



COMPUTER NETWORKS

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- Introduction
- Error detection, correction
- Multiple access protocols
- LANs
 - Addressing, ARP
 - Ethernet
 - Switches
- Physical layer
- Wireless LANs: IEEE 802.11
- A day in the life of a web request





- Synthesis of web request..

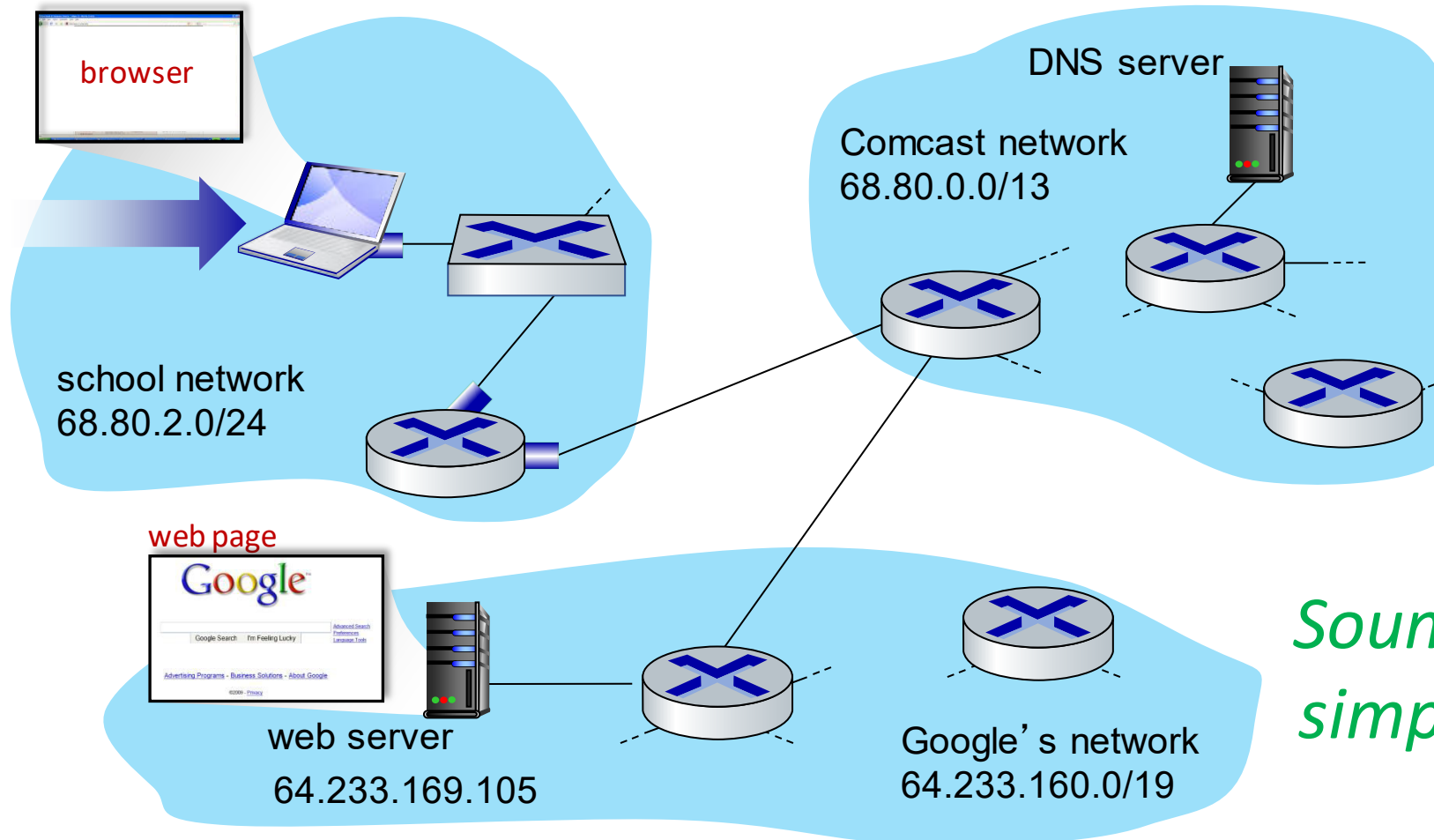


- Our journey down the protocol stack is now complete!
 - application, transport, network, link
- Putting-it-all-together: synthesis!
 - *Goal:* identify, review, understand protocols (at all layers) involved in seemingly simple scenario: requesting www page
 - *Scenario:* student attaches laptop to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

