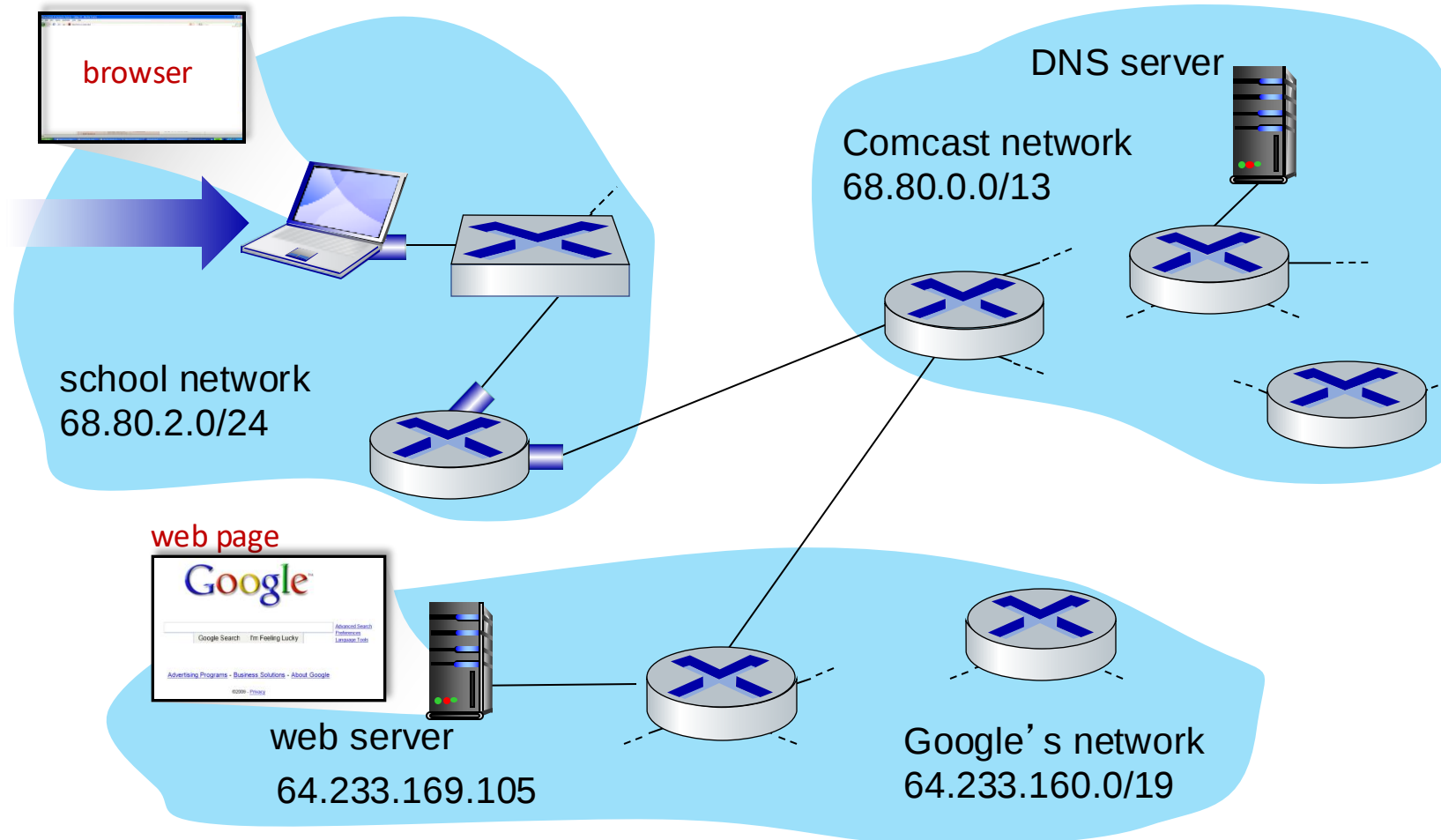


Synthesis: a day in the life of a web request

- 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

