estga escola superior de tecnologia e gestão de águeda

# 90293 - Tecnologias de Redes de Computadores

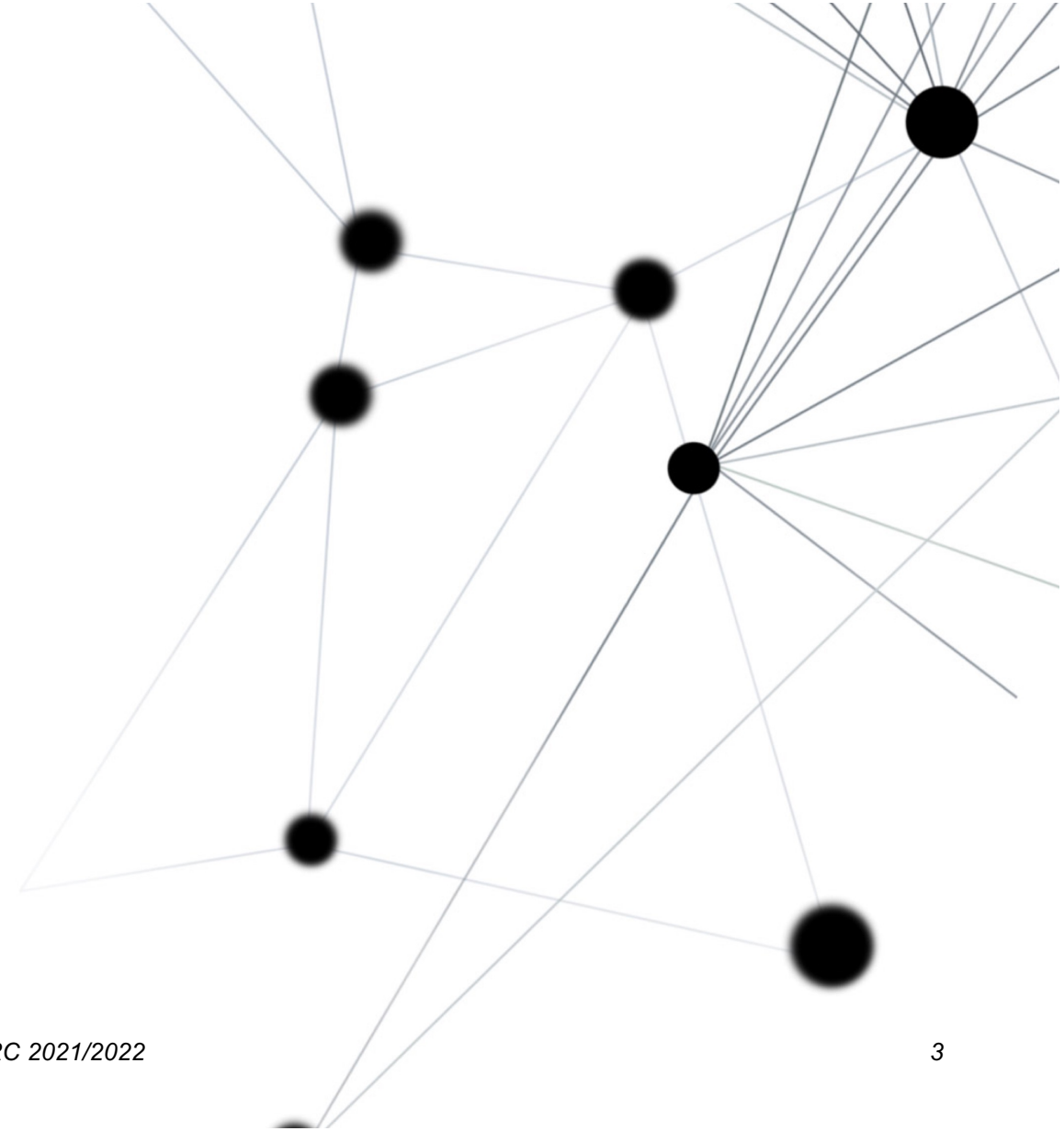
Aula 2 – Camada de acesso

Pedro Gonçalves – pasg@ua.pt

# Sumário

- Endereçamento em LANs
  - Endereços MAC
  - Protocolo ARP
- Comutação em LANs
  - Dominios de colisão
  - Switches e Hubs
- Sequência de acções no envio de pacotes.

Endereçamento em ethernet

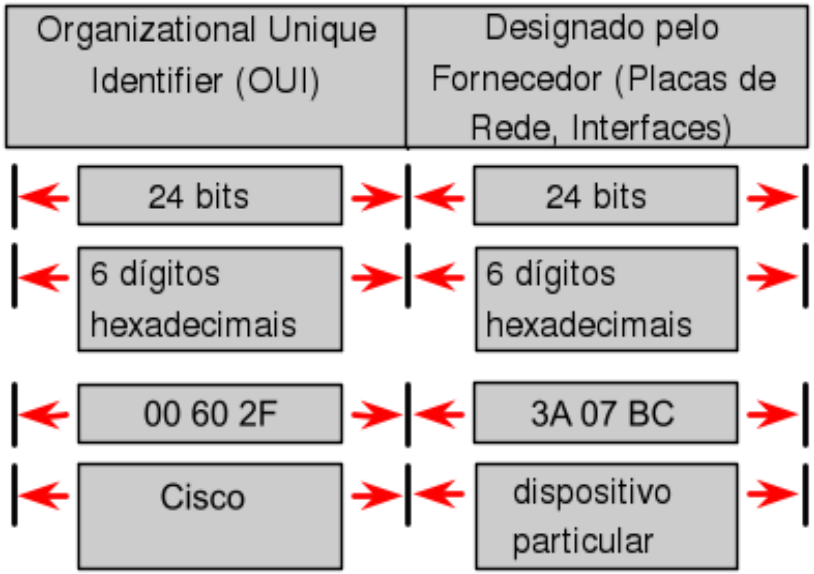


# Frame ethernet

| Quadro Ethernet | | | | | | |
|---|---|---|---|---|---|---|
| Preâmbulo | SFD | Destino | Origem | Tipo<br>Comprimento | Dados : Enchimento | FCS |
| 7 | 1 | 6 | 6 | 2 | 46 a 1500 | 4 |

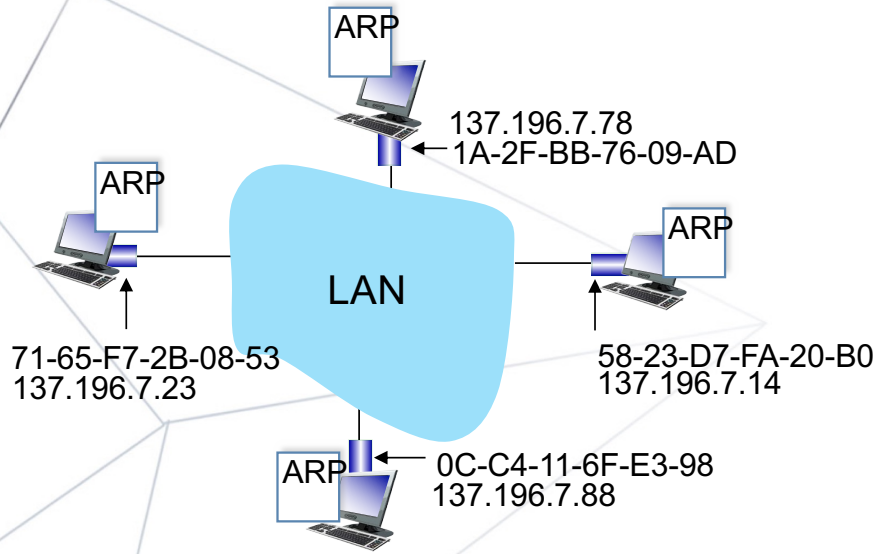
# Endereço MAC

- Endereços de 48 bits
- Representados em 12 dígitos hexamedimais
- e.g. : 00:50:56:c0:00:01
- Necessário em ethernet para enviar pacotes para destino.



# ARP: address resolution protocol

*Question:* how to determine interface's MAC address, knowing its IP address?




