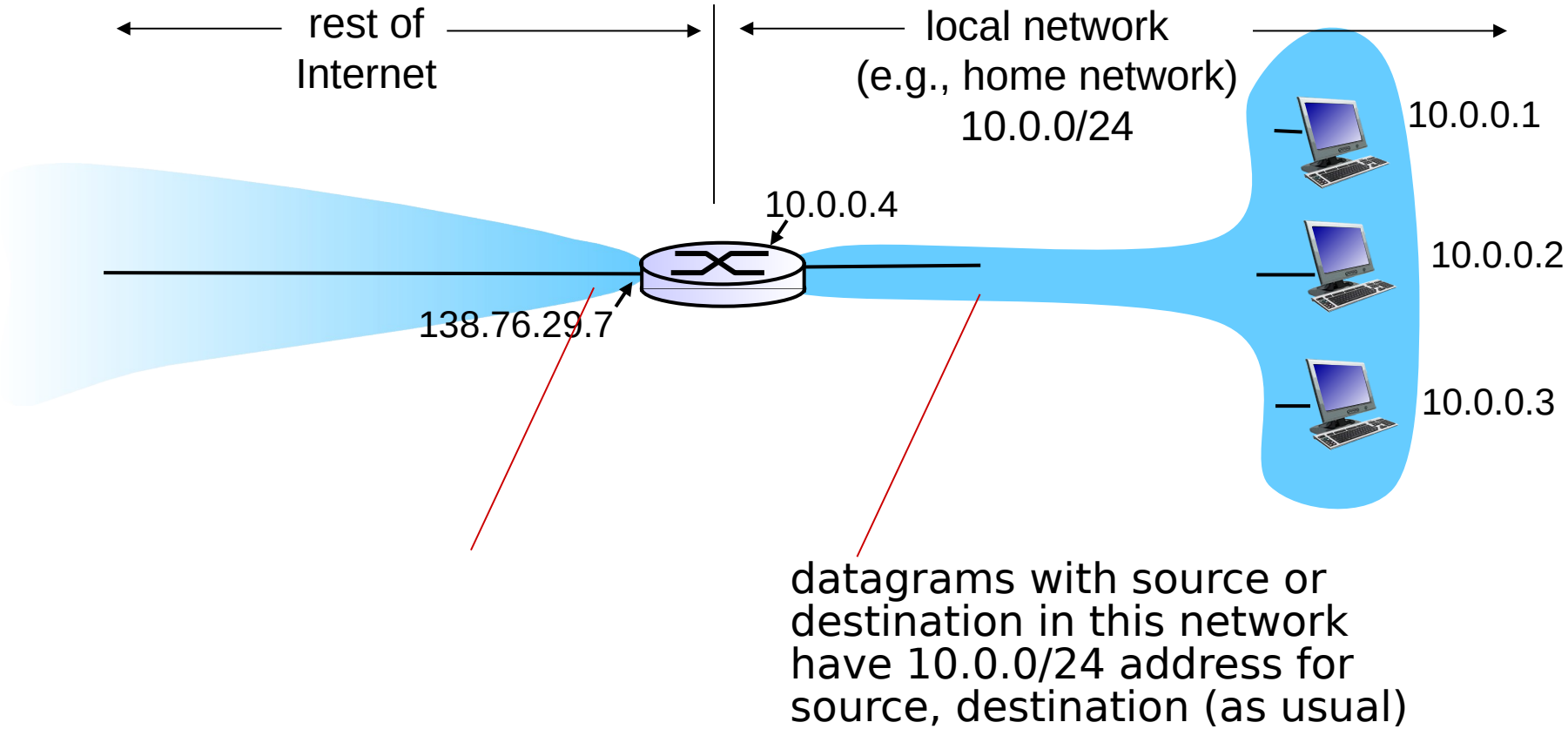
[Sell IP Address | IPv4 Space | IPv4 Connect](#)

Safely & quickly **Sell IPv4 address** space to pre qualified buyers around the world.