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A day in the life of a web request

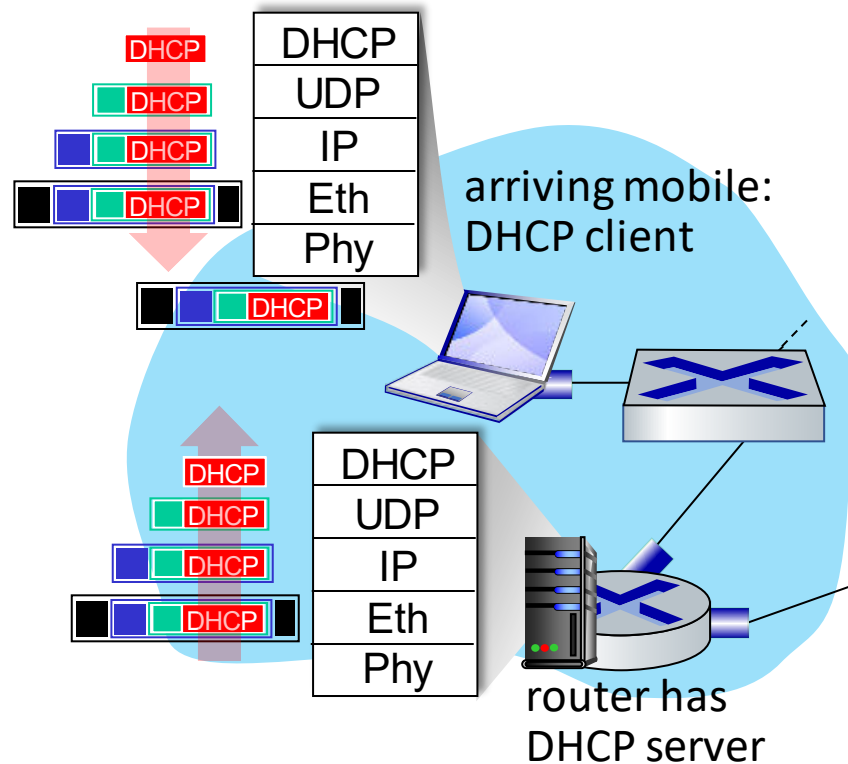
Scenario:



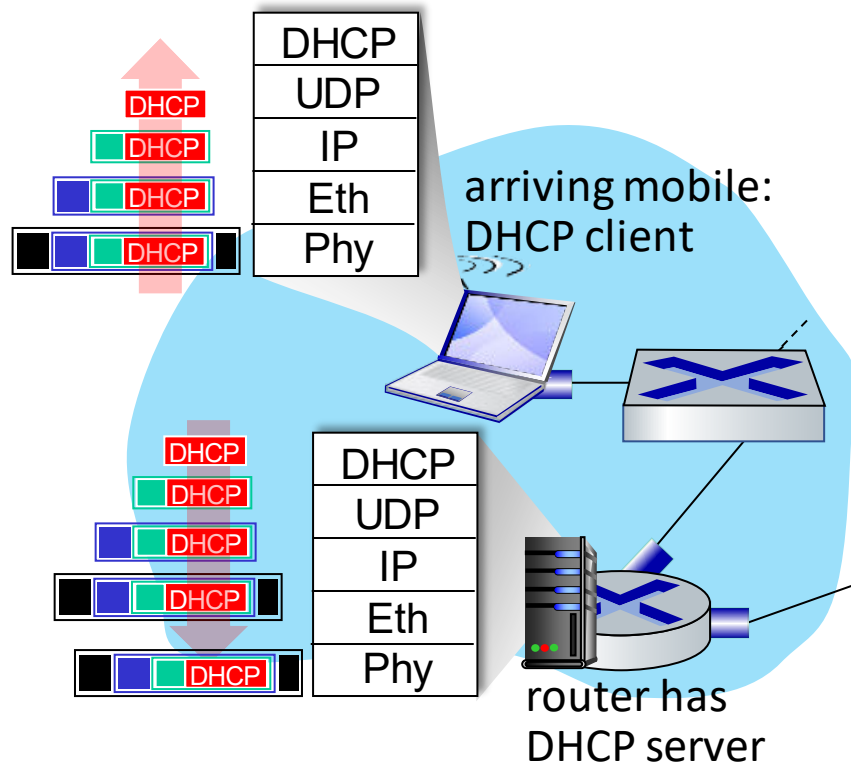
- Arriving mobile client attaches to network ...
- Requests web page: www.google.com

