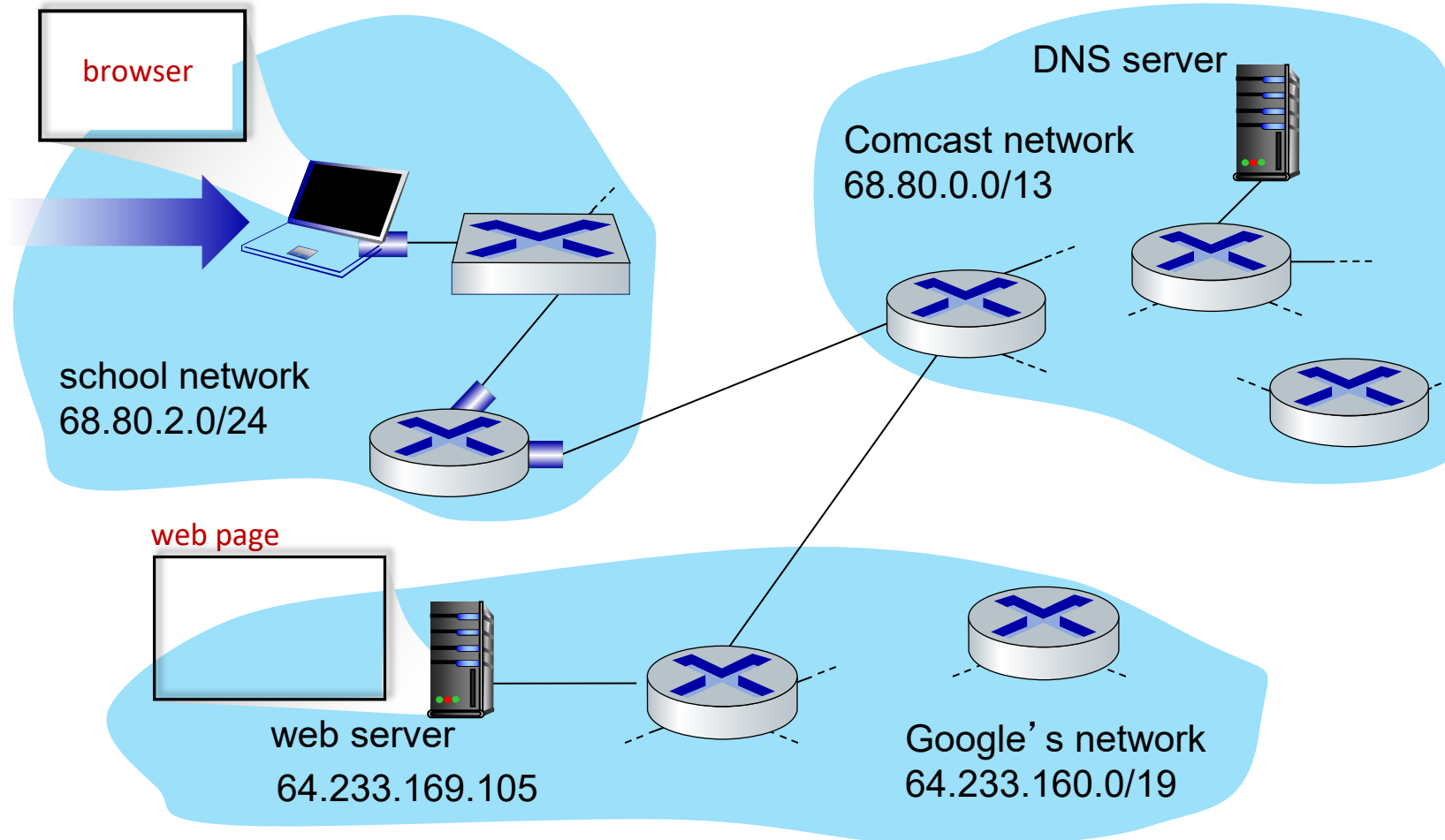


Synthesis: a day in the life of a web request

- 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