ARP table: each IP node (host, router) on LAN has table

- IP/MAC address mappings for some LAN nodes:

  < IP address; MAC address; TTL>
- TTL (Time To Live): time after which address mapping will be forgotten (typically 20 min)

# ARP protocol in action

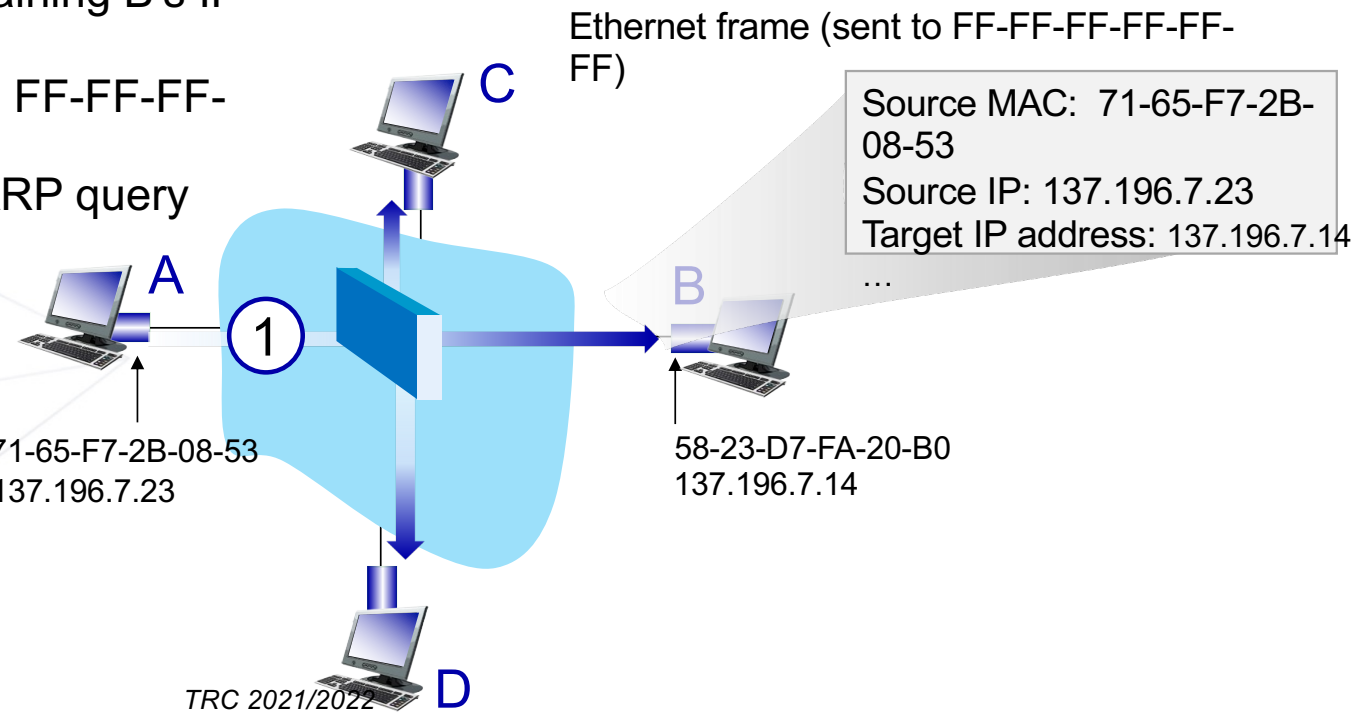
## example: A wants to send datagram to B

- B's MAC address not in A's ARP table, so A uses ARP to find B's MAC address

1. A broadcasts ARP query, containing B's IP addr
   - destination MAC address = FF-FF-FF-FF-FF-FF
   - all nodes on LAN receive ARP query

ARP table in A

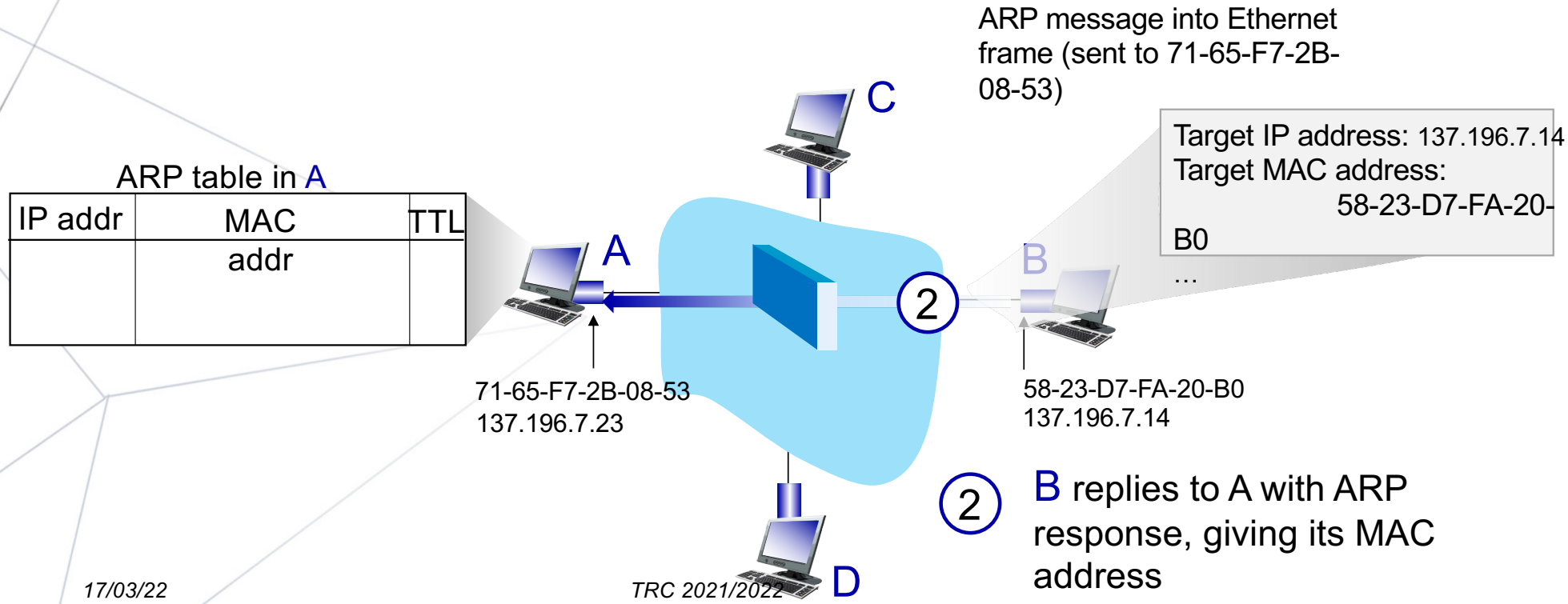
| IP addr | MAC addr | TTL |
|---|---|---|
| | | |



# ARP protocol in action

## example: A wants to send datagram to B

- B's MAC address not in A's ARP table, so A uses ARP to find B's MAC address



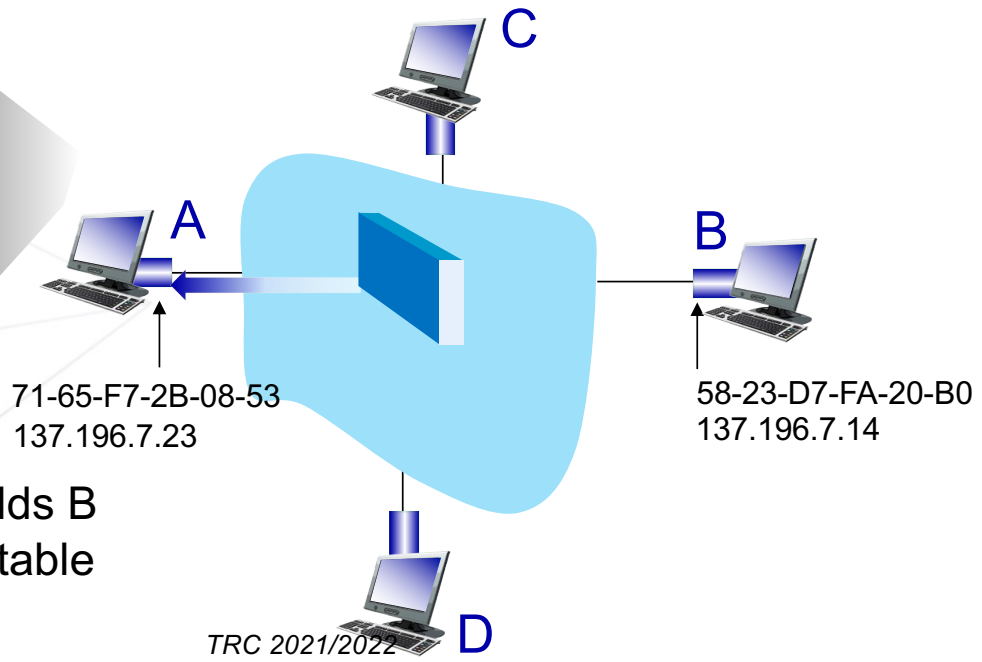
# ARP protocol in action

## example: A wants to send datagram to B

- B's MAC address not in A's ARP table, so A uses ARP to find B's MAC address

ARP table in A

| IP addr | MAC addr | TTL |
|---|---|---|
| 137.196.7.14 | 58-23-D7-FA-20-B0 | 500 |