Sounds simple!





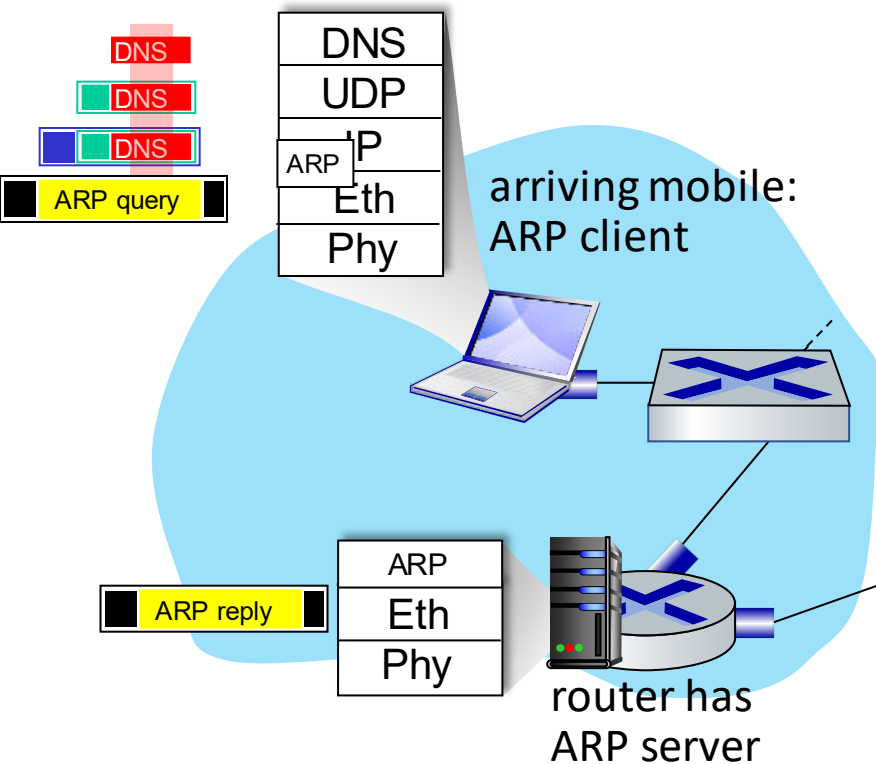
- Connecting laptop needs to get its own IP address, addr of first-hop router, addr of DNS server: use **DHCP**
- DHCP request **encapsulated** in **UDP**, encapsulated in **IP**, encapsulated in **802.3** Ethernet
- Ethernet frame **broadcast** (dest: FFFFFFFFFFFFFFFF) on LAN, received at router running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



- 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)

