INTRO TO CS
THE NUTS AND BOLTS OF THE INTERNET

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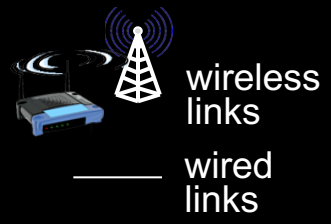
Transitions made by Aidan Katz

MY BACKGROUND

- First email circa 1988
- Streaming audio in 1995
- IRC chat in 1995
- Masters Degree in Telecommunications
- Employed as a network engineer during the peak of the Dot-Com era
- Primarily focused on protocol development and network access
- Avid “Among us” player!

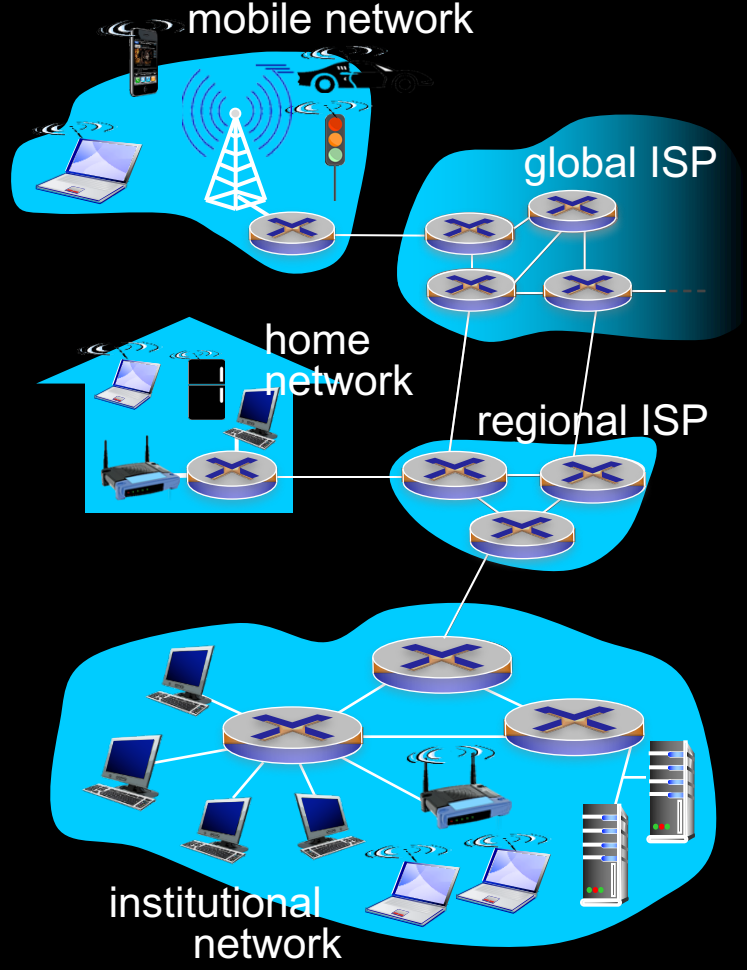
WHAT'S THE INTERNET: "NUTS AND BOLTS" VIEW

- billions of connected computing devices:
  - *hosts* = *end systems*
  - running *network apps*