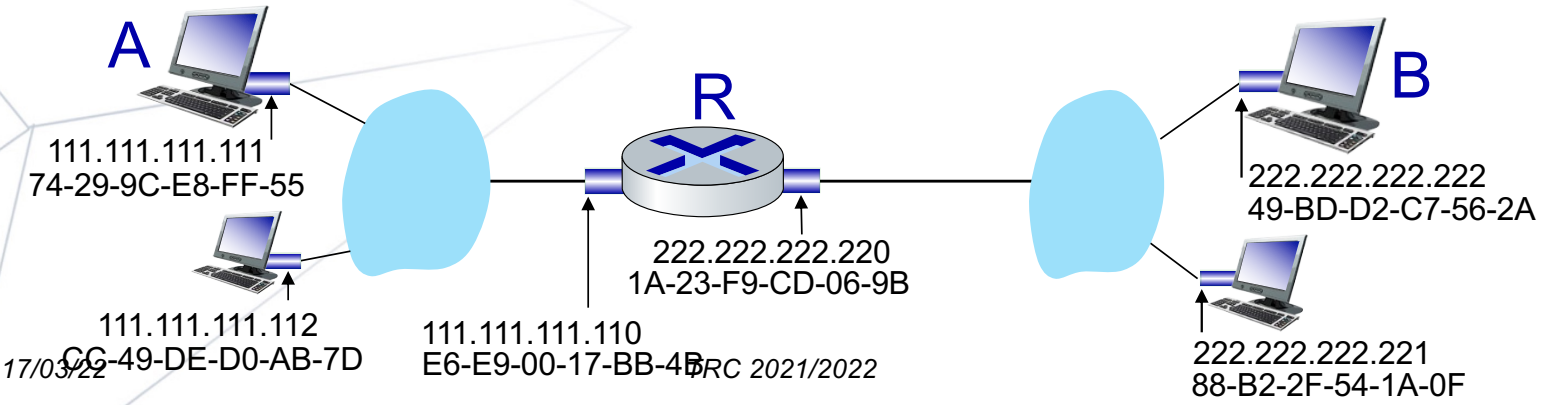



③ A receives B's reply, adds B entry into its local ARP table

# Routing to another subnet: addressing

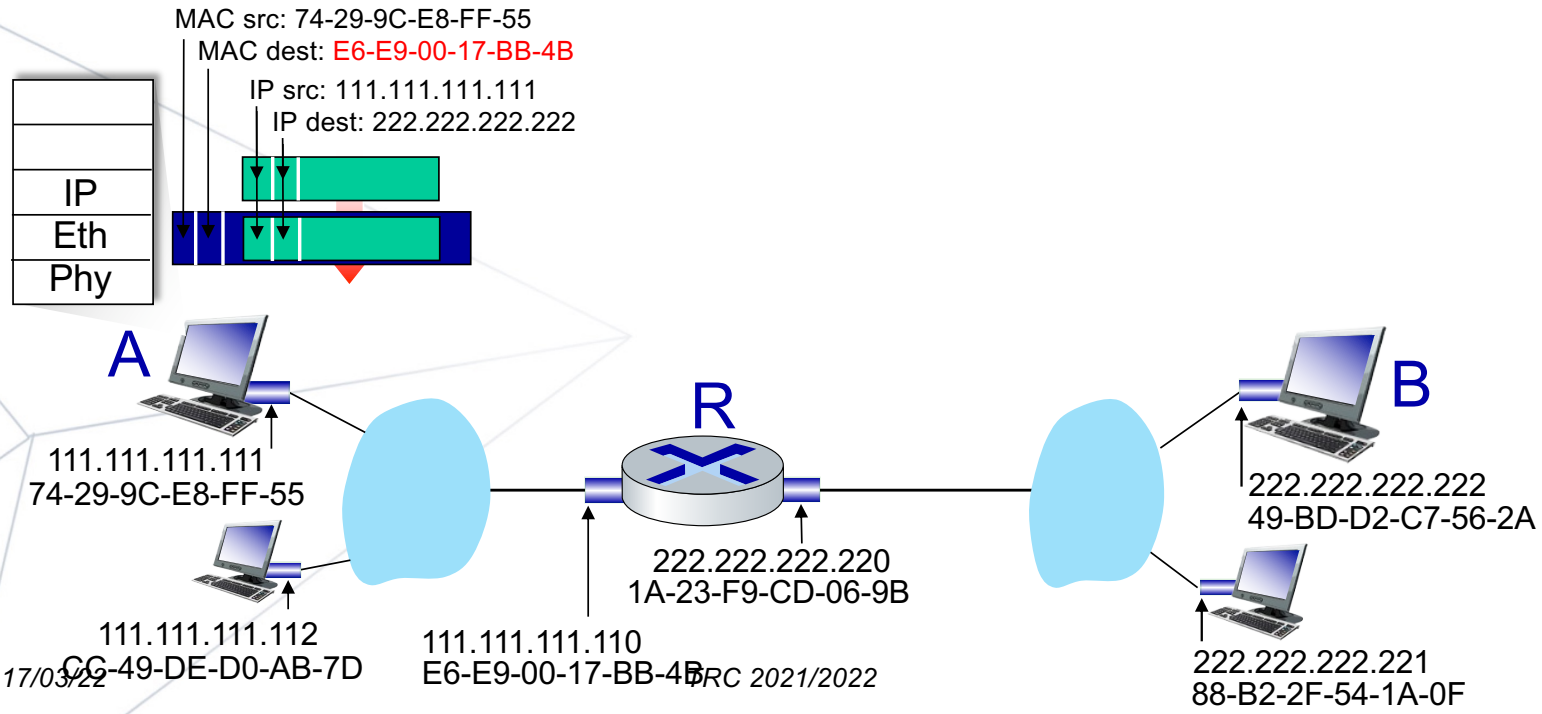
walkthrough: sending a datagram from *A* to *B* via *R*

- focus on addressing – at IP (datagram) and MAC layer (frame) levels
- assume that:
  - A knows B's IP address
  - A knows IP address of first hop router, R (how?)
  - A knows R's MAC address (how?)



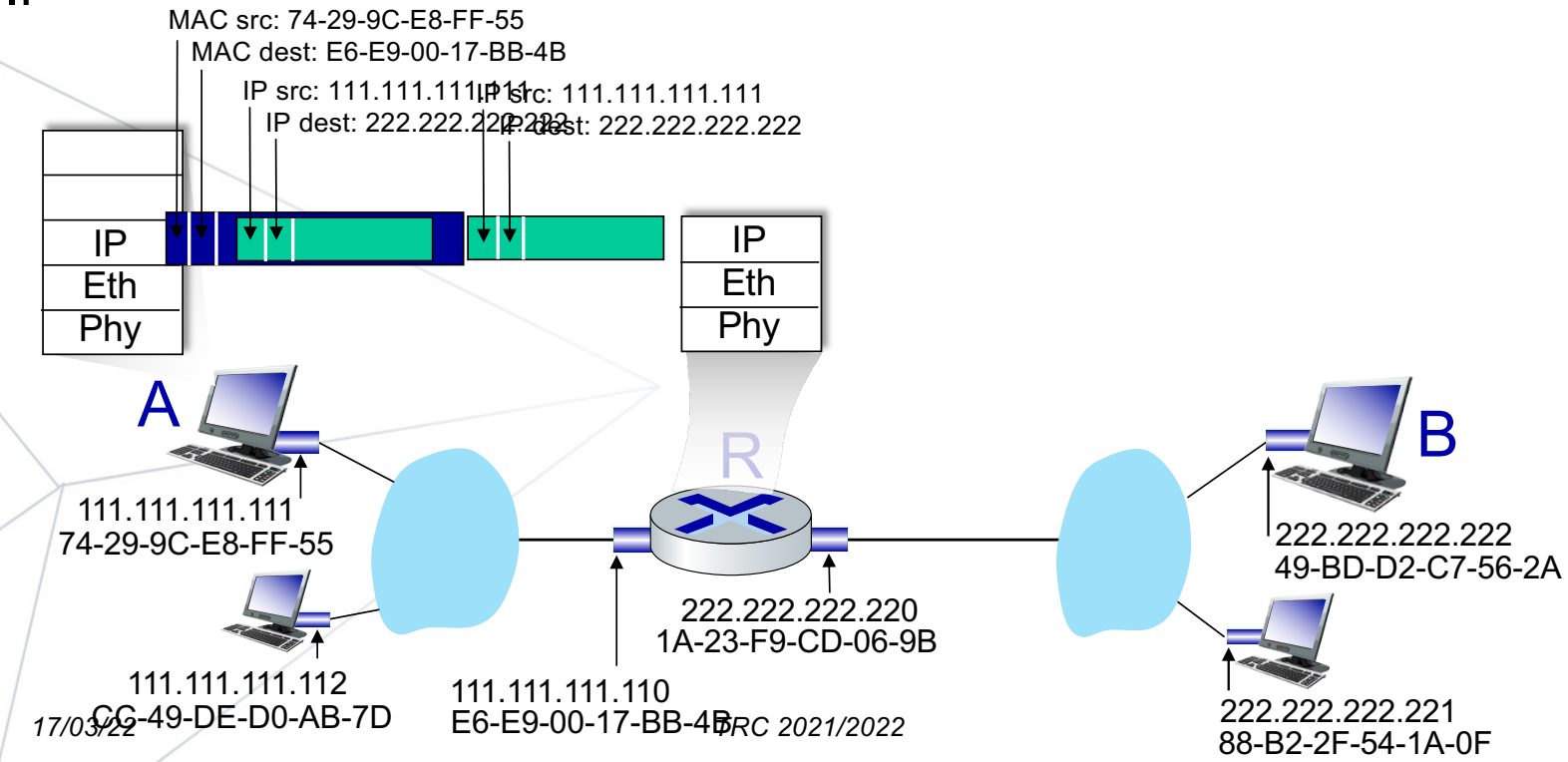
# Routing to another subnet: addressing

- A creates IP datagram with IP source A, destination B
- A creates link-layer frame containing A-to-B IP datagram
  - R's MAC address is frame's destination