NAT: network address translation



NAT: Network Address Translation

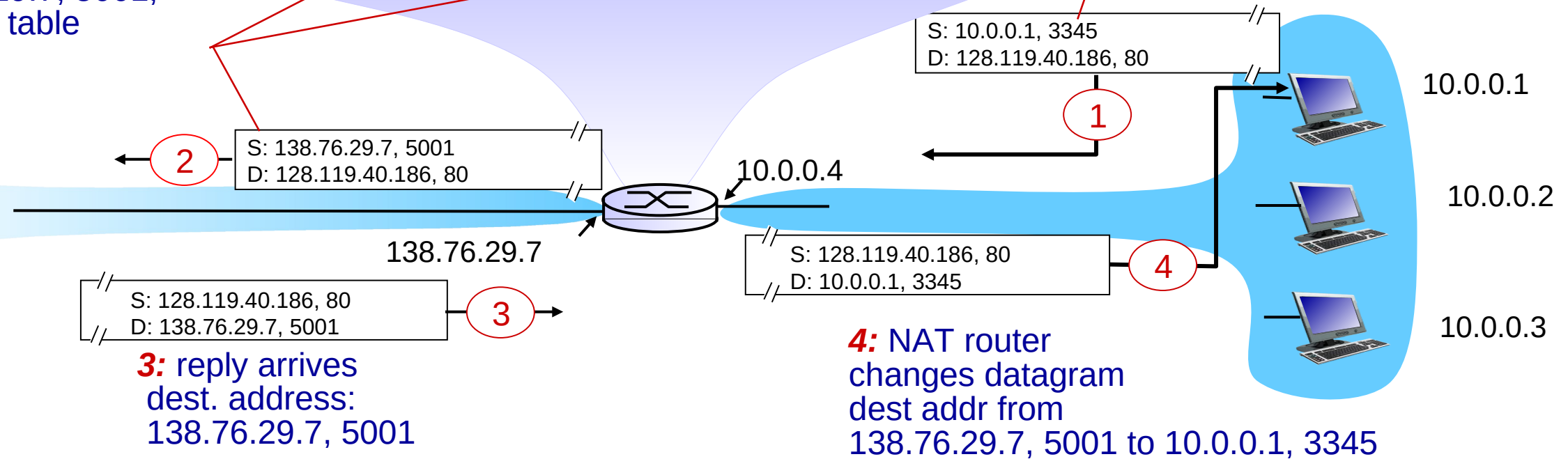


NAT: network address translation

2: NAT router changes datagram source addr from 10.0.0.1, 3345 to 138.76.29.7, 5001, updates table

NAT translation table	
WAN side addr	LAN side addr
138.76.29.7, 5001	10.0.0.1, 3345
.....

1: host 10.0.0.1 sends datagram to 128.119.40.186, 80

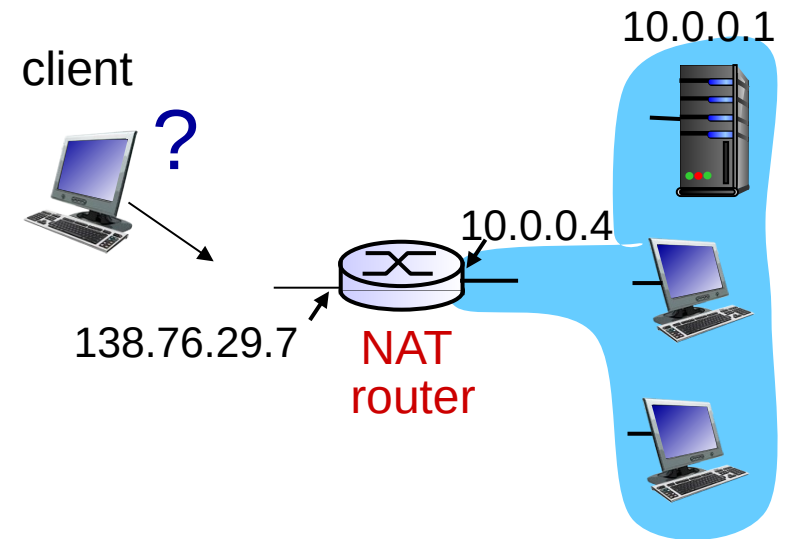


3: reply arrives
dest. address:
138.76.29.7, 5001

4: NAT router
changes datagram
dest addr from
138.76.29.7, 5001 to 10.0.0.1, 3345

NAT

- One IP address for all devices
 - Addresses the address space problem
- Can change local addresses without involving the ISP
- NAT traversal problem
 - Is a server is behind NAT, how does the client talk to it?