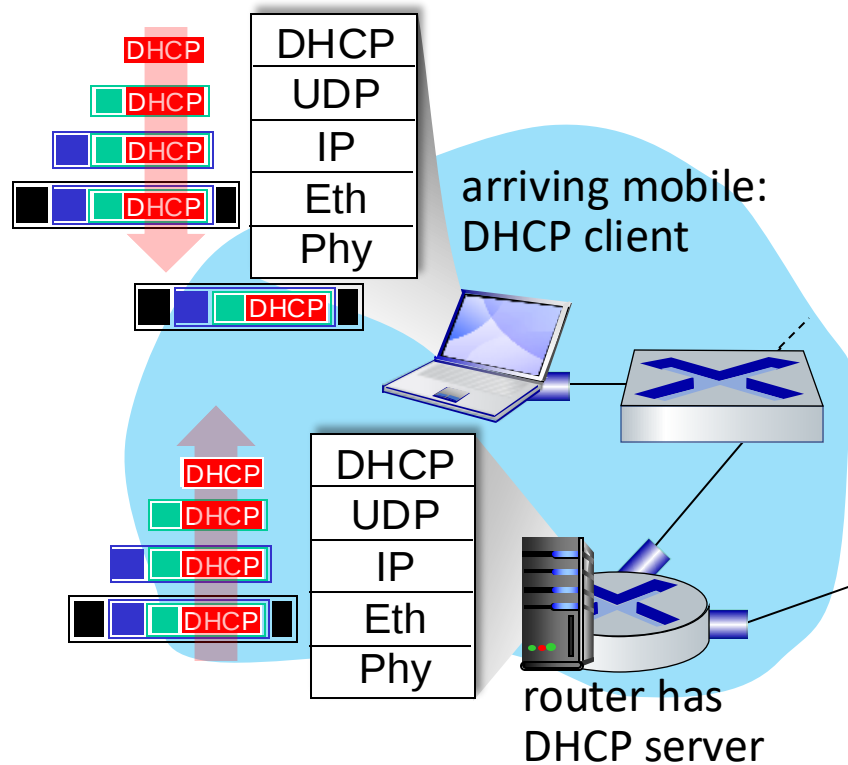


scenario:

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

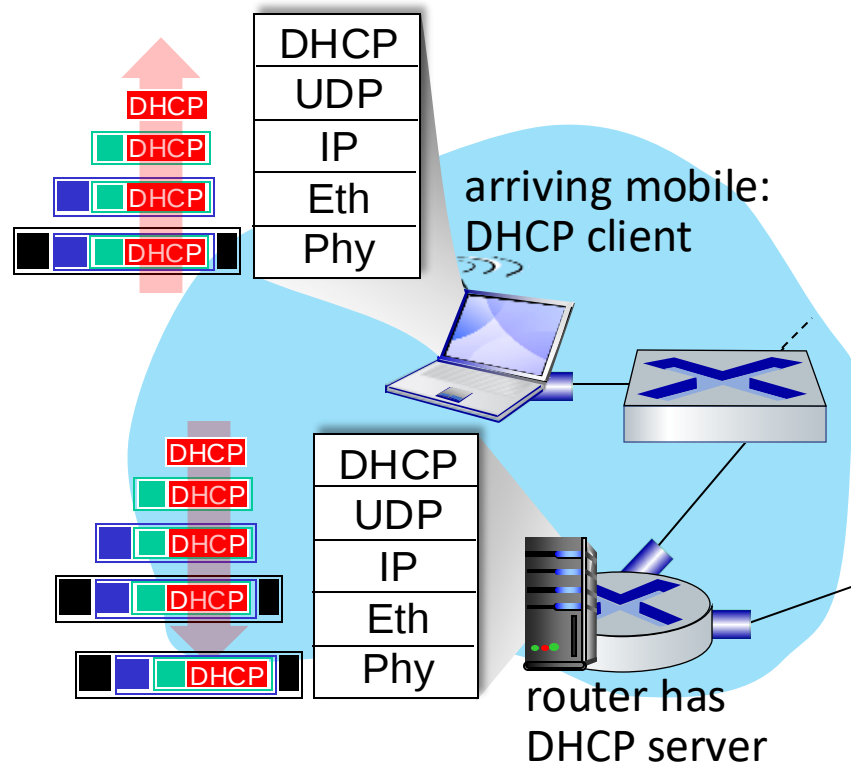
Sounds simple! 