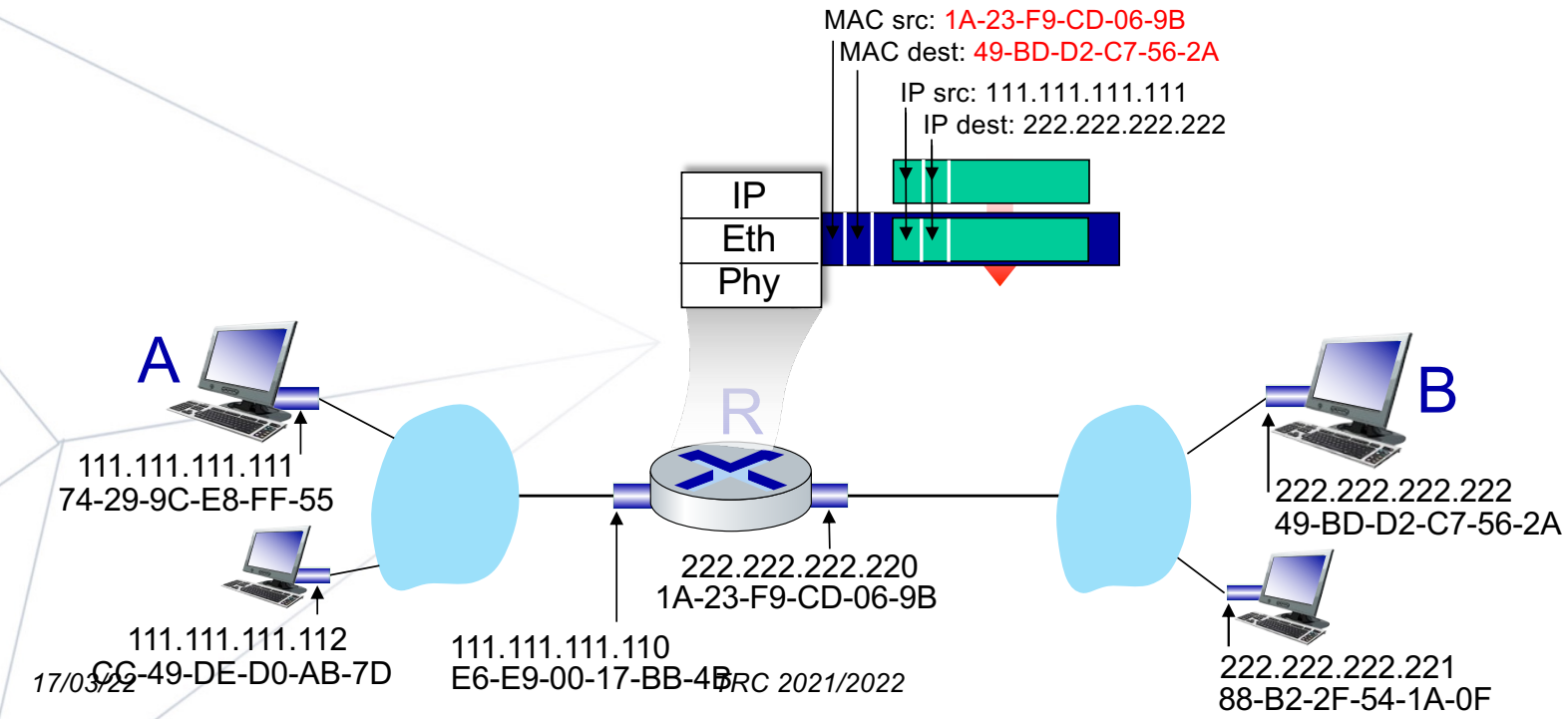
# Routing to another subnet: addressing

- frame sent from A to R
- frame received at R, datagram removed, passed up to IP



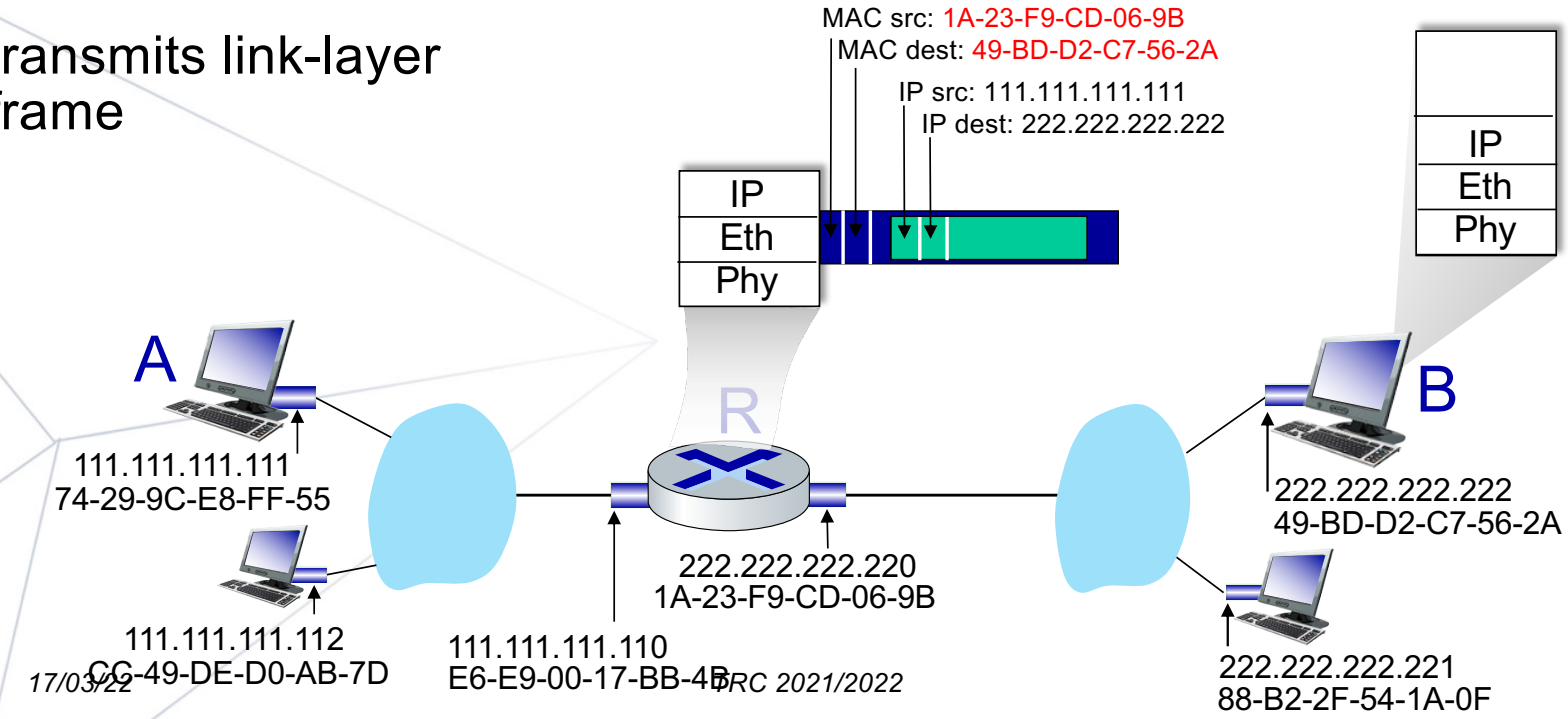
# Routing to another subnet: addressing

- R determines outgoing interface, passes datagram with IP source A, destination B to link layer
- R creates link-layer frame containing A-to-B IP datagram. Frame destination address: B's MAC address



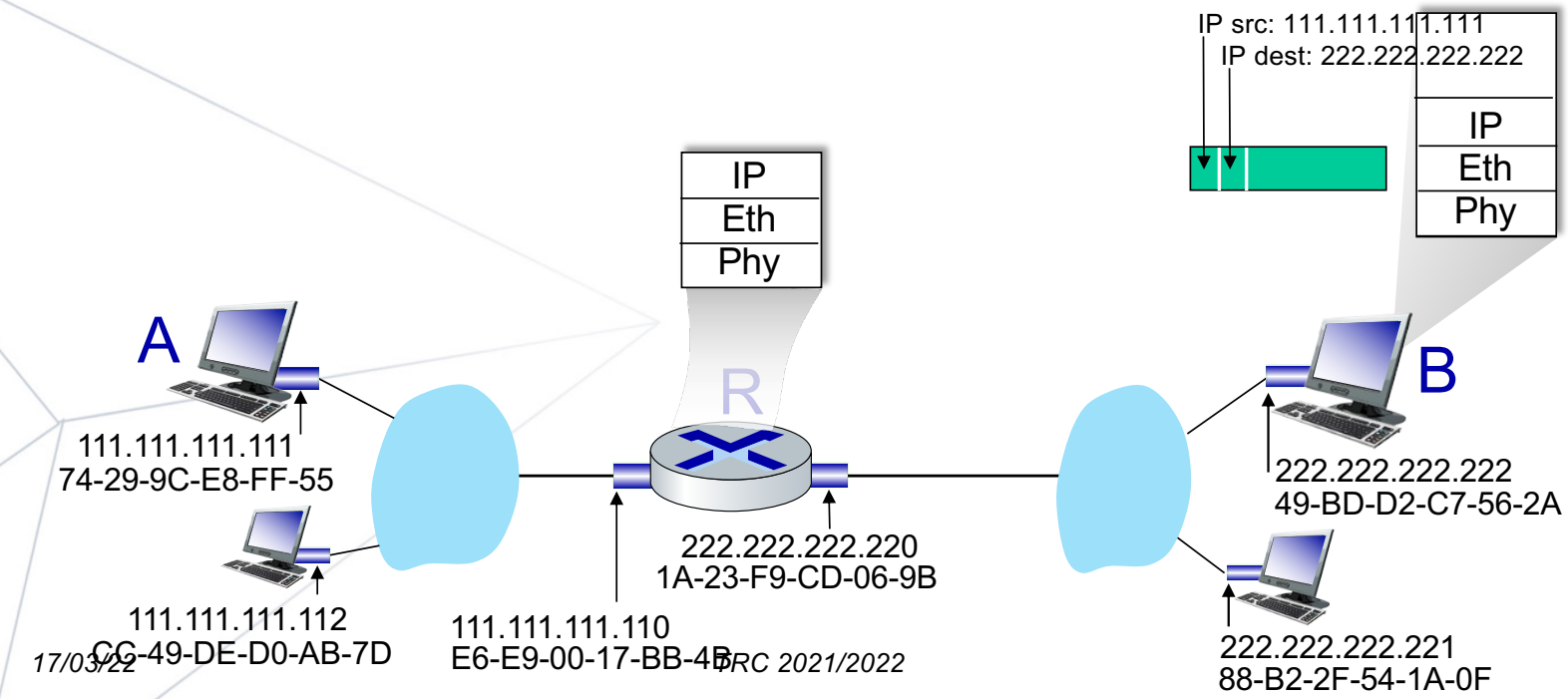
# Routing to another subnet: addressing

- R determines outgoing interface, passes datagram with IP source A, destination B to link layer
- R creates link-layer frame containing A-to-B IP datagram. Frame destination address: B's MAC address
- transmits link-layer frame