Address shortage – Better solution? IPv6

- IPv6 – 128 bits

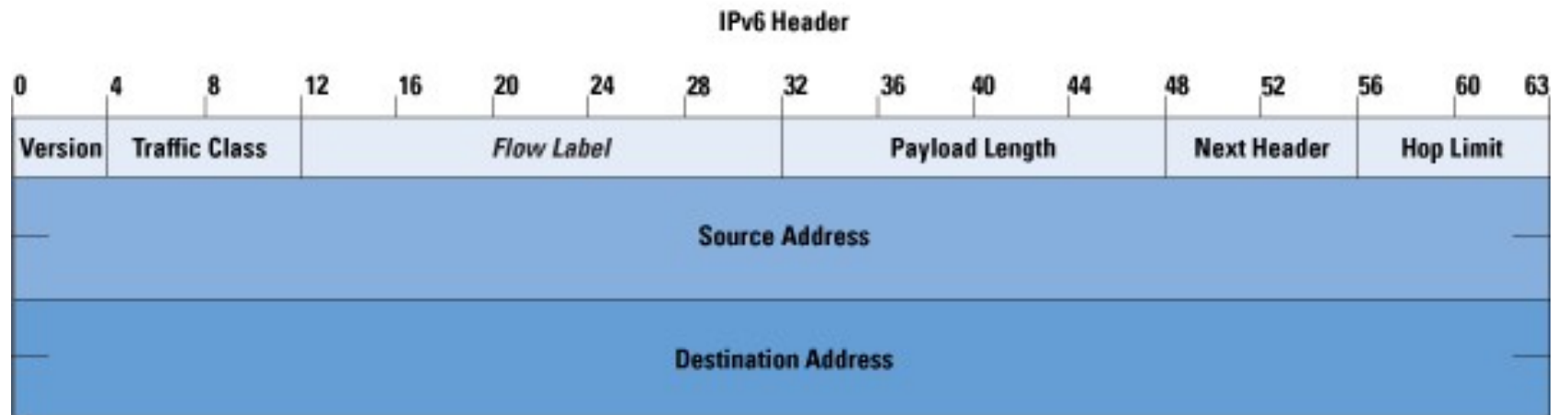
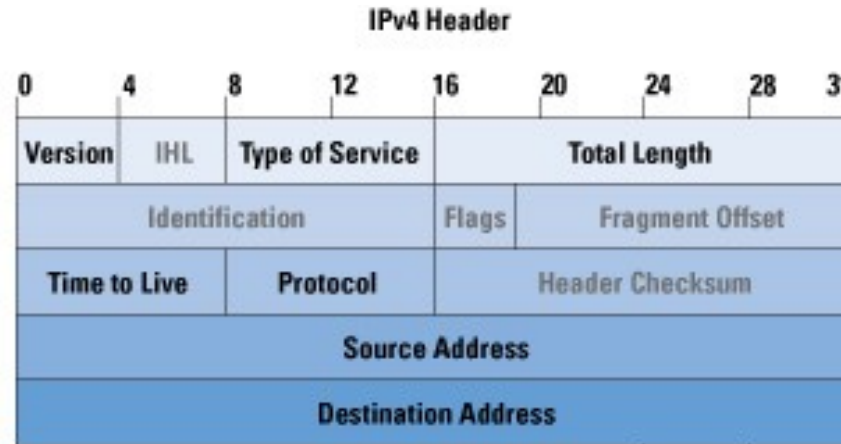
This many addresses left:

