CSCI-1680
The End (of lectures)
Tor, Wrapup

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Based partly on lecture notes by Rodrigo Fonseca, Scott Shenker and John Jannotti

Administrivia

- HW4: Due Friday 12/8
- Final project: Due 12/14
- Office hours: see the calendar

- Course feedback
  - University feedback
  - Critical Review
  - I will send you a form

My (major) TODOs

1. I owe you grades on HW2, Snowcast, TCP
2. Will send grade report next week
3. I will be watching Ed for final project questions

Today’s Lecture

- More about Tor
- Wrapup

More on Tor

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- Site addresses based on public key of server, client looks up using distributed hash table (DHT)

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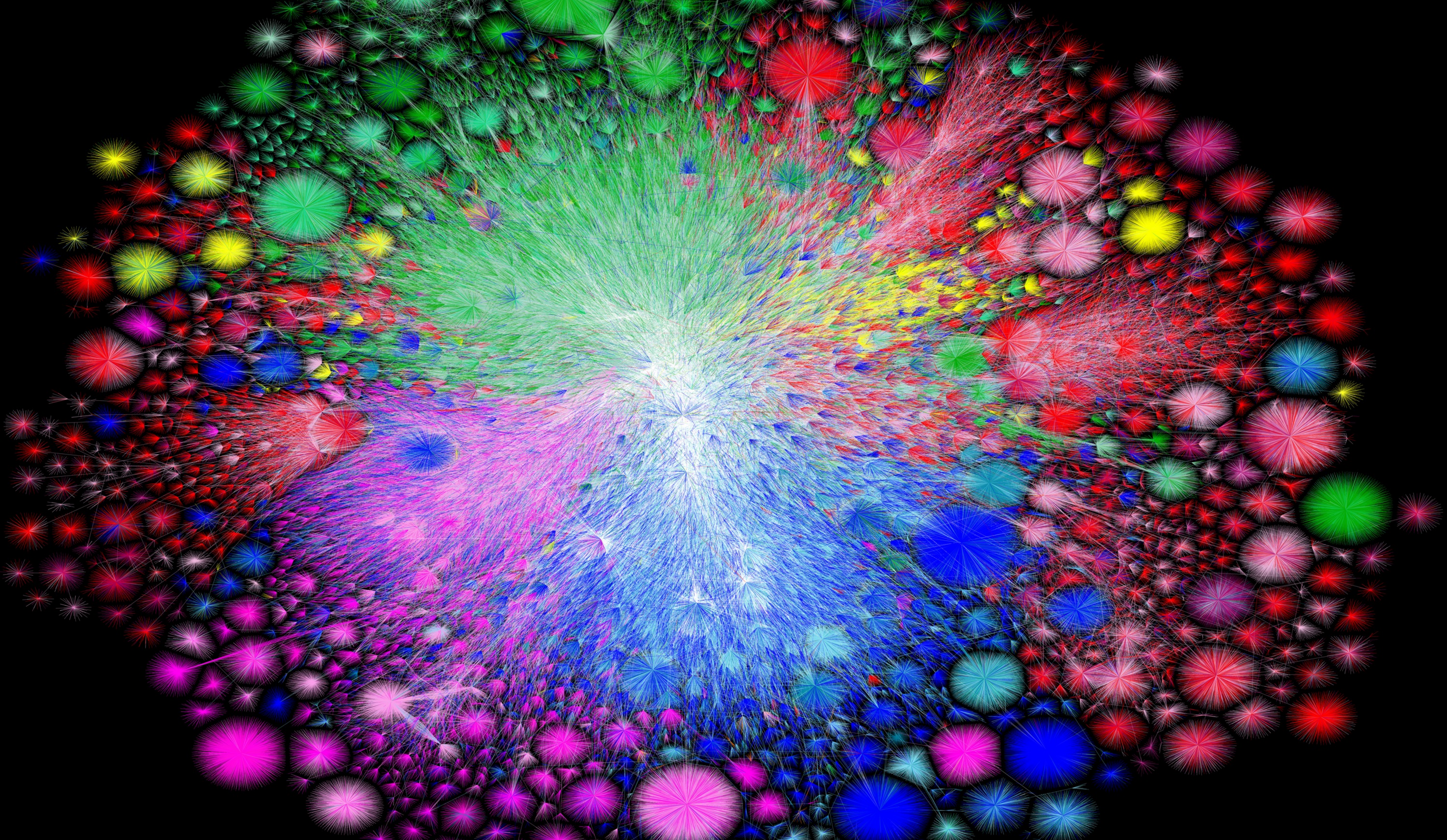
Examples