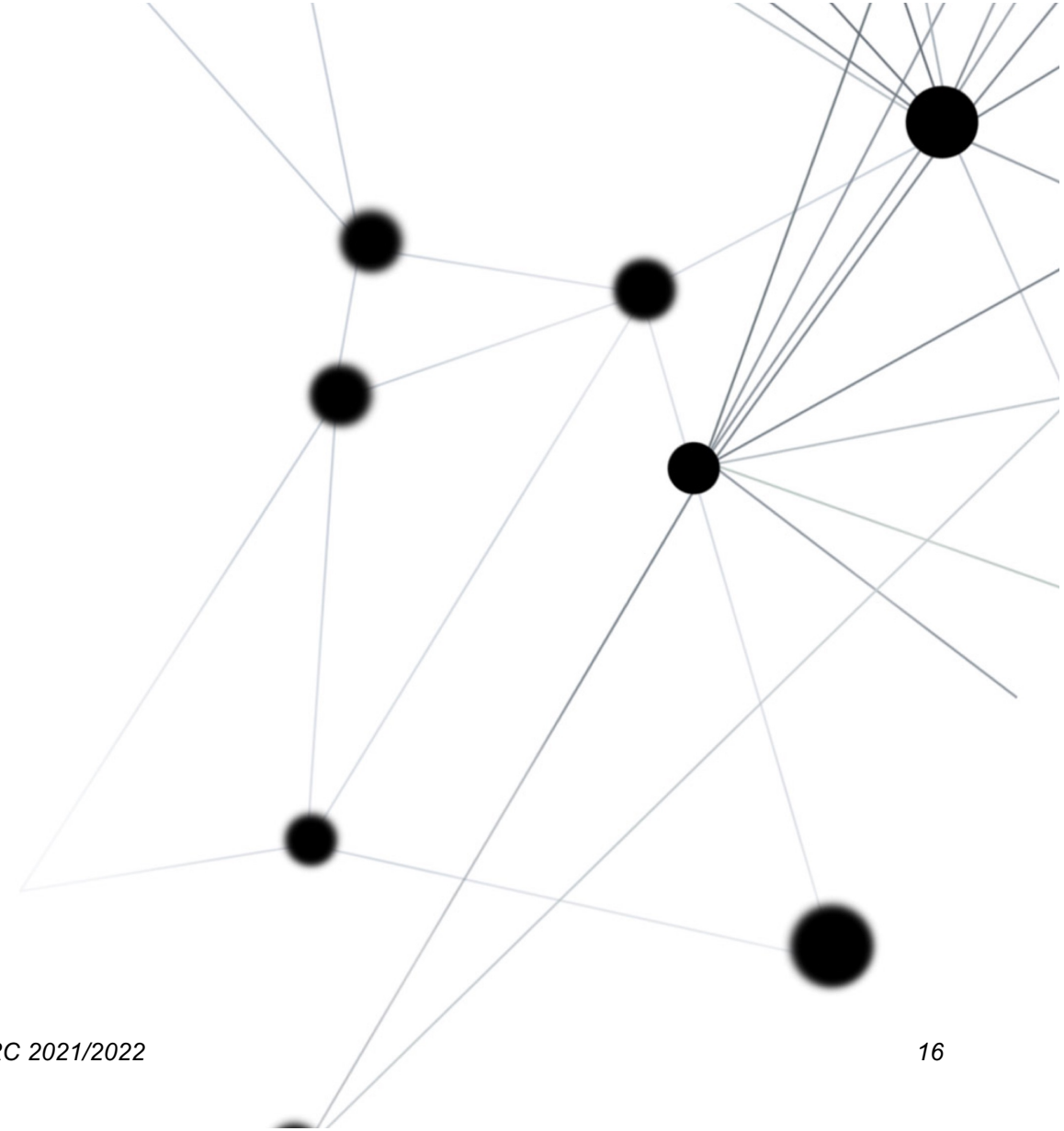


# Routing to another subnet: addressing

- B receives frame, extracts IP datagram destination B
- B passes datagram up protocol stack to IP

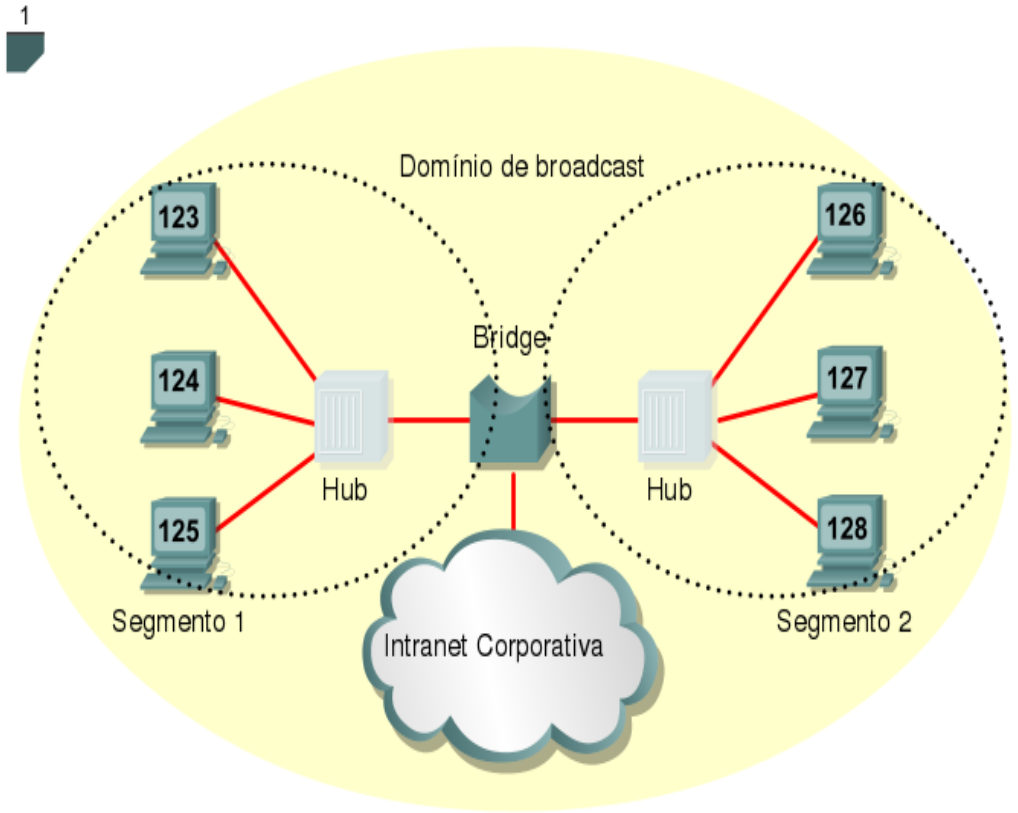


Comutação nas LANs

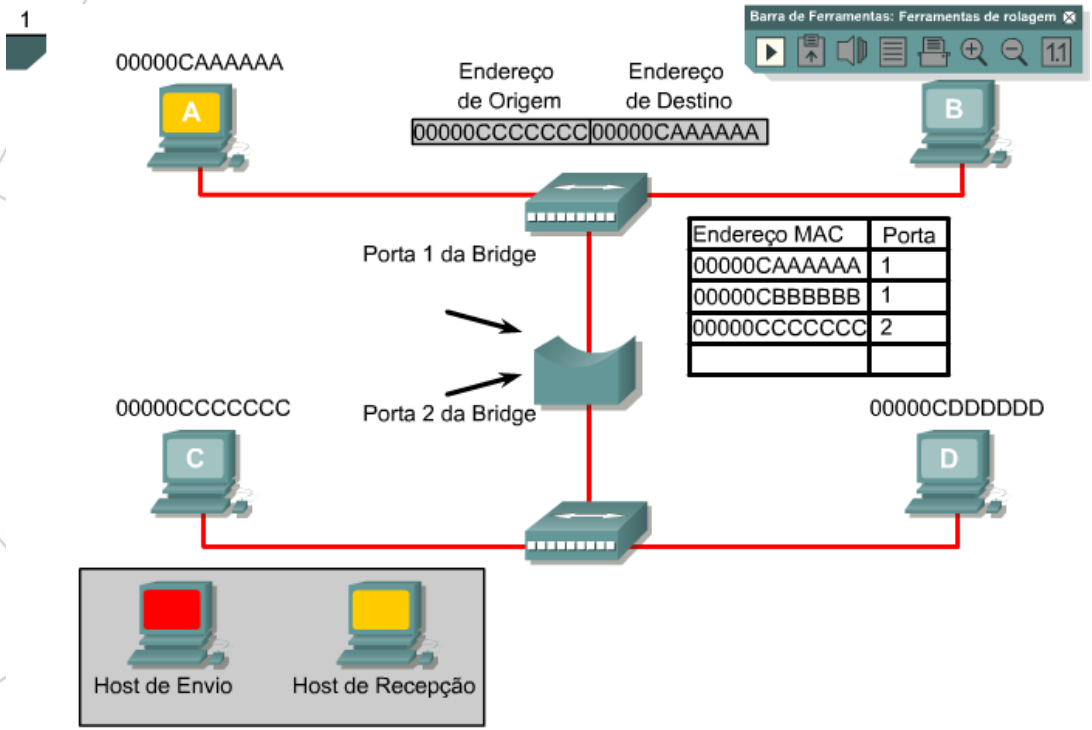


# Domínios de Colisão

- Área da rede o acesso ao meio é partilhado.
- Podem existir colisão entre pacotes enviados por cada uma das estações.