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: FFFFFFFFFFFFFFFF) on LAN, received at router running **DHCP** server
- Ethernet **demuxed** to IP demuxed, UDP demuxed to DHCP

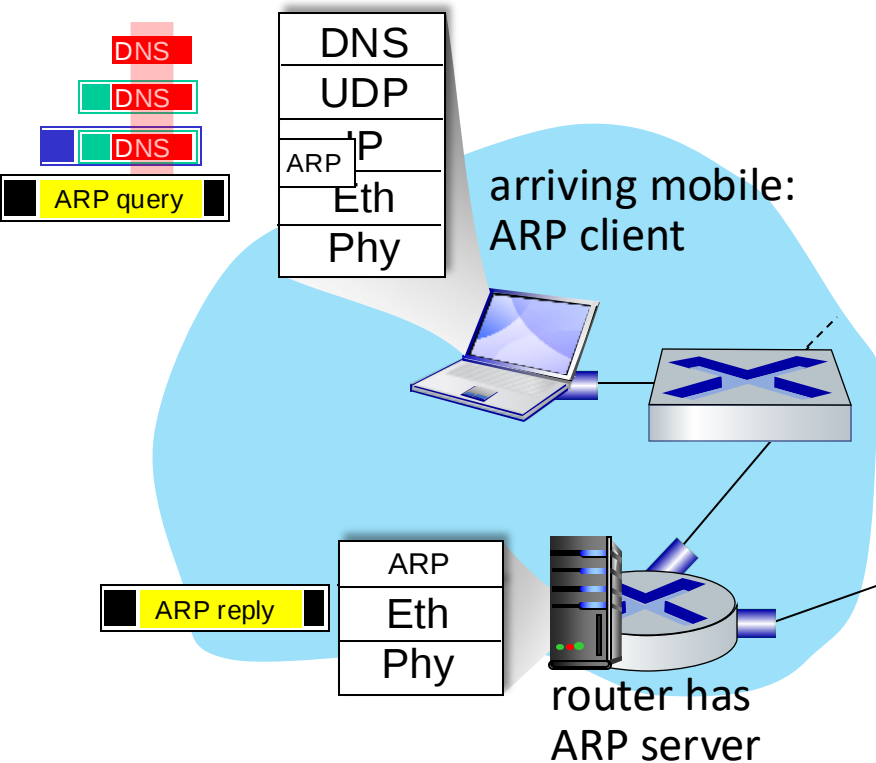
A day in the life: connecting to the Internet



