Logistics

- HW4sol: posted
- HW5:
  - due on ~~Fri 5pm~~ (EH 4207), Sat 2pm (online)
  - solution will be posted then
- Evaluations
  - open until June 5th
  - as of today: 93/287
  - ok here it is: +1% for completing it
- Office hours
  - Thu: Kasra 14:00-16:00, EH3404
  - Fri: Fred 11:00-13:00, EH3404
  - Mon: Sush 15:00-17:00, EH3404
  - Athina's extra on Mon: 2-3pm in EH 4207

Final Exam

- Tue 6/7 8-10am

- Same format as midterm
  - Open books/notes/paper materials
  - No phones/laptops/any electronics
  - Come early, so we can get seated and start on time
  - In addition: bring your IDs
- All inclusive but more focus on later chapters
  - everything we covered minus some sections (see next)

- Sample Final and Solution posted (F13)

How to prepare

- Lectures + Discussions: slides
- Class website: homeworks + solutions, Midterm, Sample Exams
- Book:
  - Reading: only sections listed in black in this review (not the ones in gray)
  - Problems
  - Companion website: interactive exercises, self-assessment, applets
- Focus on 2nd part, but all inclusive
  - See sample final+solution from F13

Predictable and familiar (≠trivial)

- A day in the life of a web request (5.7)
  - You should practice it on your own!!

Chapter 1: Introduction

1.1 What is the Internet?

1.2 Network edge

1.3 Network core

1.4 Performance, Network core

1.5 Protocol layers, service models

1.6 Networks under attack: security

1.7 History

Chapter 2: Application layer

2.1 Principles of network applications

2.2 Web and HTTP

2.3 FTP

2.4 Electronic Mail

- SMTP, POP3, IMAP

2.5 DNS

2.6 P2P applications

2.7 Socket programming with TCP

2.8 Socket programming with UDP

Chapter 3: Transport Layer

3.1 Transport-layer services

3.2 Multiplexing and demultiplexing

3.3 Connectionless transport: UDP

3.4 Principles of reliable data transfer

3.5 Connection-oriented transport: TCP

- segment structure
- reliable data transfer
- flow control
- connection management

3.6 Principles of congestion control

3.7 TCP congestion control

Chapter 4: Network Layer

4. 1 Introduction

4.2 Virtual circuit and datagram networks

4.3 What's inside a router

4.4 IP: Internet Protocol

- Datagram format
- IPv4 addressing
- ICMP
- IPv6
- IP security

4.5 Routing algorithms

- Link state
- Distance Vector
- Hierarchical routing

4.6 Routing in the Internet

- RIP
- OSPF
- BGP

4.7 Broadcast and multicast routing

Chapter 5: Link Layer

5.1 Introduction

5.2 Error detection and correction

5.3 Multiple access protocols

- 5.3.1: Channel partitioning: TDMA, FDMA, (CDMA)
- 5.3.2: Random access: Aloha, Slotted Aloha, CSMA, CSMA/CD
- Taking turns, DOCSIS