# Funcionamento de uma bridge

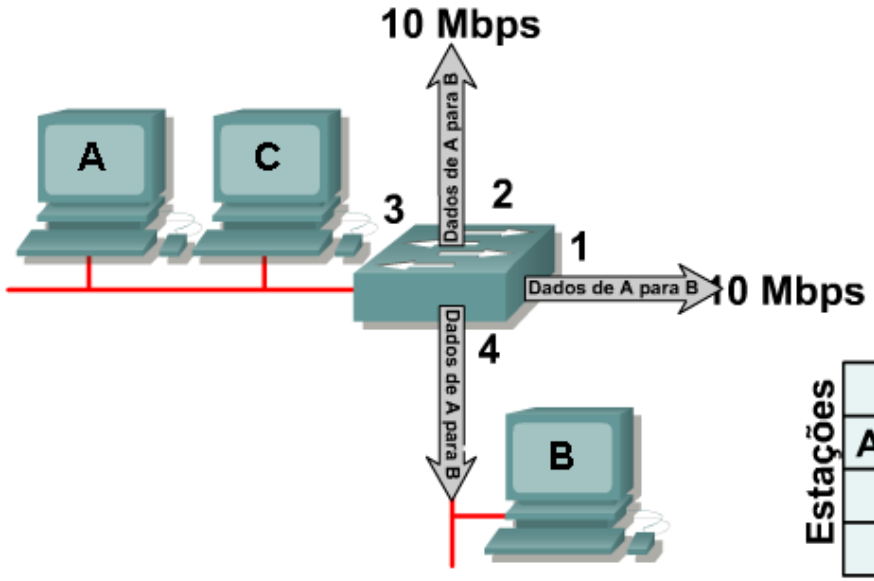



Quando o Host D transmite dados, o seu endereço MAC também é registrado na tabela da bridge. É assim que a bridge controla o tráfego entre os domínios de colisão.

# Switchs

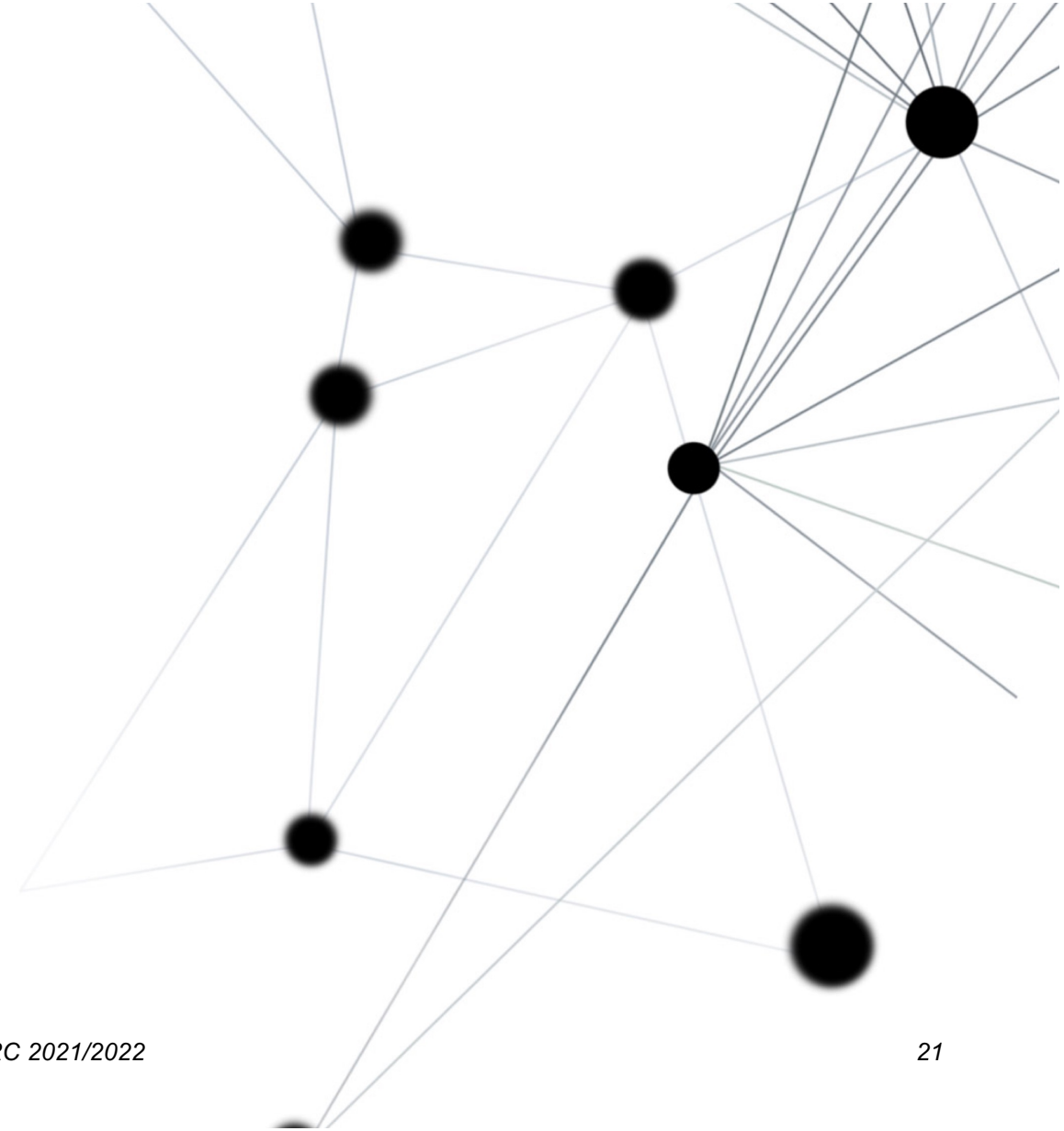
- Não são mais do que conjuntos de bridges.
- Com a baixa de preços dos equipamentos electrónicos vulgarizaram-se muito.
- Hoje em dia são muito mais baratos do que Hubs.

# Operação de um switch




- Encaminhar pacotes baseado no endereço MAC na tabela de encaminhamento
- Funciona na Camada 2 do Modelo OSI
- Aprende o local de uma estação ao examinar o endereço de origem