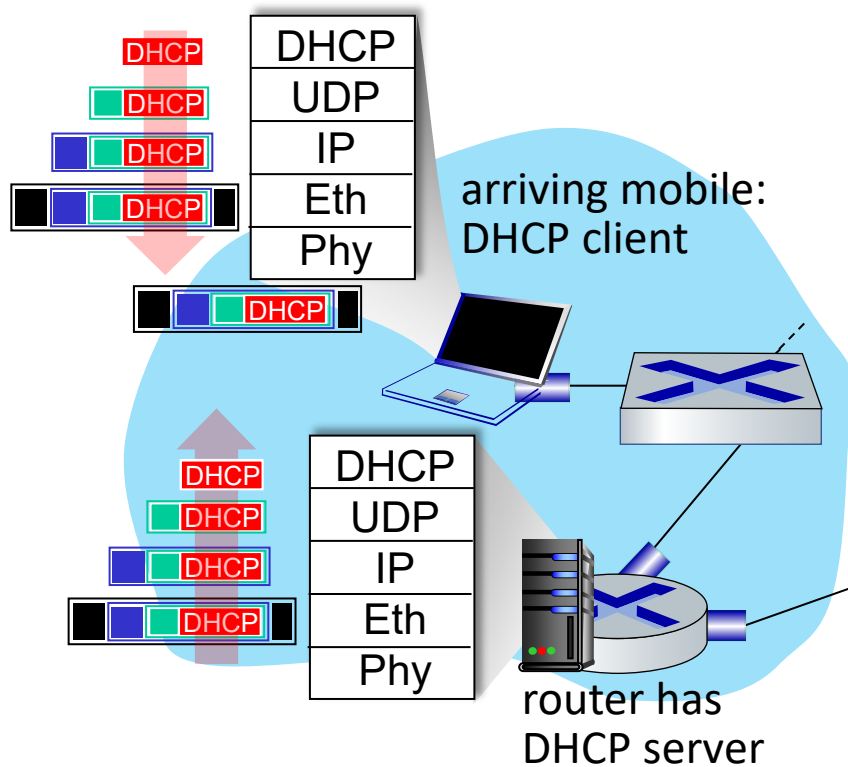


scenario:

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

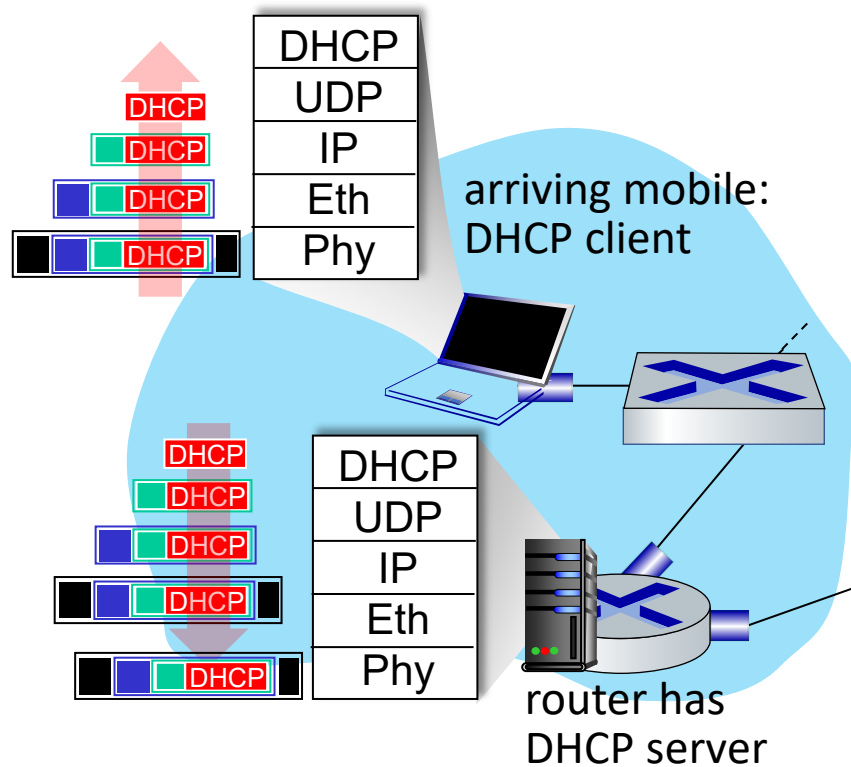
Sounds simple!