- *New York Times:*
  `https://www.nytimesn7cgmftshazwhfgzm37qxb44r64ytbb2dj3x62d2lljsciiyd.onion`
- Facebook
  `https://facebookwkhpilnemxj7asaniu7vnjjbiltxjqhye3mhbshg7kx5tfyd.onion`
- Cloudflare public DNS
  `dns4torpnlfs2ifuz2s2yf3fc7rdmsbhm6rw75euj35pac6ap25zgqad.onion`

Wrapping up

- This is our last formal lecture
- From here: work on final project

What I hope you have learned



We can‘t cover (or remember) everything

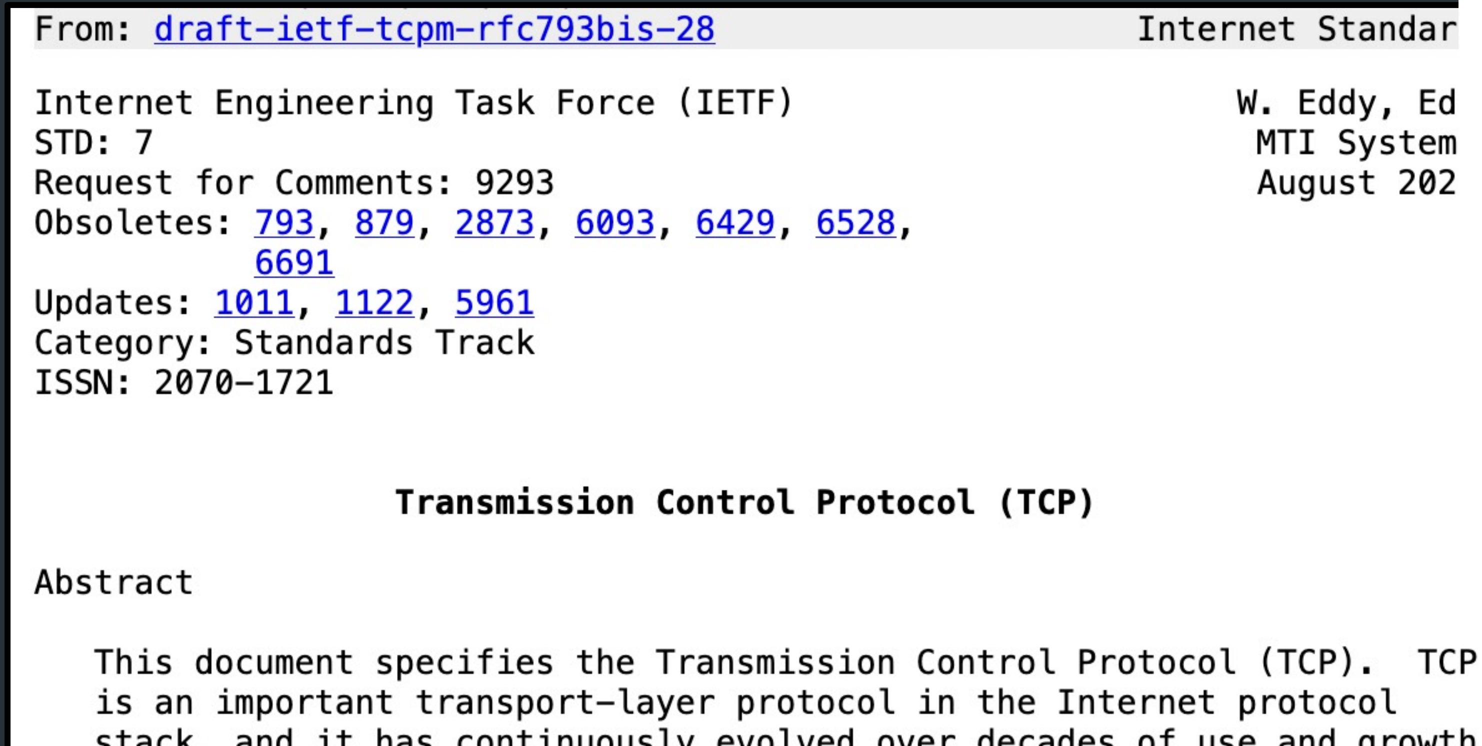
Hope you learn important tools/principles to understand networking challenges you encounter