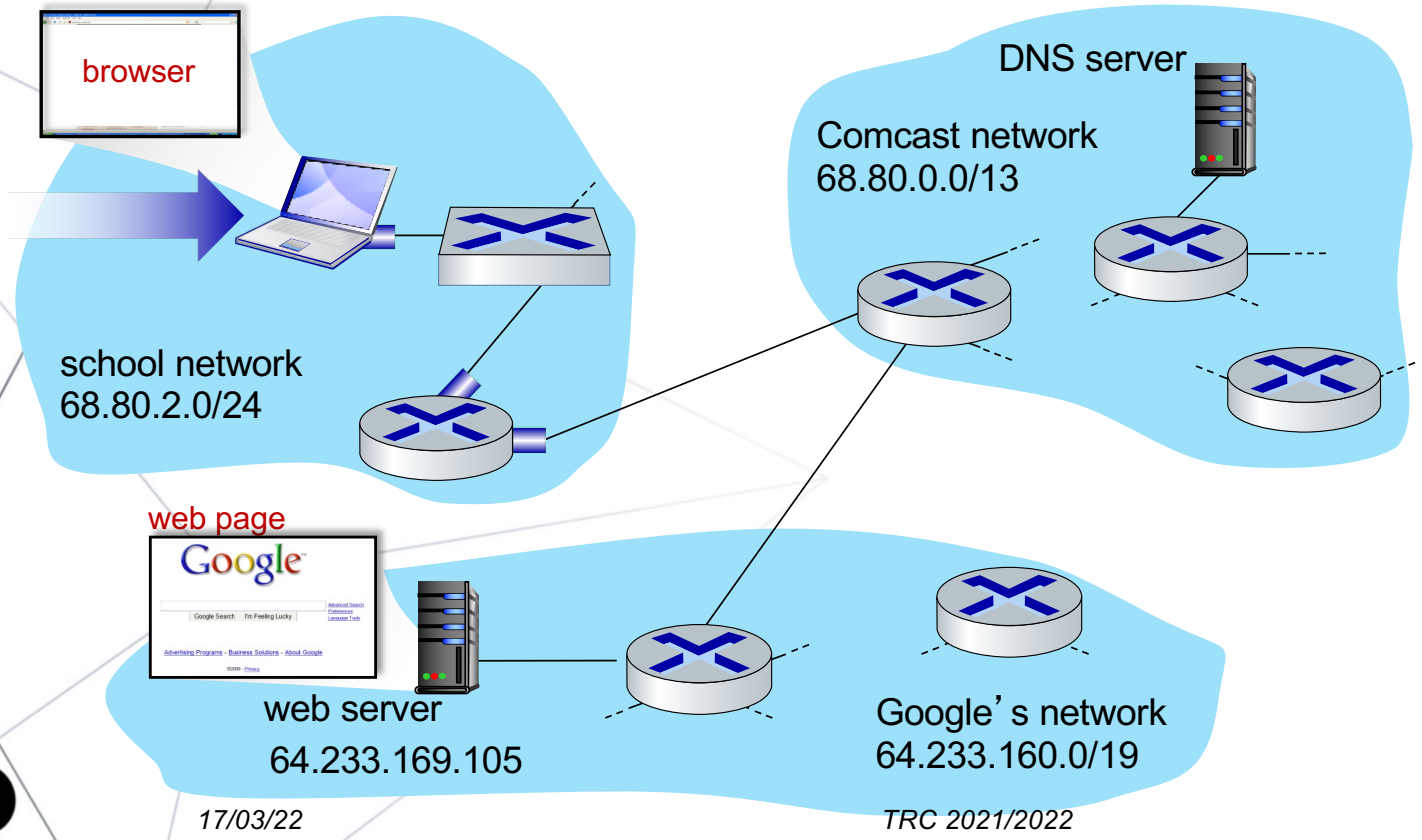
Resumindo tudo



# Synthesis: a day in the life of a web request

- our journey down the protocol stack is now complete!
  - application, transport, network, link
- putting-it-all-together: synthesis!
  - *goal:* identify, review, understand protocols (at all layers) involved in seemingly simple scenario: requesting www page
  - *scenario:* student attaches laptop to campus network, requests/receives www.google.com

# A day in the life: scenario

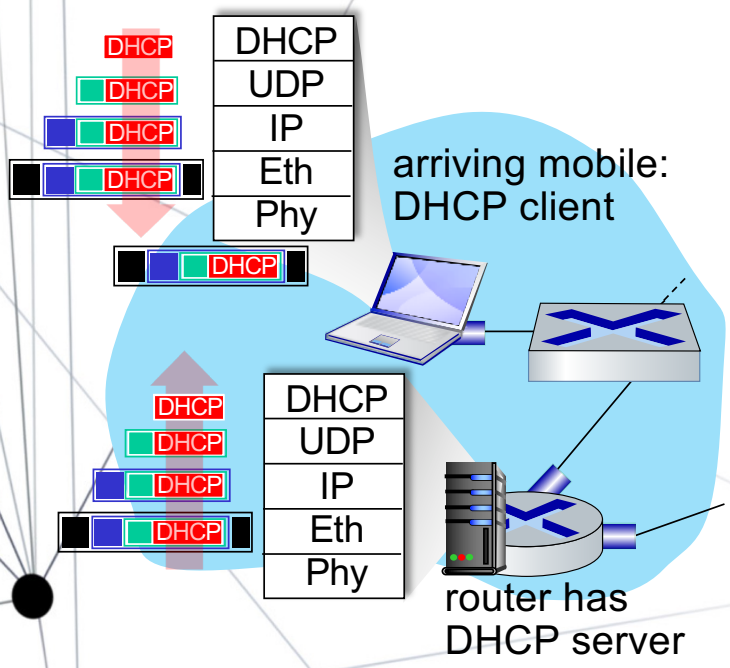



scenario:

- arriving mobile client attaches to network …
- requests web page: www.google.com

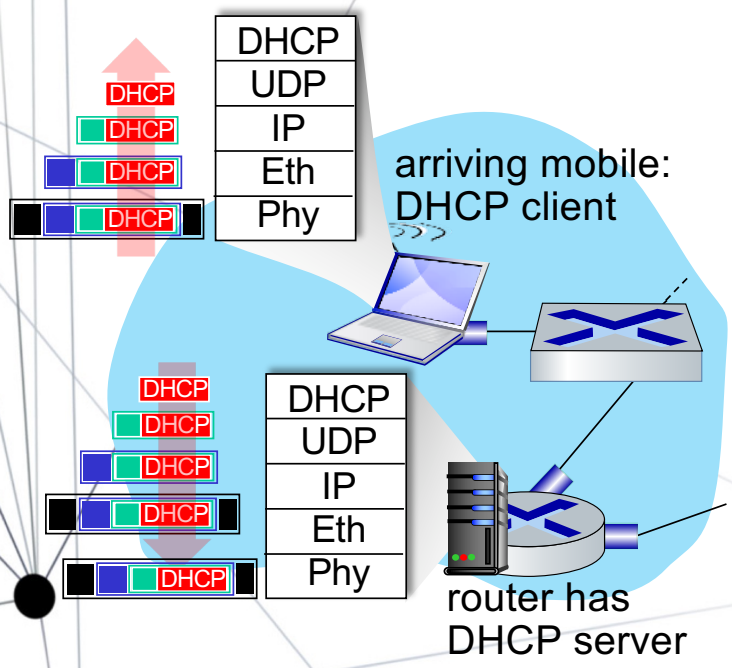
*Sounds simple!*

# A day in the life: connecting to the Internet




- connecting laptop needs to get its own IP address, addr of first-hop router, addr of DNS server: use DHCP
- DHCP request encapsulated in UDP, encapsulated in IP, encapsulated in 802.3 Ethernet
- Ethernet frame broadcast (dest: FFFFFFFFFFFF) on LAN, received at router running DHCP server
- Ethernet demuxed to IP demuxed, UDP demuxed to DHCP

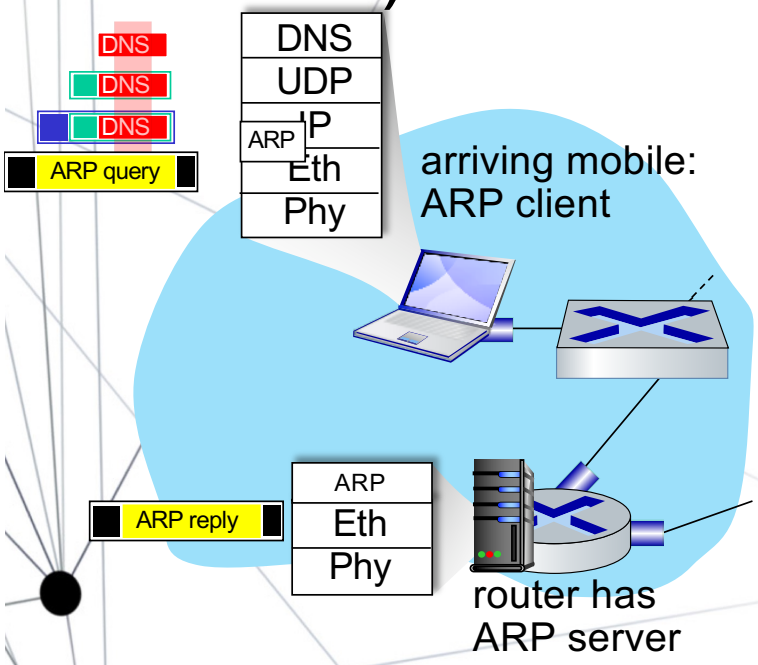
# A day in the life: connecting to the Internet




- DHCP server formulates DHCP ACK containing client's IP address, IP address of first-hop router for client, name & IP address of DNS server
- encapsulation at DHCP server, frame forwarded (switch learning) through LAN, demultiplexing at client
- DHCP client receives DHCP ACK reply

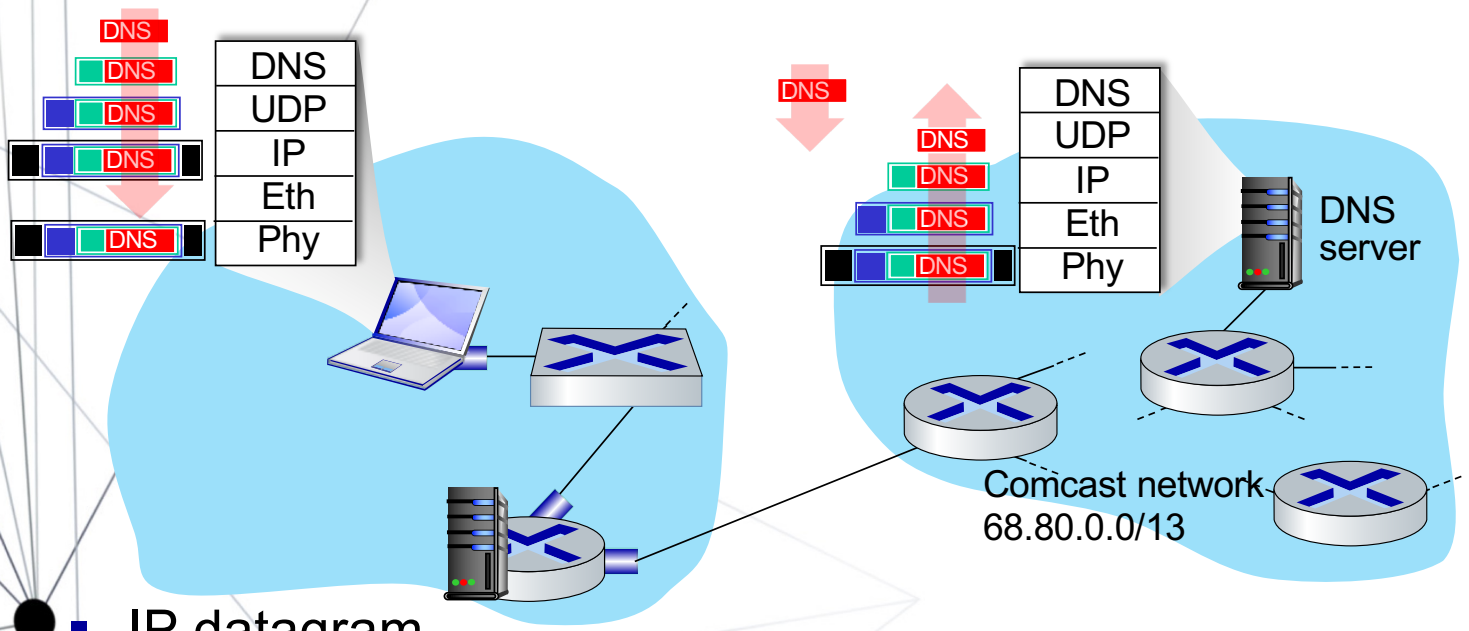
*Client now has IP address, knows name & addr of DNS server, IP address of its first-hop router*