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

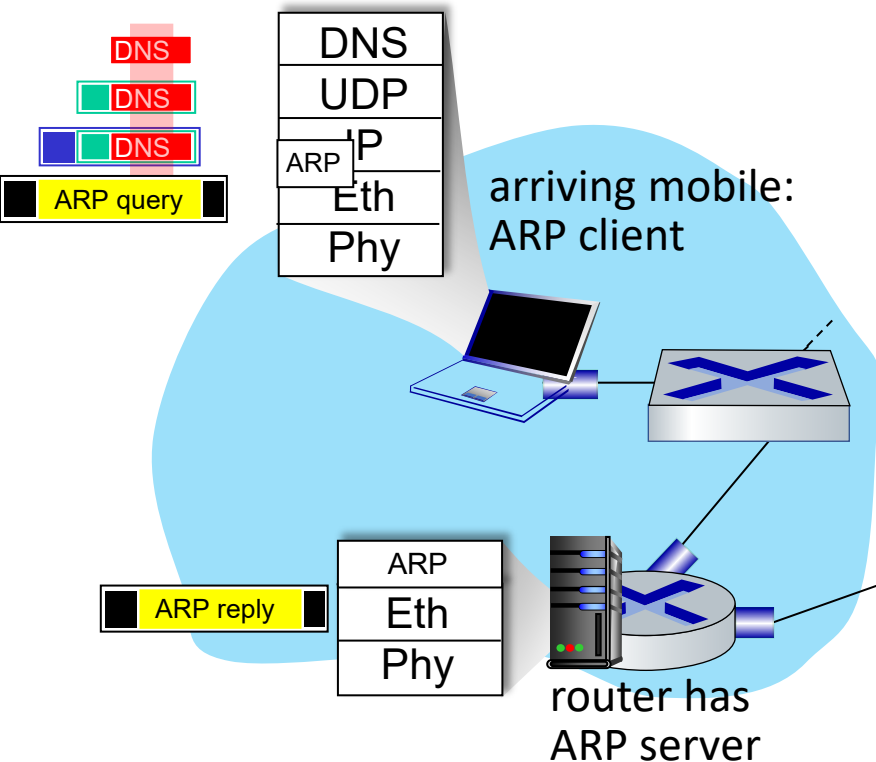
A day in the life: connecting to the Internet



- 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

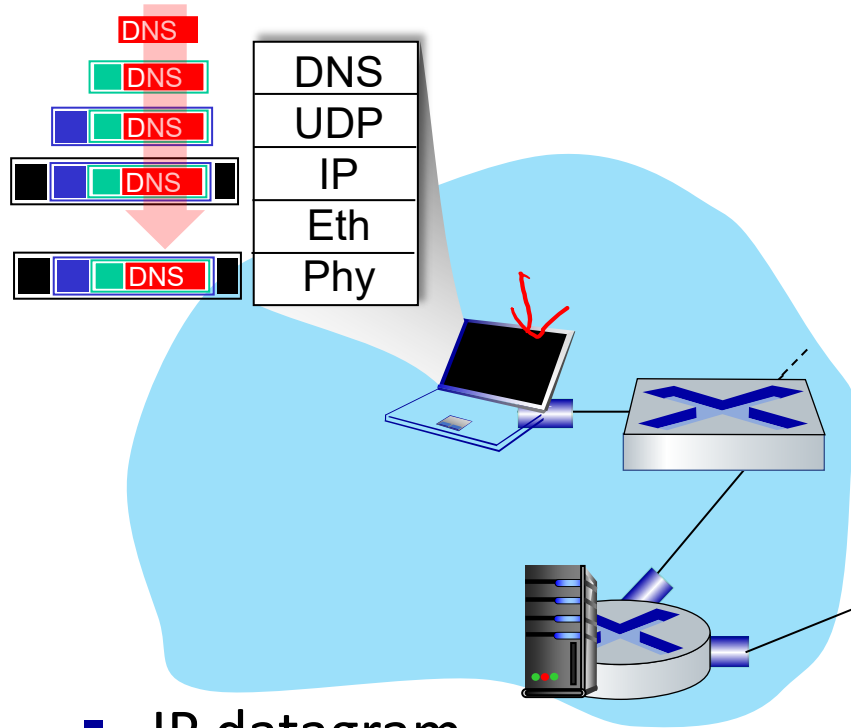
Client now has IP address, knows name & addr of DNS server, IP address of its first-hop router