Protocols

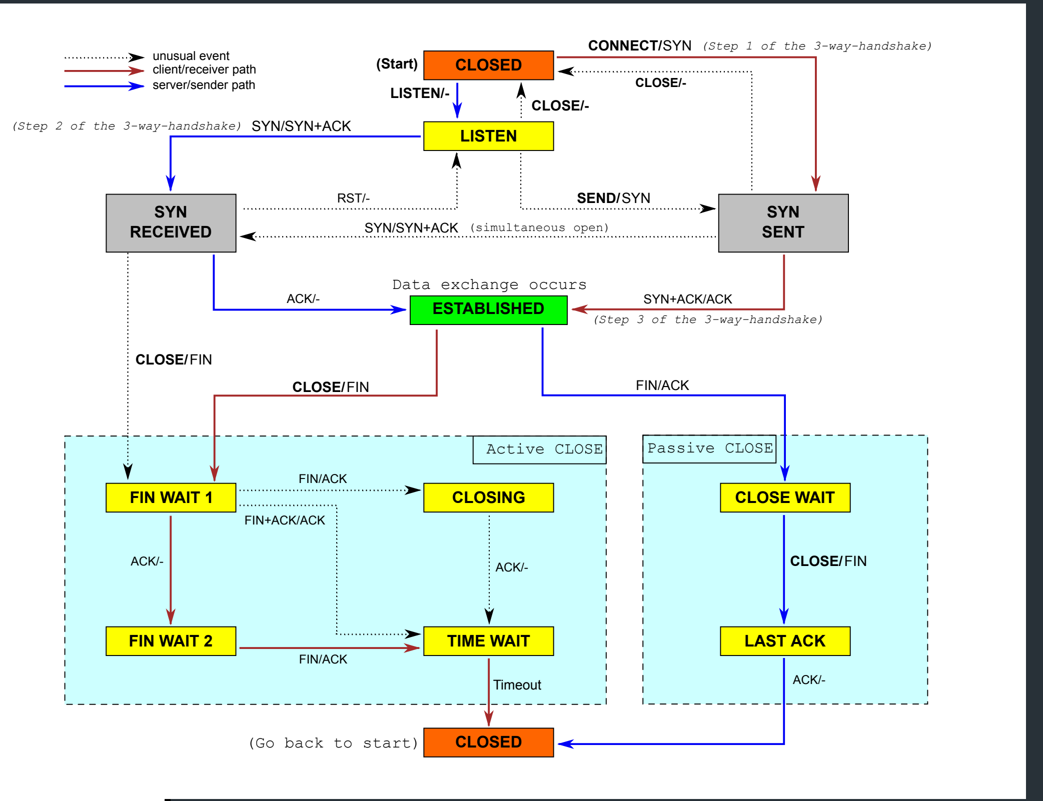
Ways to communicate between *heterogeneous* systems

Network programming

```
conn, err :=  net.Dial(“tcp”, “10.0.0.1:80”)
. . .

someBuf := make([]byte, . . .)
conn.Write(someBuf)
```

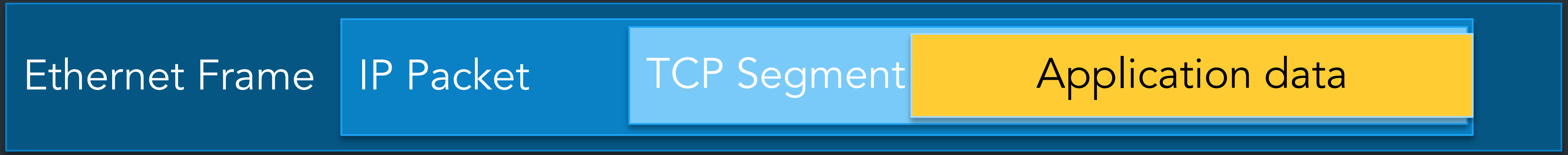


```
From: draft-ietf-tcpm-rfc793bis-28                  Internet Standar

Internet Engineering Task Force (IETF)                   W. Eddy, Ed
STD: 7                                                    MTI System
Request for Comments: 9293                                August 202
Obsoletes: 793, 879, 2873, 6093, 6429, 6528,
           6691
Updates: 1011, 1122, 5961
Category: Standards Track
ISSN: 2070-1721


                 Transmission Control Protocol (TCP)

Abstract

   This document specifies the Transmission Control Protocol (TCP).  TCP
   is an important transport-layer protocol in the Internet protocol
   stack, and it has continuously evolved over decades of use and growth
```