- 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

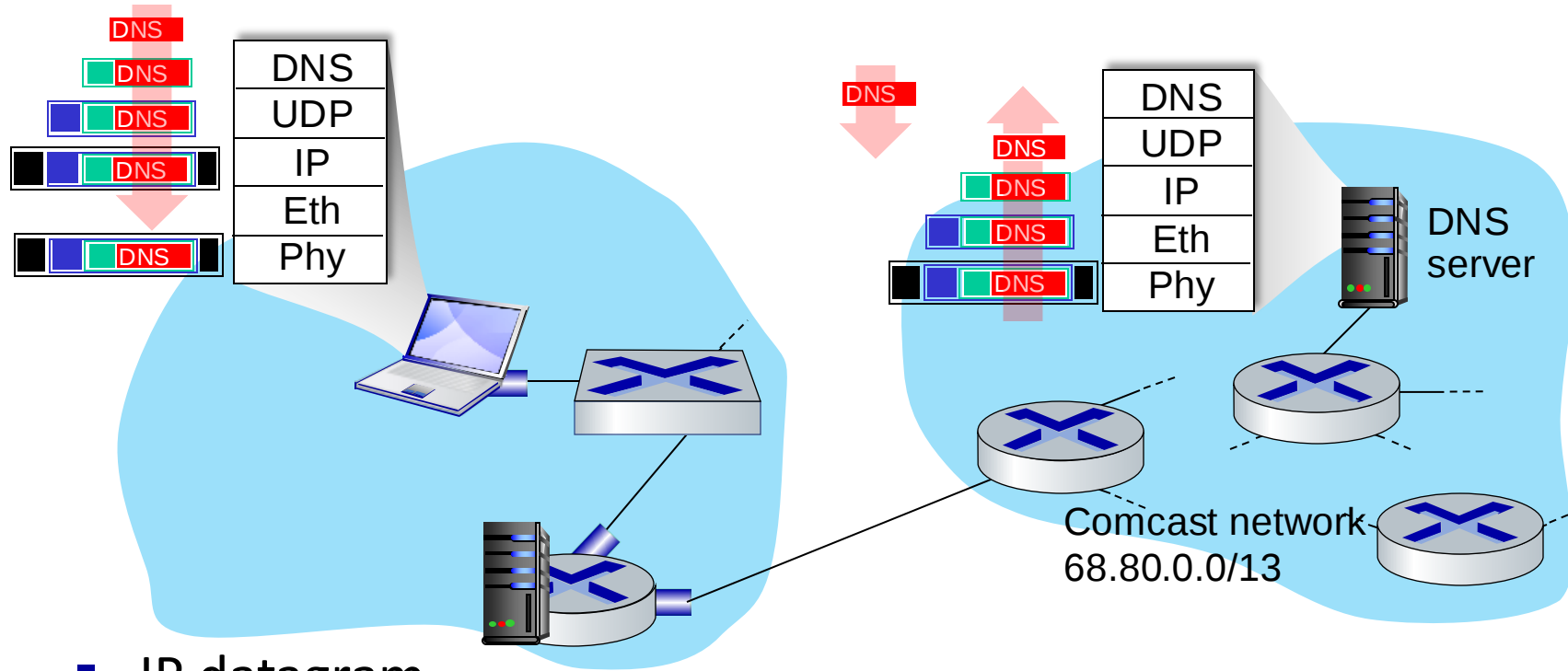
Client now has IP address, knows name & addr of DNS server, IP address of its first-hop router