# A day in the life… ARP (before DNS, before HTTP)



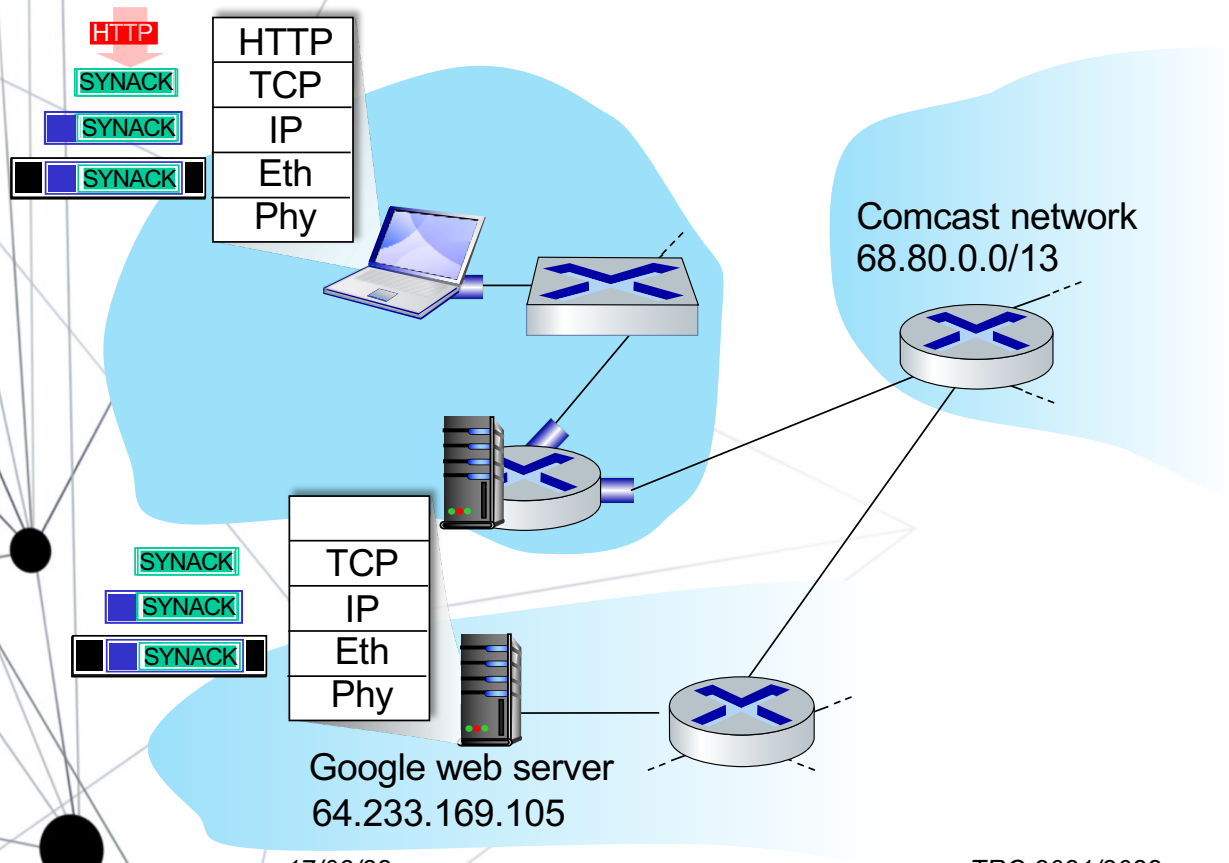

- before sending HTTP request, need IP address of www.google.com: DNS
- DNS query created, encapsulated in UDP, encapsulated in IP, encapsulated in Eth. To send frame to router, need MAC address of router interface: ARP
- ARP query broadcast, received by router, which replies with ARP reply giving MAC address of router interface
- client now knows MAC address of first hop router, so can now send frame containing DNS query

# A day in the life… using DNS



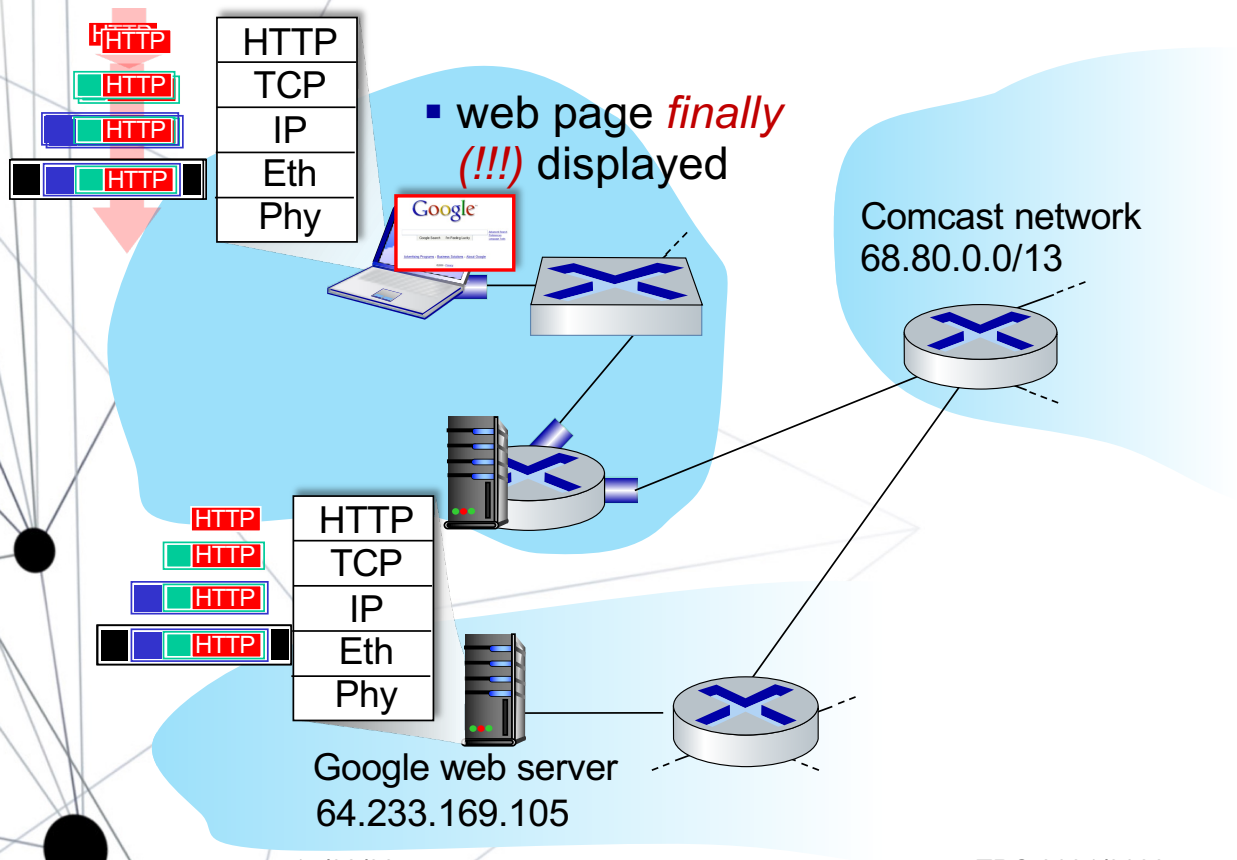

- IP datagram containing DNS query forwarded via LAN switch from client to 1st hop router
- IP datagram forwarded from campus network into Comcast network, routed (tables created by RIP, OSPF, IS-IS and/or BGP routing protocols) to DNS server
- demuxed to DNS
- DNS replies to client with IP address of www.google.com

# A day in the life…TCP connection carrying HTTP




- to send HTTP request, client first opens TCP socket to web server
- TCP SYN segment (step 1 in TCP 3-way handshake) inter-domain routed to web server
- web server responds with TCP SYNACK (step 2 in TCP 3-way handshake)
- TCP connection established!

# A day in the life… HTTP request/reply




- HTTP request sent into TCP socket
- IP datagram containing HTTP request routed to www.google.com
- web server responds with HTTP reply (containing web page)
- IP datagram containing HTTP reply routed back to client

# Mais informação

- “Computer Networking: A Top-Down Approach”,  8th edition, Jim Kurose, Keith Ross Pearson, 2020
- "Computer Networks", Andrew Tanenbaum, 3rd ed. Prentice Hall, 1996.
- “Internetworking with TCP-IP”, Douglas E. Comer
- “Data and Computer Communications”, William Stallings

# E é tudo...

- Questões?
- Comentários?