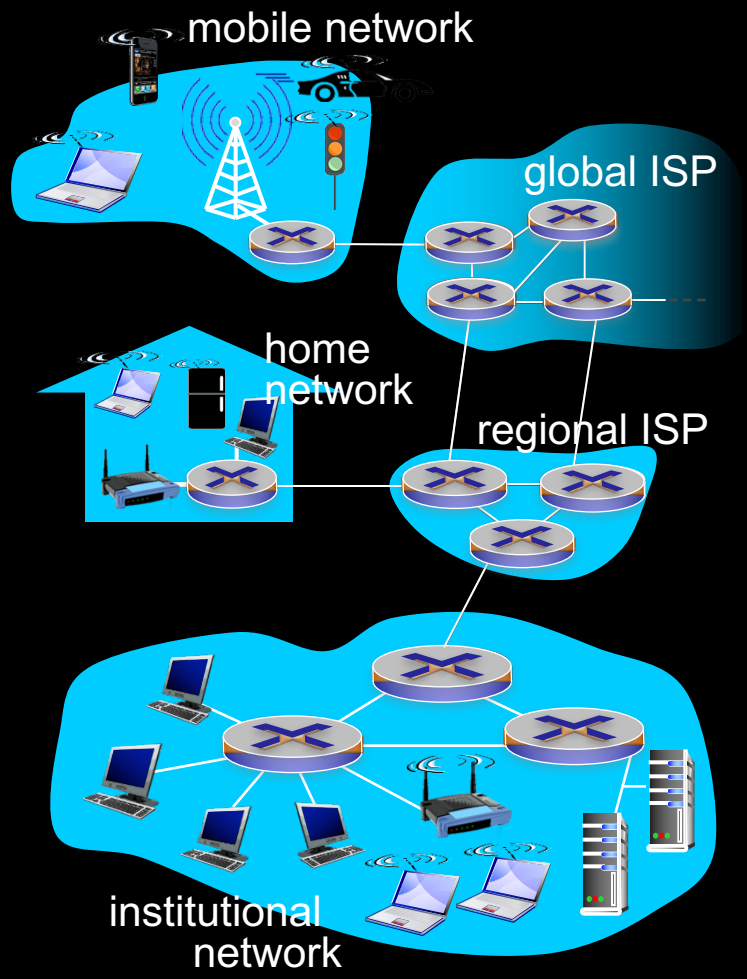
- *communication links*
  - fiber, copper, radio, satellite
  - transmission rate: *bandwidth*

- *packet switches:* forward packets (chunks of data)
  - *routers* and *switches*



What's the Internet: "nuts and bolts" view

- *Internet*: "network of networks"
  - Interconnected ISPs
- *protocols* control sending, receiving of messages
  - e.g., TCP, IP, HTTP, Skype, 802.11
- *Internet standards*
  - RFC: Request for comments
  - IETF: Internet Engineering Task Force

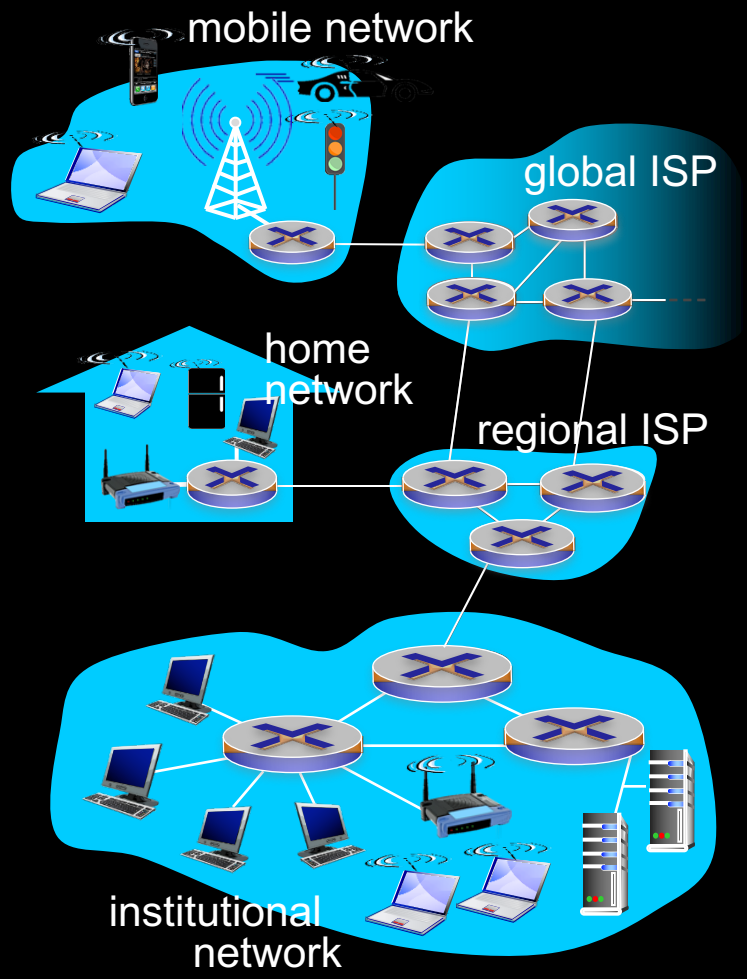


THE INTERNET != THE WEB

- The Internet
  - a global network of interconnected devices
  - existed before the WWW (orthogonality issues)
  - carries a lot more than just www traffic
- The world wide web
  - originally designed to be a virtual construct of “linked” web pages.
  - Doesn’t exist in a reality