5.4 LANs

- addressing, ARP, Ethernet, switches, VLANS

5.5 Link virtualization: MPLS

5.6 Data center networking

5.7 day in the life of a web request

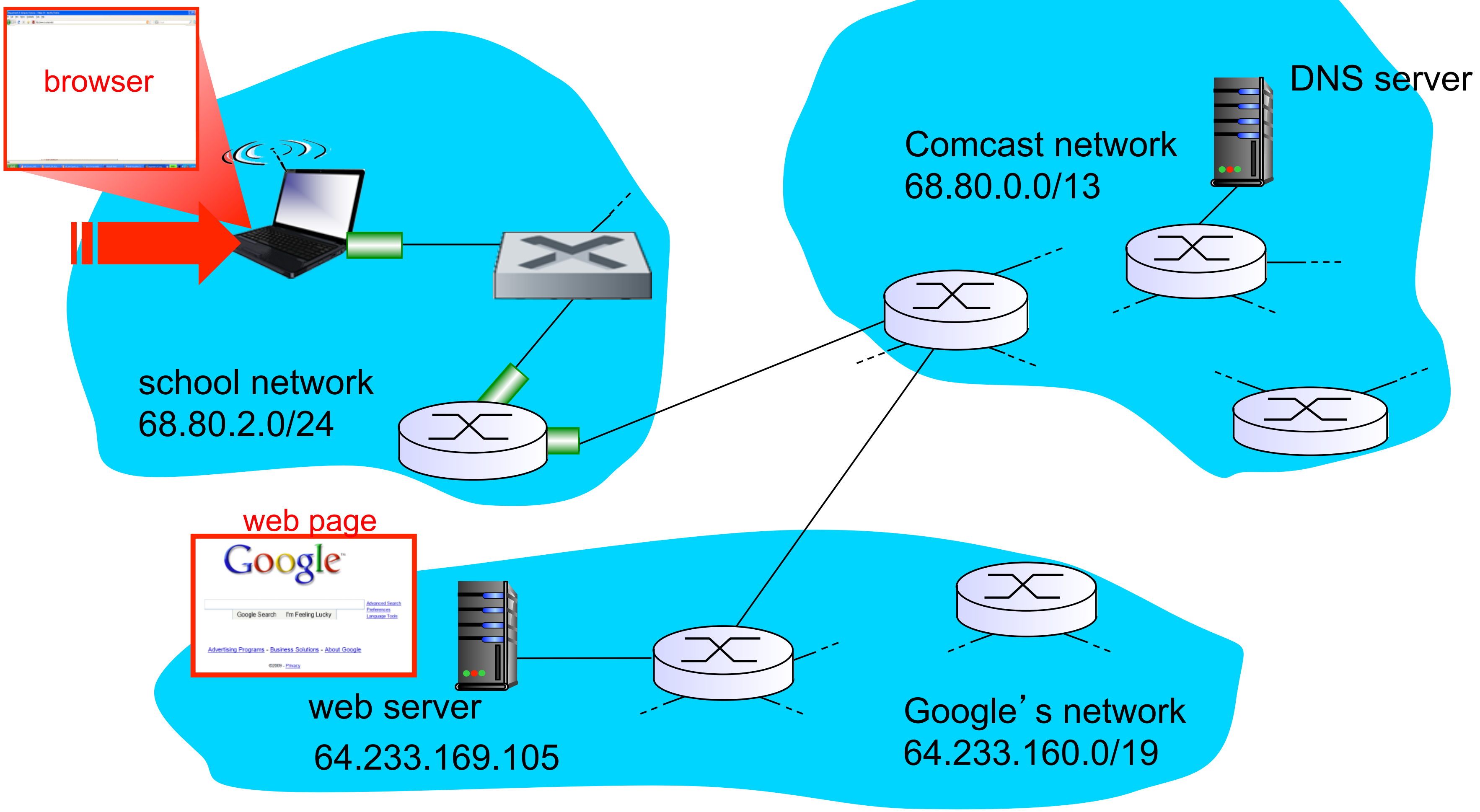
More networking at UCI

- http://www.networkedsystems.uci.edu/
  - MS and PhD program
  - Faculty from EECS and ICS
  - Courses
  - Individual Research
  - Senior Design in CS and EE/CpE

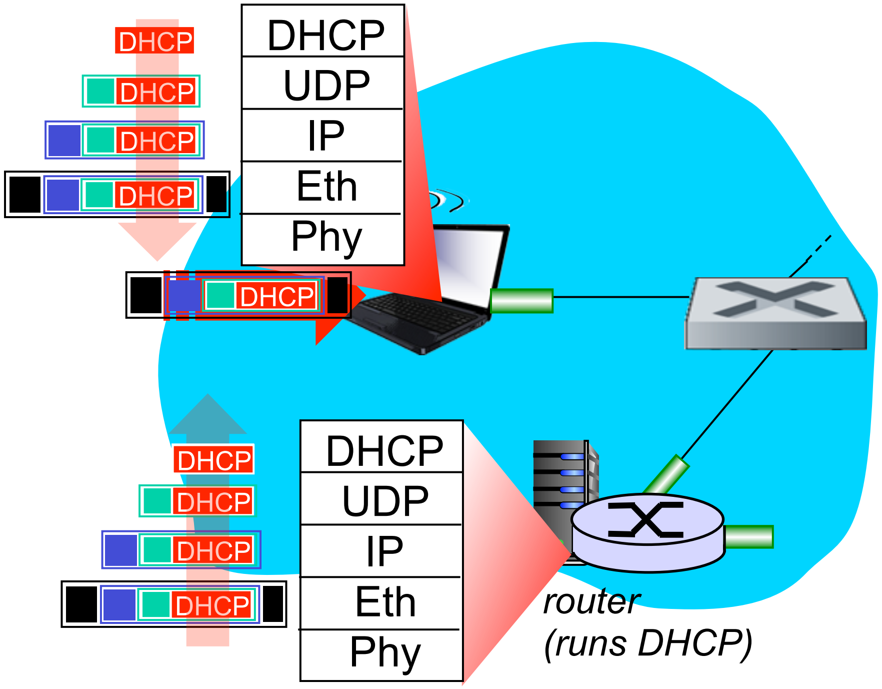
Synthesis: a day in the life of a web request