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

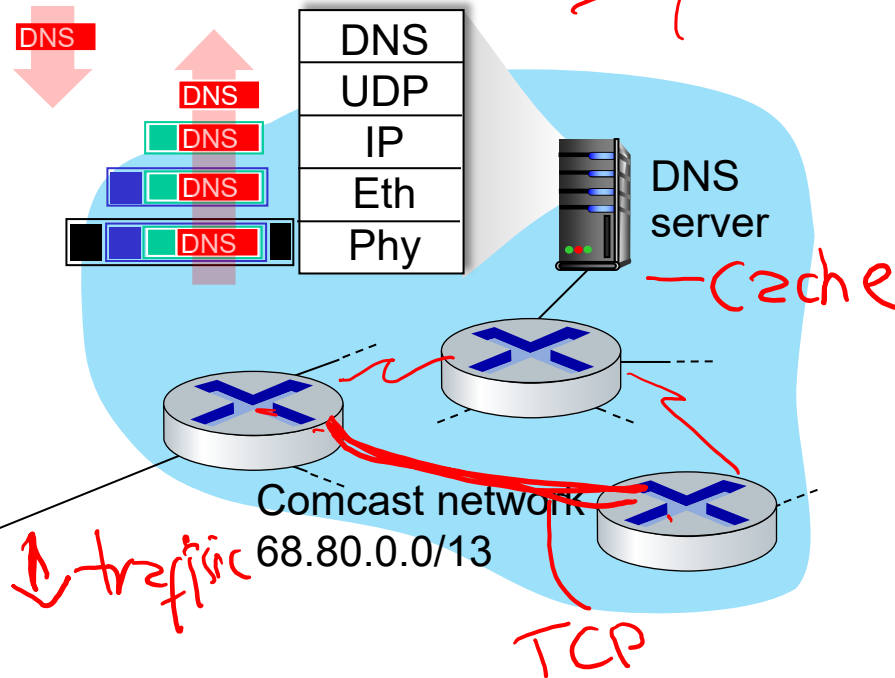


- before sending **HTTP** request, need IP address of `www.google.com`: **DNS**
- DNS query created, encapsulated in UDP, encapsulated in IP, encapsulated in Eth. To send frame to router, need MAC address of router interface: **ARP**
- **ARP query** broadcast, received by router, which replies with **ARP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



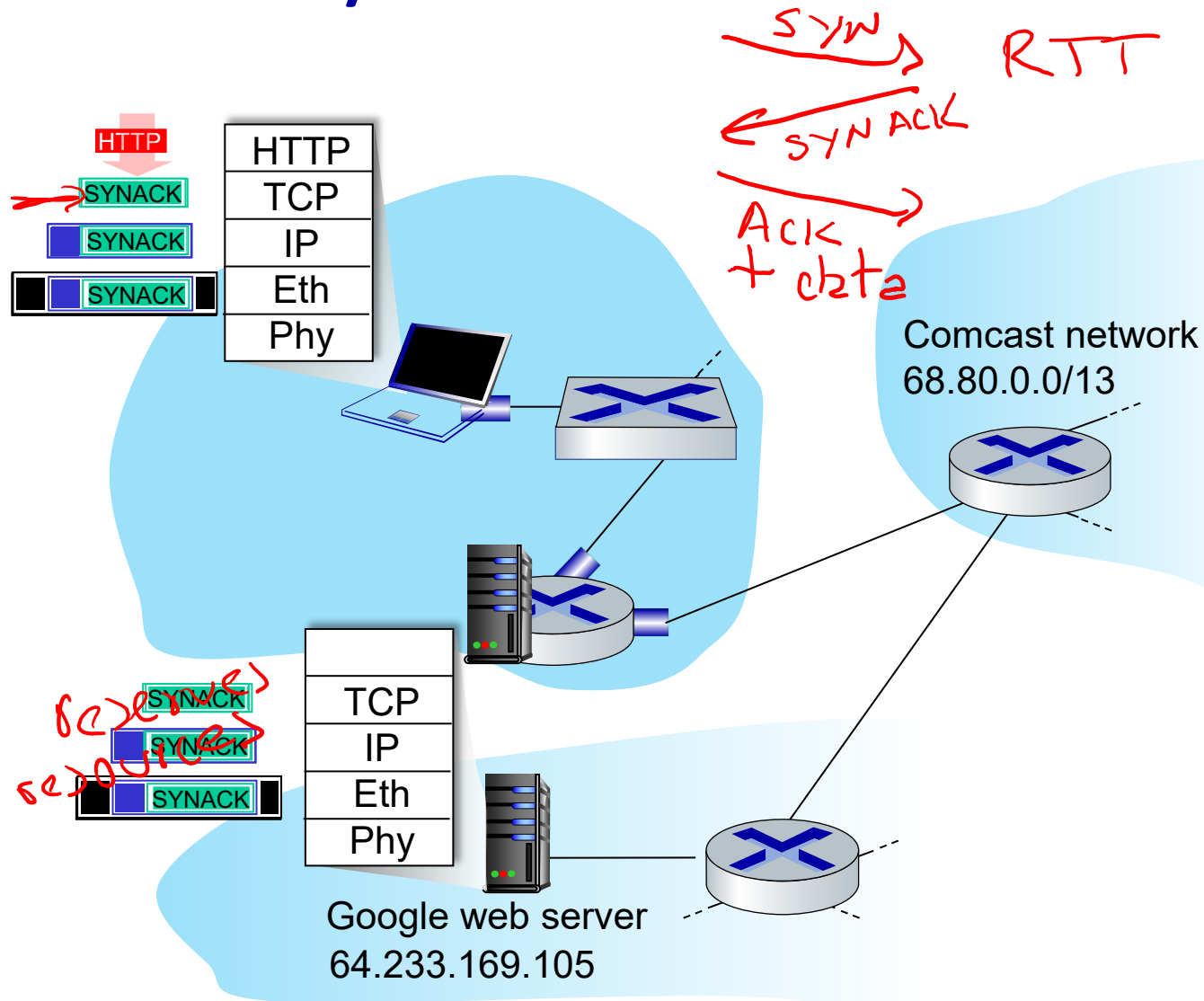
- IP datagram forwarded from campus network into Comcast network, routed (tables created by **RIP**, **OSPF**, **IS-IS** and/or **BGP** routing protocols) to DNS server