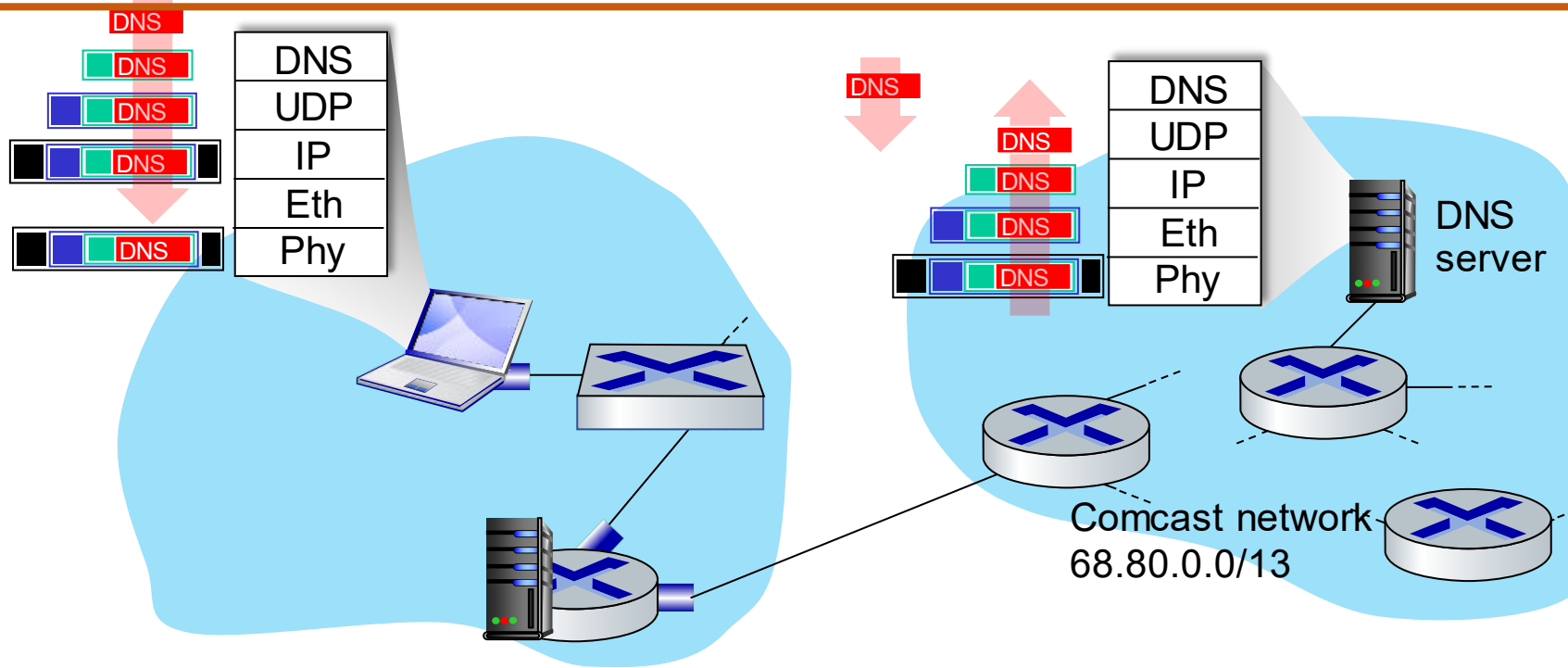


- Before sending **HTTP** request, need IP address of `www.google.com`: **DNS**
- DNS query created, encapsulated in UDP, encapsulated in IP, encapsulated in Eth. To send frame to router, need MAC address of router interface: **ARP**
- **ARP query** broadcast, received by router, which replies with **ARP reply** giving MAC address of router interface

- Client now knows MAC address of first hop router, so can now send frame containing DNS query