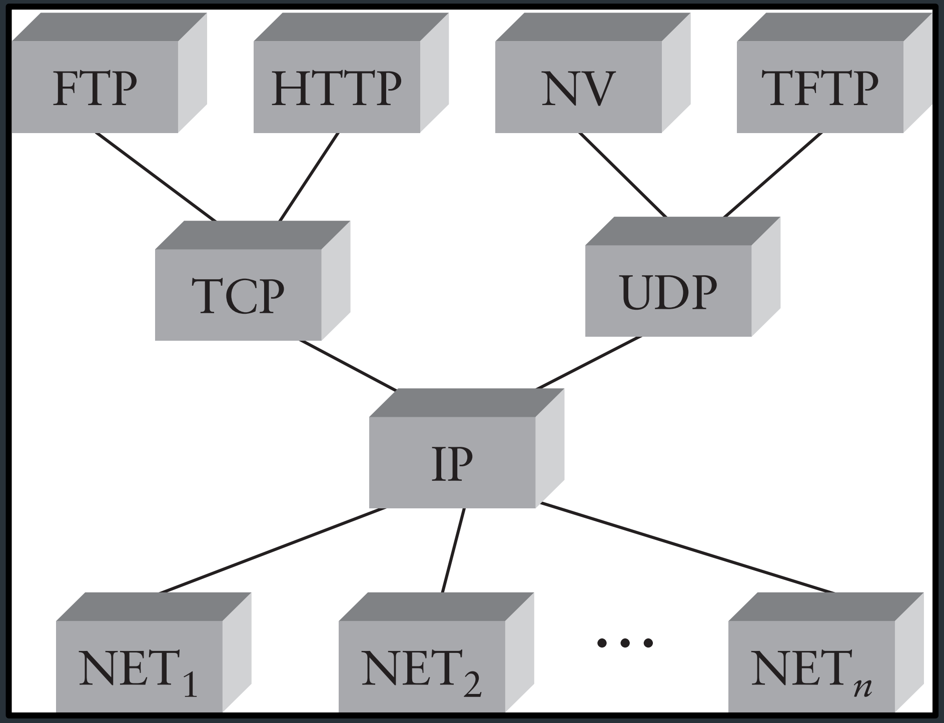
Layering / Encapsulation

Building abstractions and interfaces to hide lower-level details from “higher” layers



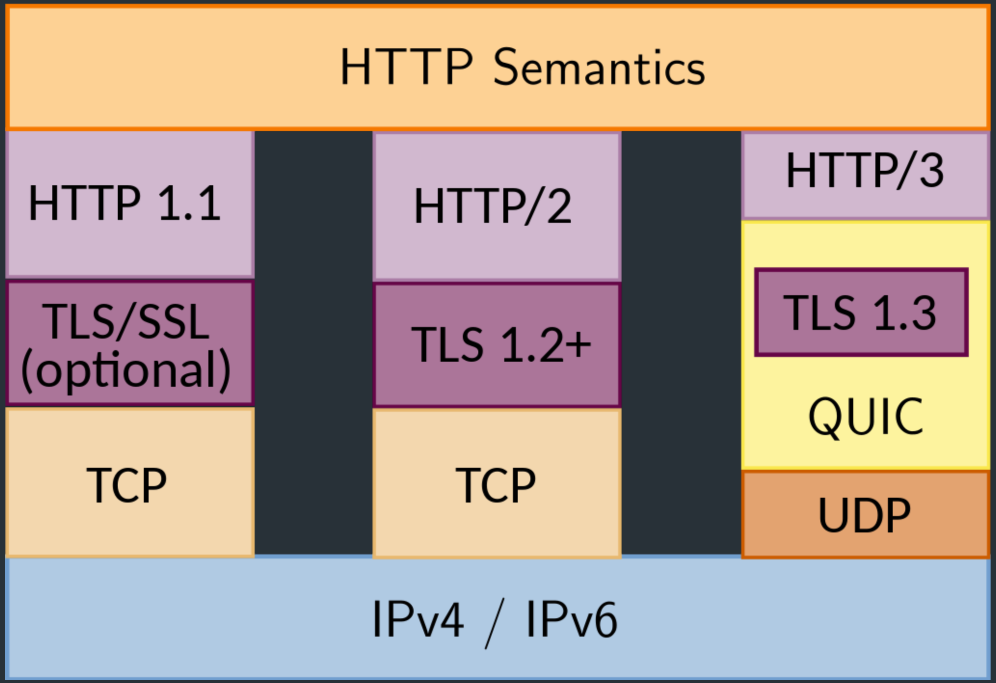
Abstractions are great!

- Can support huge variety of devices, protocols
- Allows independent evolution => new protocols!