~~root (.com)
authoritative (google)
google's DNS (www)~~

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

Mistake here (during lecture). Correct way is the query starts with the root, then the query goes to TLD (to solve google.com) and then to the authoritative (that is Google's DNS server) for solving www.google.com

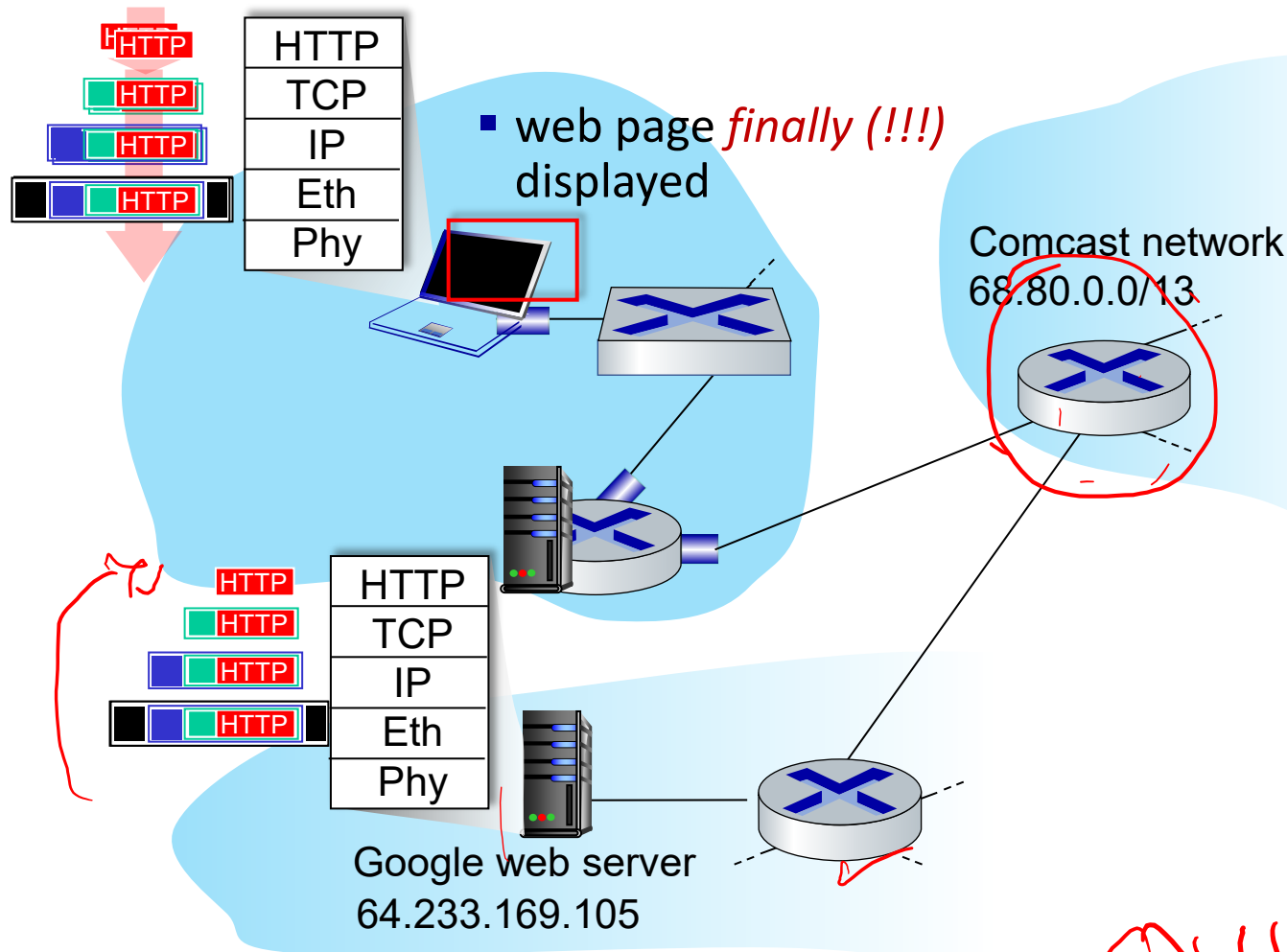
A day in the life...TCP connection carrying HTTP