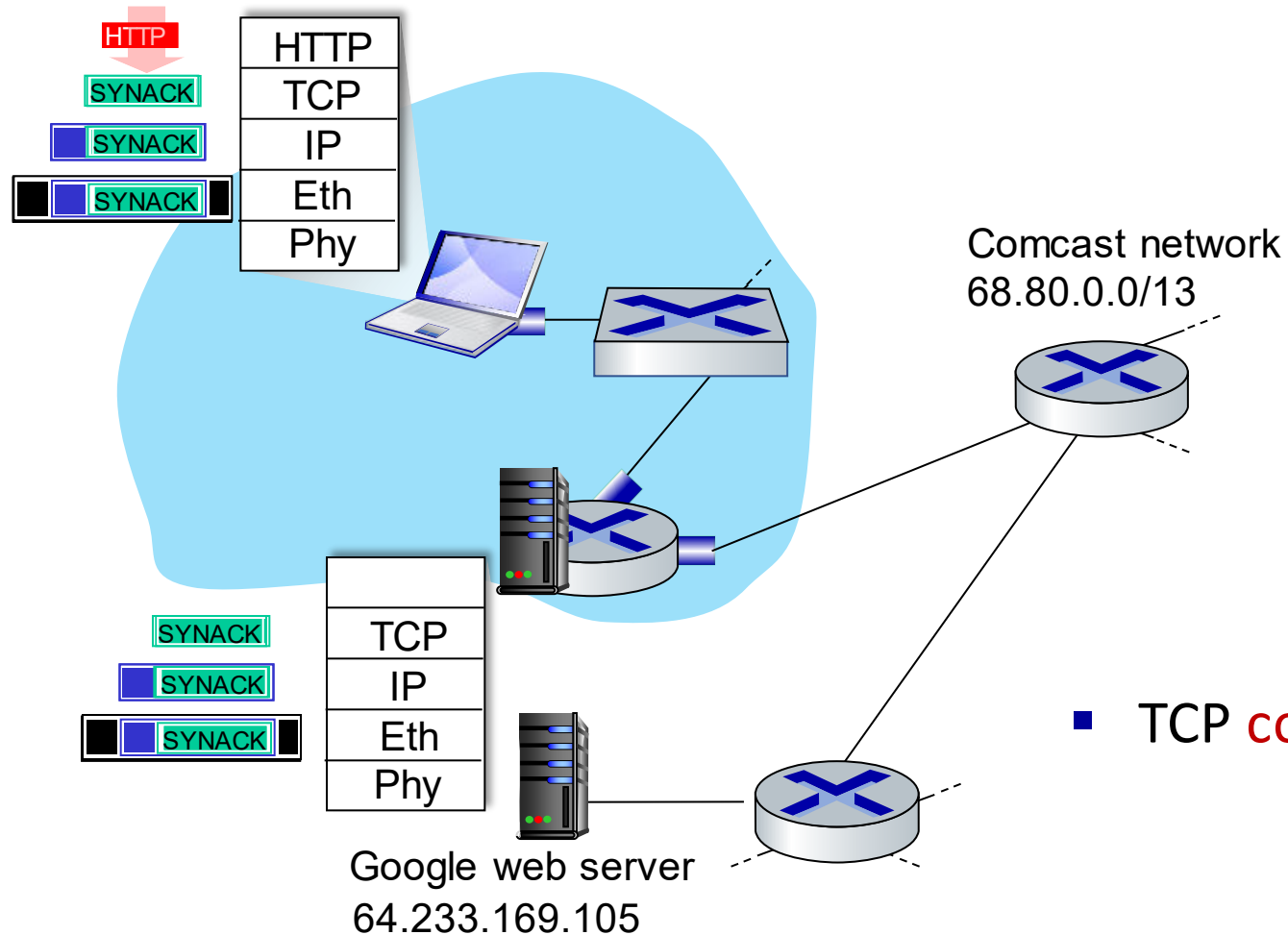
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A day in the life.... Using DNS