- A day in the life of a web request (5.7)
  - You should practice it on your own!!
- journey down protocol stack 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

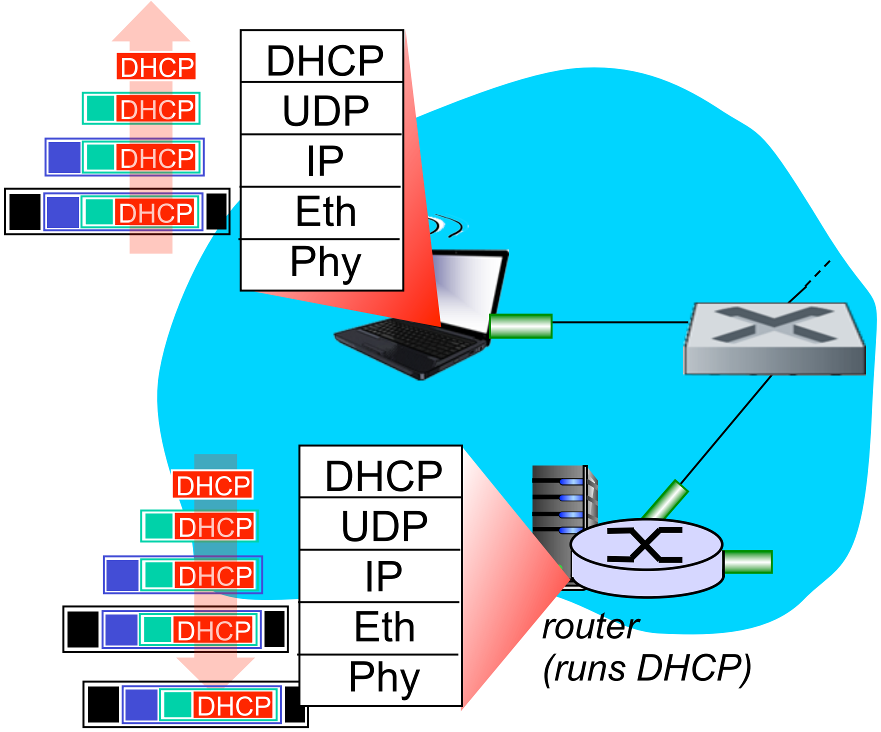


A day in the life… connecting to the Internet



- 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

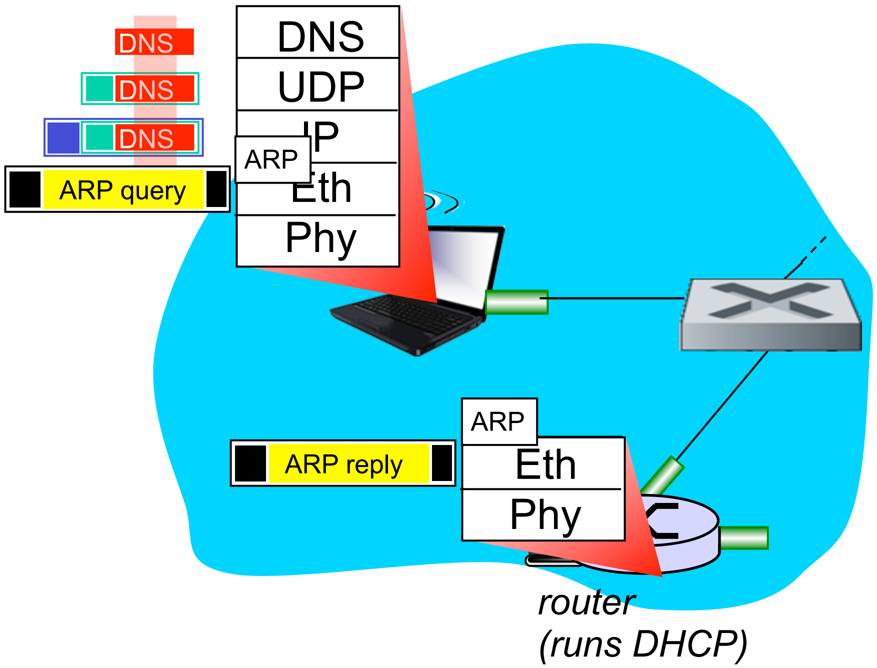
A day in the life… connecting to the Internet