… until they aren't

Sometimes, need to break them



HTTP Semantics

HTTP 1.1

TLS/SSL (optional)

TCP

HTTP/2

TLS 1.2+

TCP

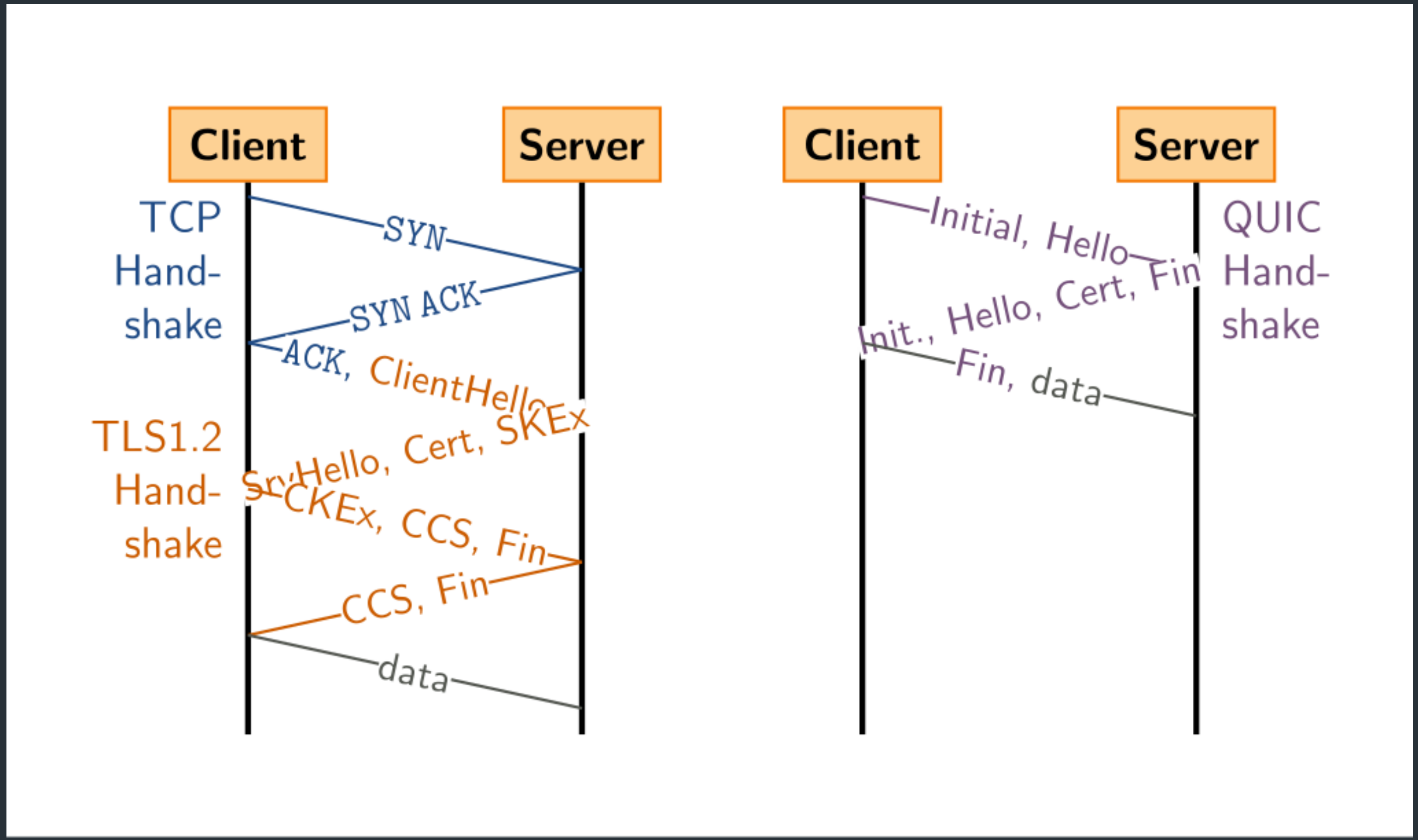
HTTP/3

TLS 1.3