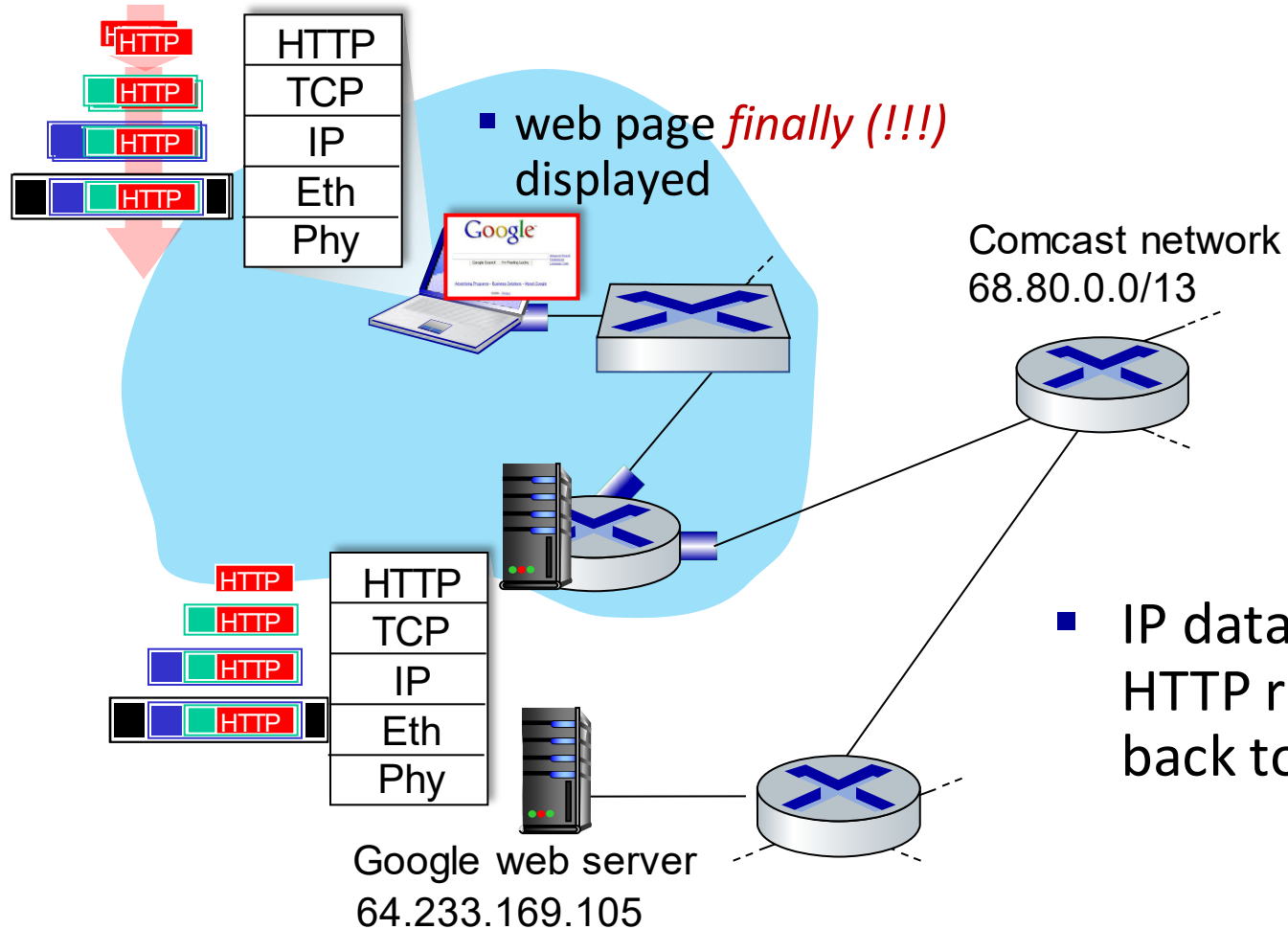


- IP datagram containing DNS query forwarded via LAN switch from client to 1st hop router
- IP datagram forwarded from campus network into Comcast network, routed (tables created by **RIP**, **OSPF**, **IS-IS** and/or **BGP** routing protocols) to DNS server

- Demuxed to DNS
- DNS replies to client with IP address of www.google.com



- 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!**



- 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

- Principles behind data link layer services:
 - Error detection, correction
 - Sharing a broadcast channel: multiple access
 - Link layer addressing
- Instantiation, implementation of various link layer technologies
 - Ethernet
 - switched LANS
- Synthesis: a day in the life of a web request
- Intro to Physical layer and Wireless LAN

- Journey down protocol stack *complete*
- Solid understanding of networking principles, practice!
- could stop here but *more* interesting topics!
 - deep understanding of wireless
 - security



THANK YOU

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