- 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

TLS (TCP)
(SSL)
DTLS (UDP)

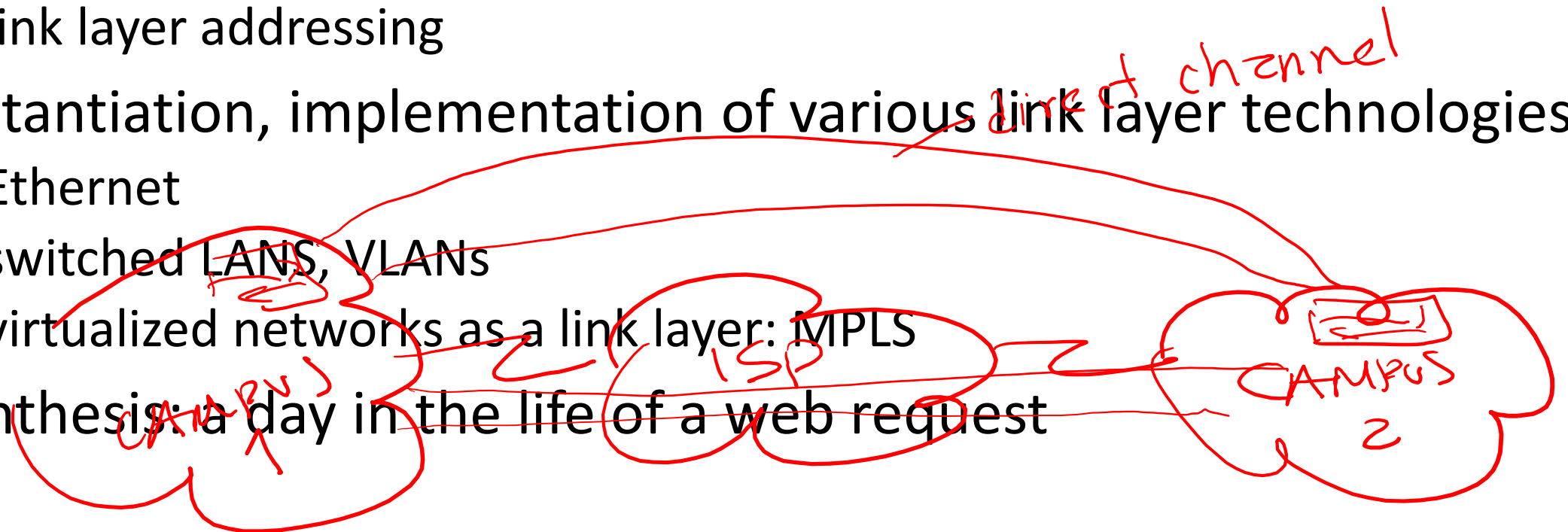


- HTTP request sent into TCP socket
- IP datagram containing HTTP request routed to www.google.com
- web server responds with HTTP reply (containing web page)
- IP datagram containing HTTP reply routed back to client

QUIC / HTTP/3

Chapter 6: Summary

- 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, VLANs
 - virtualized networks as a link layer: MPLS
- synthesis: a day in the life of a web request



Chapter 6: let's take a breath

- journey down protocol stack *complete* (except PHY)
- solid understanding of networking principles, practice!
- could stop here but *more* interesting topics!
 - wireless
 - security