- 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

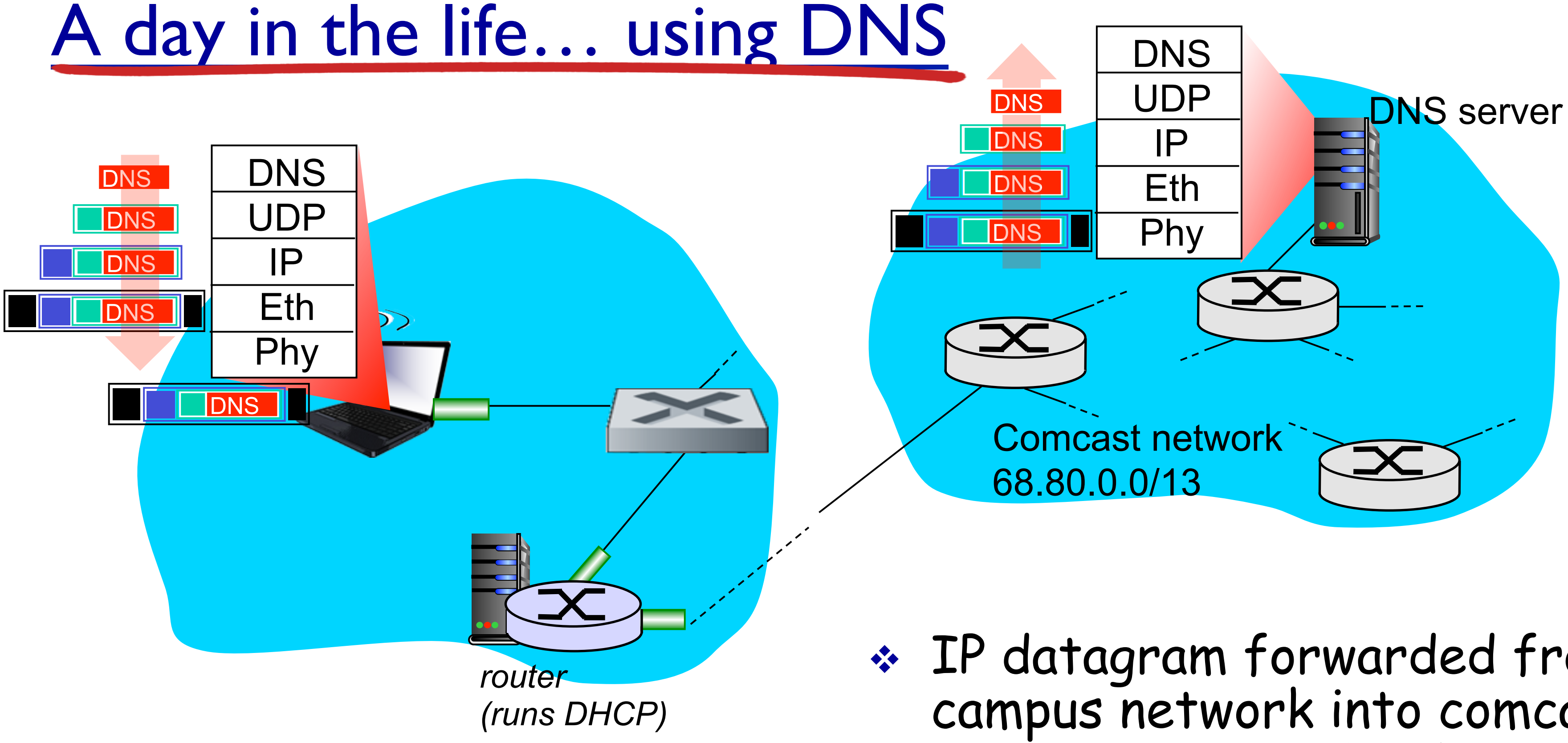
Client now has IP address, knows name & addr of DNS server, IP address of its first-hop router