QUIC

UDP

IPv4 / IPv6



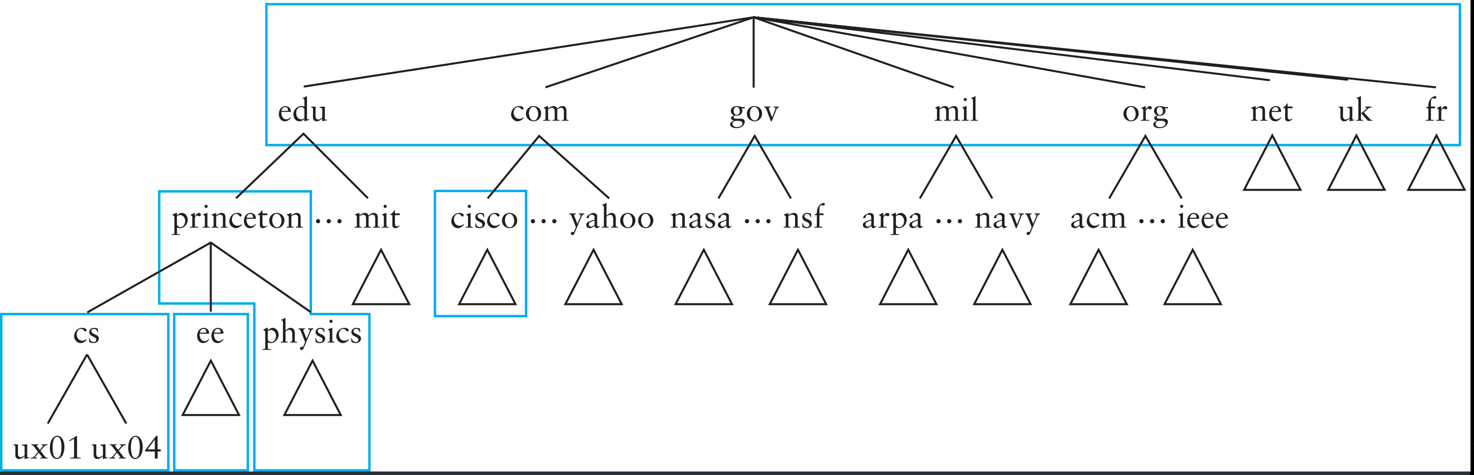
Naming

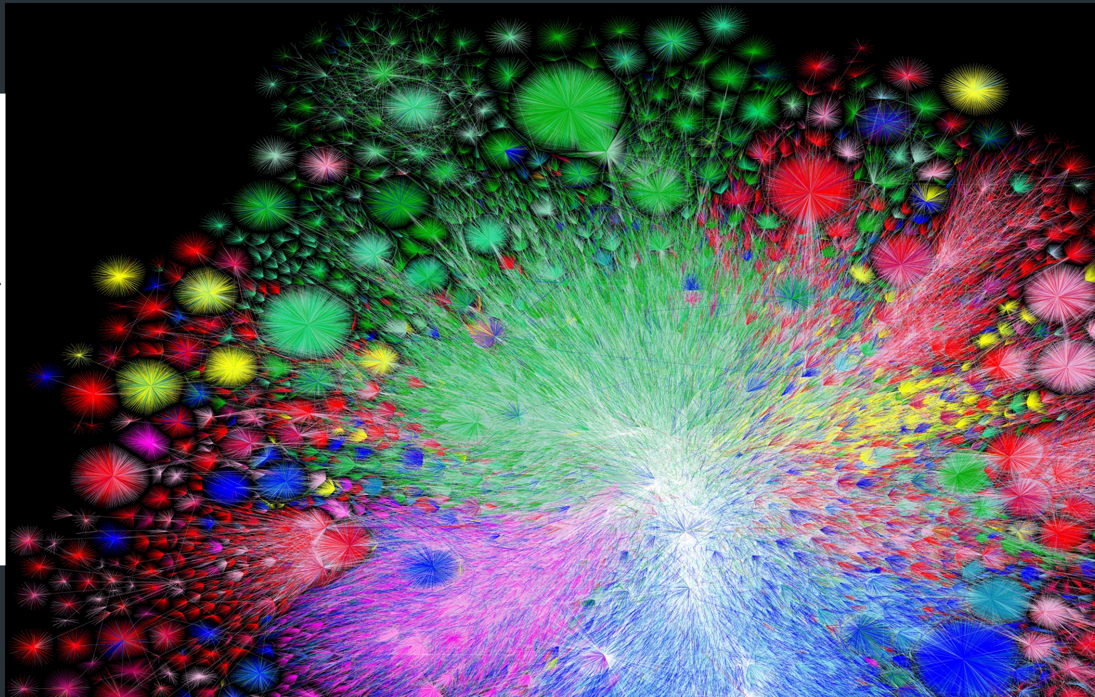
Indirection: abstract low-level info with a higher-level name