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

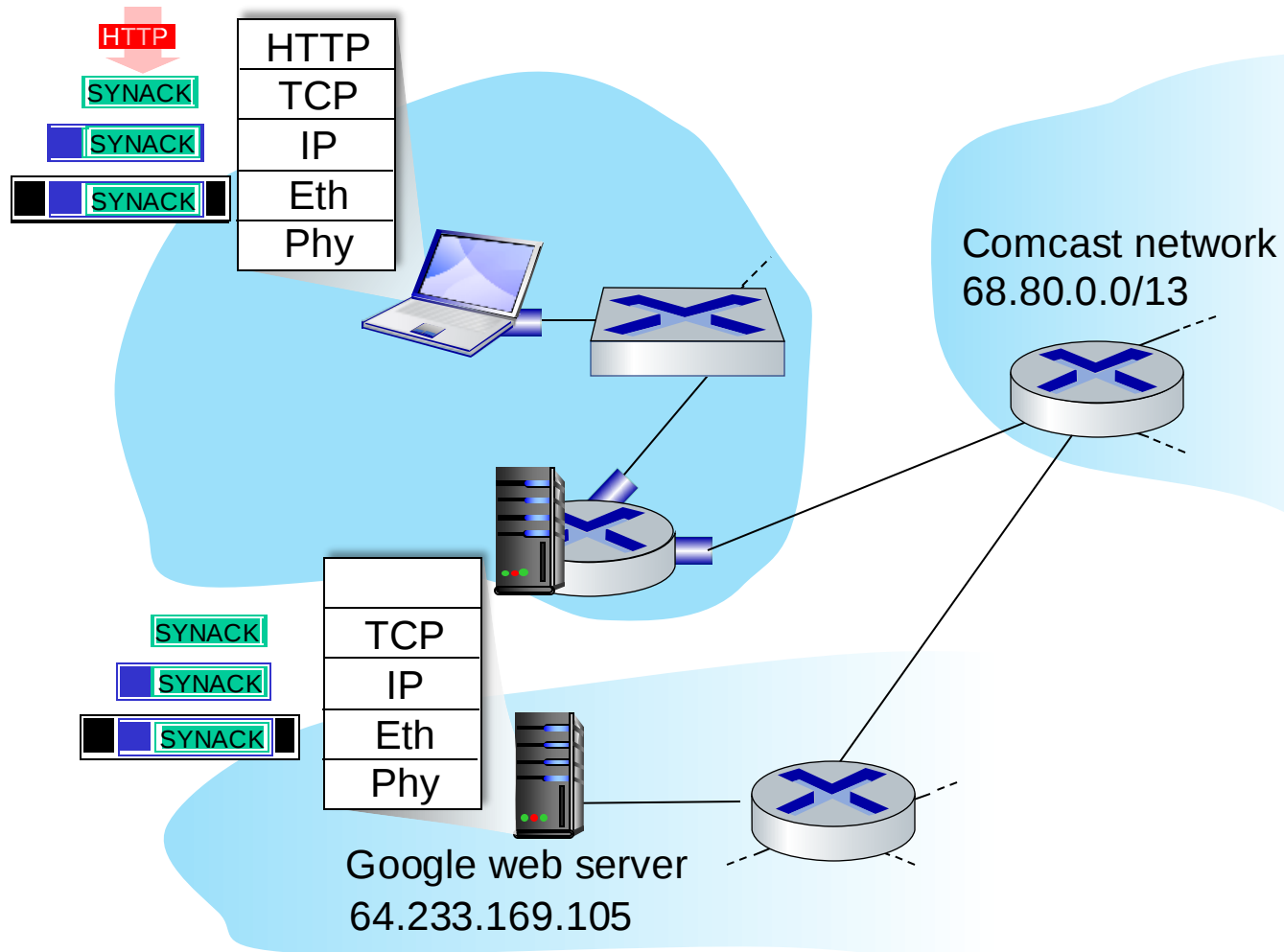


- IP datagram containing DNS query forwarded via LAN switch from client to 1st hop router