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

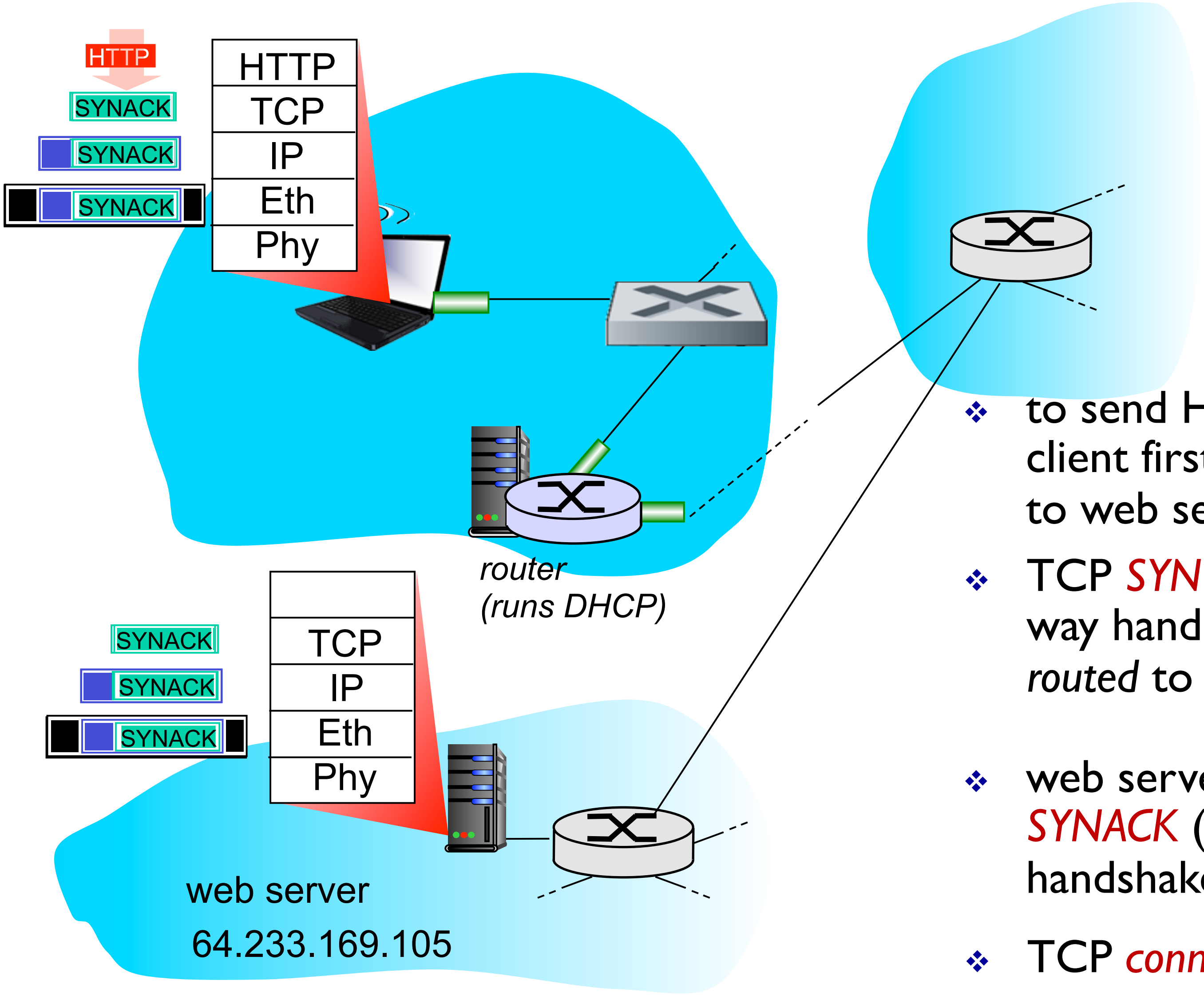
A day in the life… using DNS



- IP datagram containing DNS query forwarded via LAN switch from client to 1st hop router