340,282,366,920,938,463,463,374,607,429,929,813,392

Projected IPv6 Exhaustion Date: 9,000,000 AD

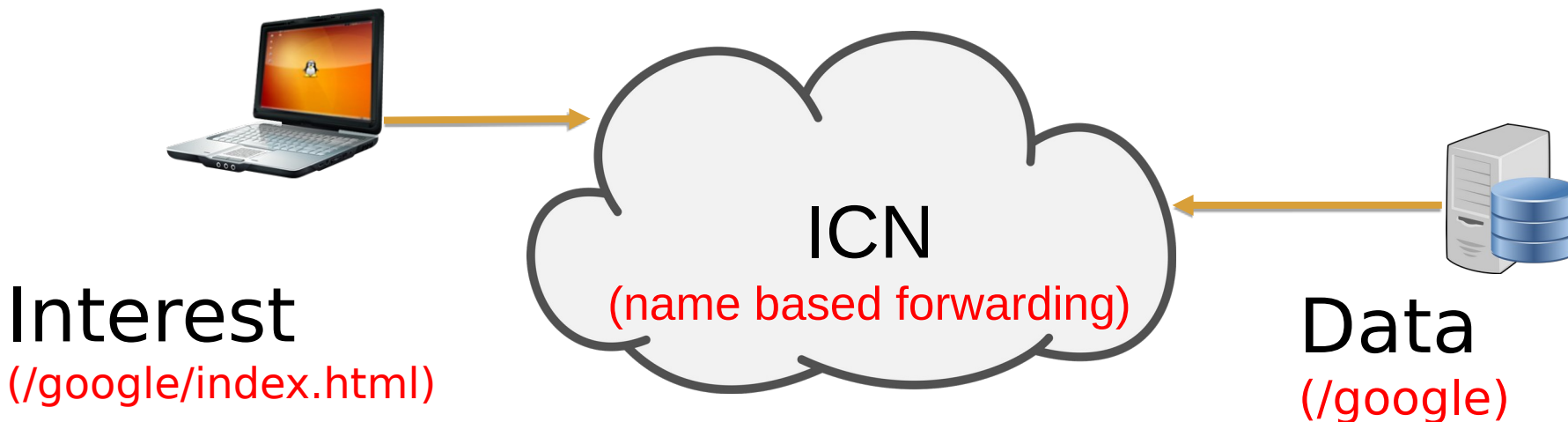
Address shortage – Better solution? IPv6

- IPv4 – 128 bits



Address shortage – Better solution? Get rid of the Addresses!

- Next generation of the Internet
- You don't care about the hosts anyway
 - For most part
- Why not ask for content directly?
 - Information Centric Networking (ICN)



DHCP

- **New laptop joins a network**
 - Does not have source address
 - Does not know who to ask
 - Does not know other network parameters like DNS or Gateway router information

DHCP client-server scenario

DHCP server: 223.1.2.5



DHCP discover

Broadcast: is there a DHCP server out there?

arriving client



DHCP offer

Broadcast: I'm a DHCP server!
Here's an IP address you can use

DHCP request

Broadcast: OK. I'll take that IP address!

DHCP ACK

Broadcast: OK. You've got that IP address!

kurose/ross

DHCP Server

- A local central database with a list of IP addresses
 - 10.0.0.1/8
- Offers an available IP to a client for a period of time
 - Lease time – 24 hours, 1 hour, configurable ← **Soft State**
- Multiple servers might coexist and offer IP to the same request
 - Broadcast medium
 - Client decides which one to accept

DHCP Client – Keep refreshing!

- IP address provided expires after time t
- Client can release DHCP lease
 - Shutdown the laptop
- If you walk away from the building
 - Crash
- Performance trade off
 - Short time – too many broadcasts, quick recovery of addresses
 - Long time – less network traffic, longer recovery of addresses

Reading Assignment

- **ARP**
 - <https://book.systemsapproach.org/internetworking/basic-ip.html#address-translation-arp>
 - About 10 minutes
- **DHCP**
 - <https://book.systemsapproach.org/internetworking/basic-ip.html#host-configuration-dhcp>
 - About 10 minutes

Tying it all together in the network layer