- 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

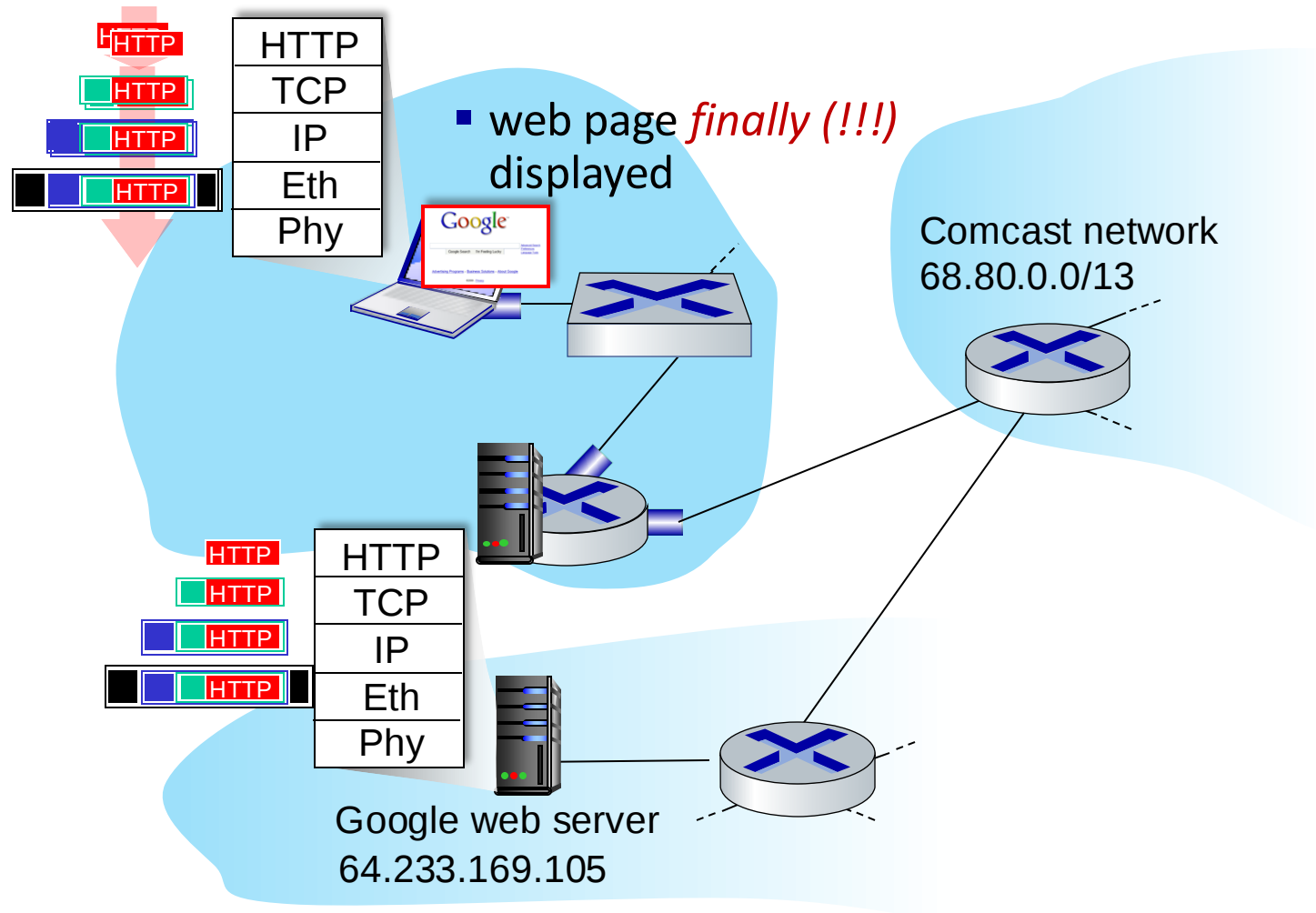
- demuxed to DNS
- DNS replies to client with IP address of www.google.com

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

Another Example in Your Daily Life

- Suppose you walk into LWSN, power on your laptop, connect to **PAL3.0 (WiFi)**, open **Youtube** to watch a TED talk.
 - What are all the protocol steps that take place? Please introduce each step and protocols used as much as you can.
 - Please explicitly indicate in your steps how you obtain the IP and MAC address of a gateway router.

A Synthesis Example: More

@ Hosts

- DHCP first, if no valid IP
 - why? a valid IP first, regardless of applications
- The rest is invoked by the application
 - Dependence → other protocols
 - e.g., WEB (URL) → DNS → UDP → IP → MAC address in Ethernet (or 802.11) → ARP
 - e.g., HTTP → TCP → the first TCP segment (three-way handshaking)
 - e.g., L2 delivery via WiFi → CSMA/CA

@Routers (switches) [a network: a **distributed** system]

- Routing protocols (inter-AS, intra-AS) performed
- Self-learning performed at switches