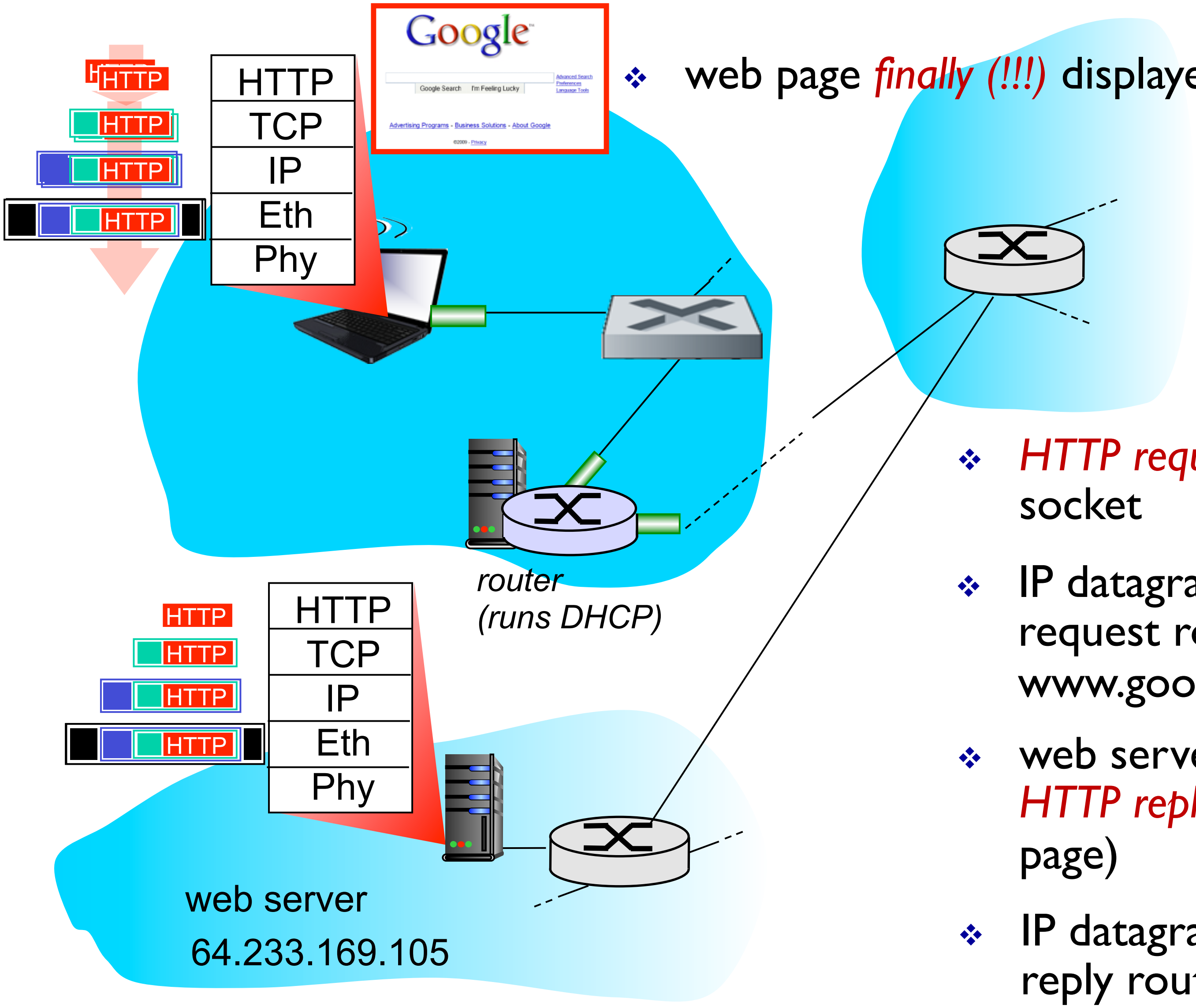
- IP datagram forwarded from campus network into comcast network, routed (tables created by *RIP, OSPF, IS-IS* and/or *BGP* routing protocols) to DNS server
- demux'ed to DNS server
- DNS server replies to client with IP address of www.google.com

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 3-way handshake) *inter-domain routed* to web server
- web server responds with *TCP SYNACK* (step 2 in 3-way handshake)
- TCP *connection established!*

A day in the life… HTTP request/reply



- web page *finally (!!!)* displayed

- *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

The End