=> Human-readable DNS names

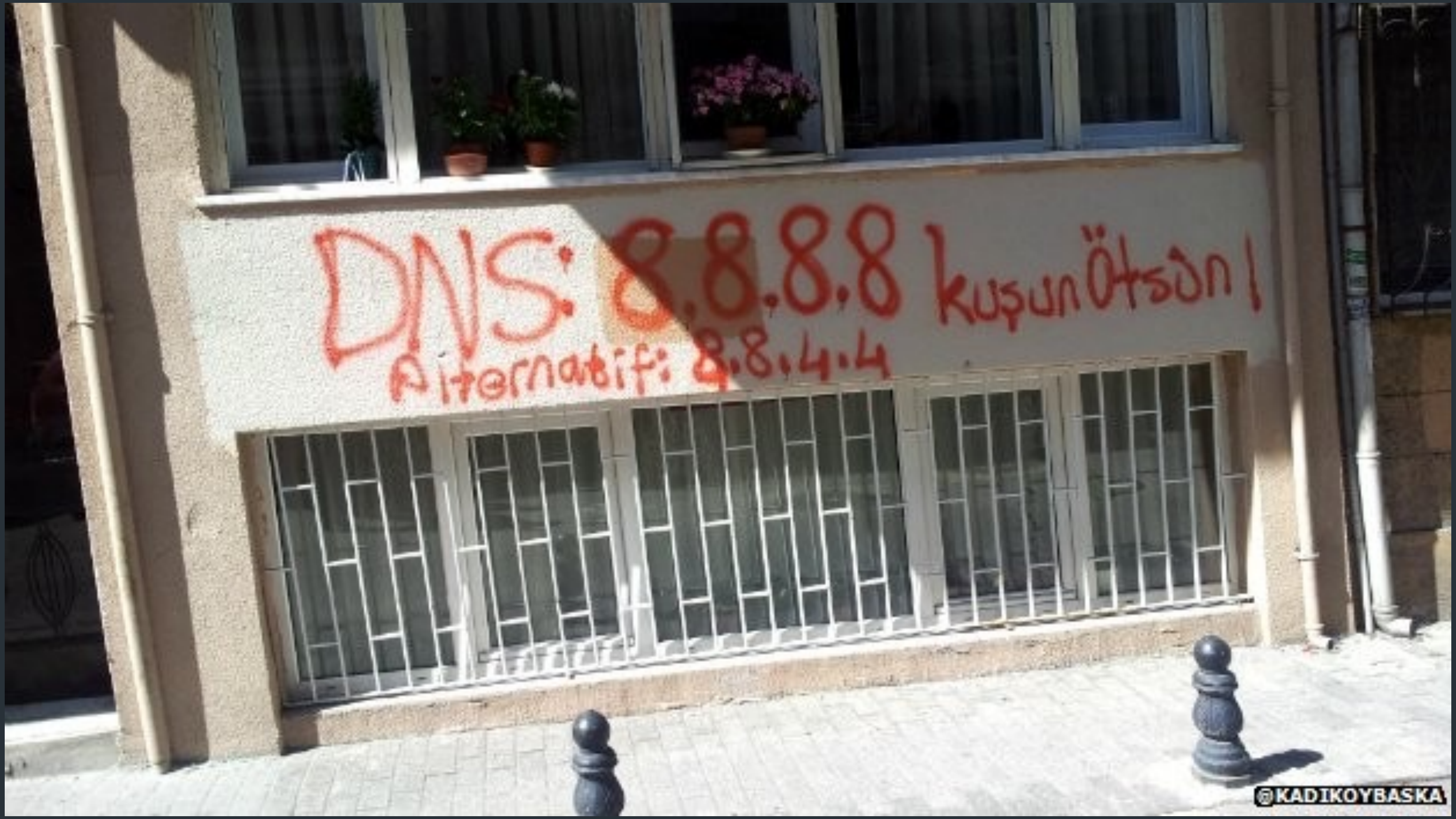
=> Scalability: redundancy, proxies, load balancing

Can leverage hierarchy of naming => scalability (IP, DNS, …)





How naming, etc. can be controlled…



Changing DNS servers in response to blocking of Twitter in Turkey (2014)

Writeup, with more links: https://www.thousandeyes.com/blog/internet-censorship-around-the-world

Lots of challenges out there

Our Internet architecture was designed in the 1980s, where modern scale and complexity was unimaginable

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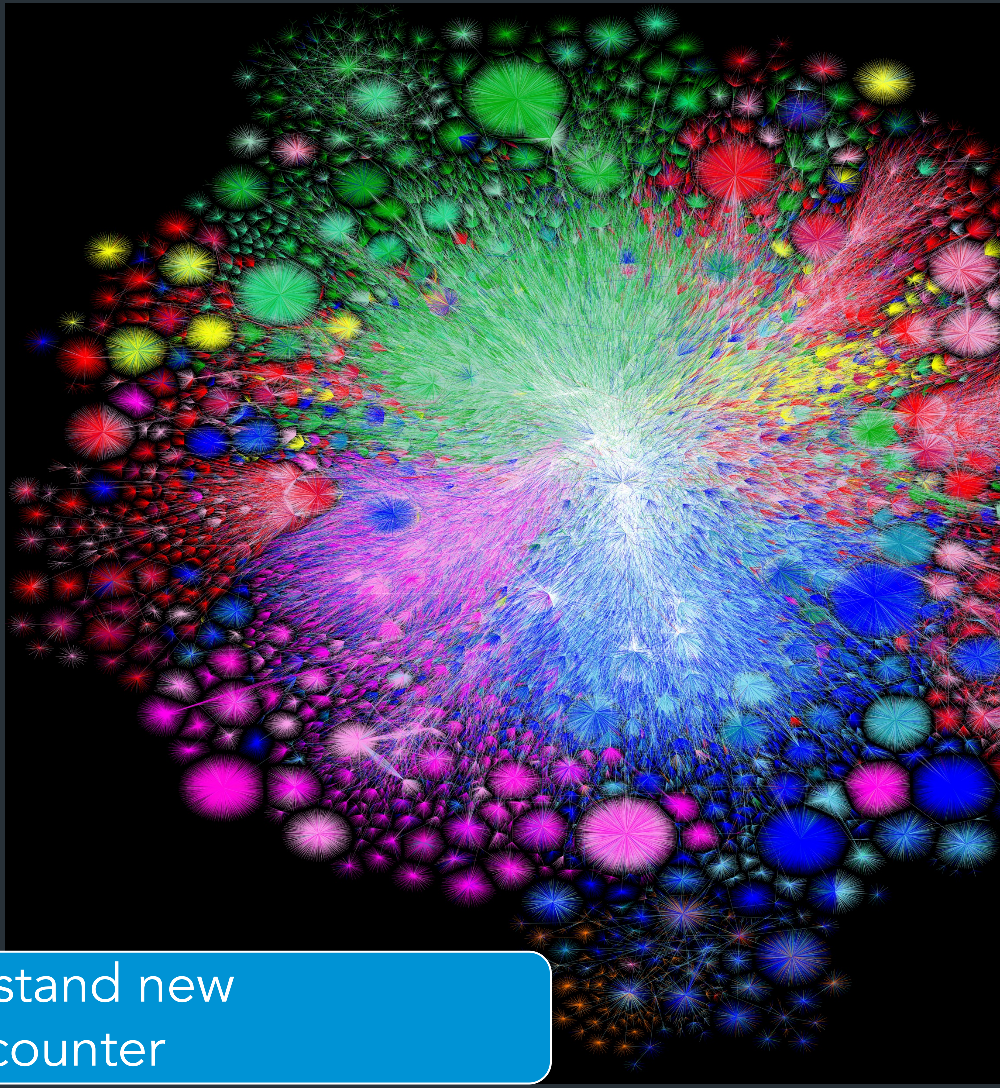
Now…

- No one knows how big the Internet is
- No one is in charge
- Anyone can add any application
- Packets traverse many paths, countries, regulatory domains

Thank you!
Please stay in touch!

What (I hope) you have learned

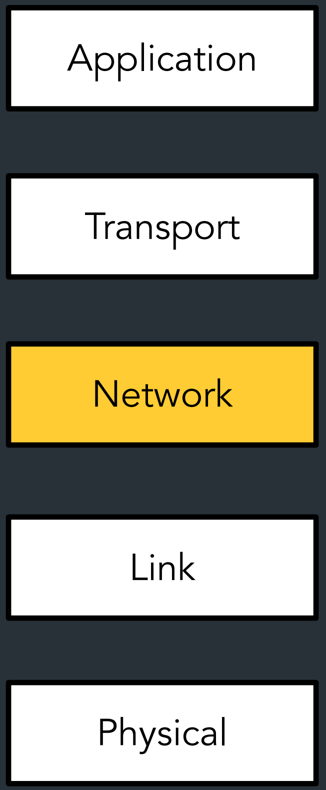
- Skill: network programming (and soft. eng) Socket programming
  - Server programming/robustness
  - Implementing protocols
- Knowledge: How the Internet Works
  - Internet architecture and design
  - Key Internet protocols
  - Some applications (Web, DNS, …)



My goal: give you tools to understand new networking challenges you encounter

Networking principles

- Some general CS concepts
  - Hierarchy (IP addressing, DNS, PKI, …)
  - Indirection (ARP, DNS, …)
  - Caching
- Some concepts (a bit) networking-specific
  - Layering
  - Multiplexing
  - End-to-end argument
  - Robustness principles



Service: user-facing application.
Application-defined messages

Service: multiplexing applications
Reliable byte stream to other node (TC
Unreliable datagram (UDP)

Service: move packets to any other no
Internet Protocol (IP)

Service: move frames to other node ac
May add reliability, medium access cor

Service: move bits to other node acros

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