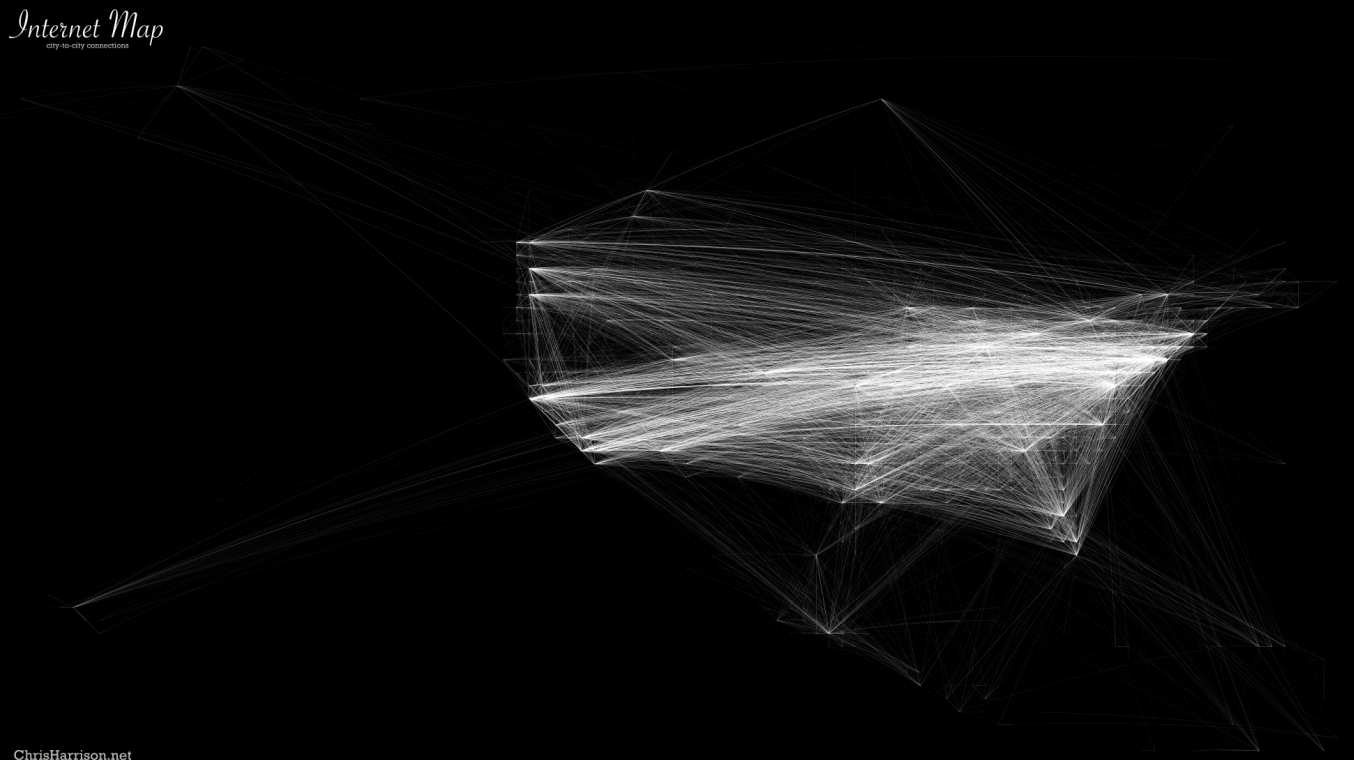
WHAT'S THE INTERNET: A SERVICE VIEW

- *infrastructure that provides services to applications:*
  - Web, VoIP, email, games, e-commerce, social nets, …
- *provides programming interface to apps*
  - hooks that allow sending and receiving app programs to "connect" to Internet
  - provides service options, analogous to postal service

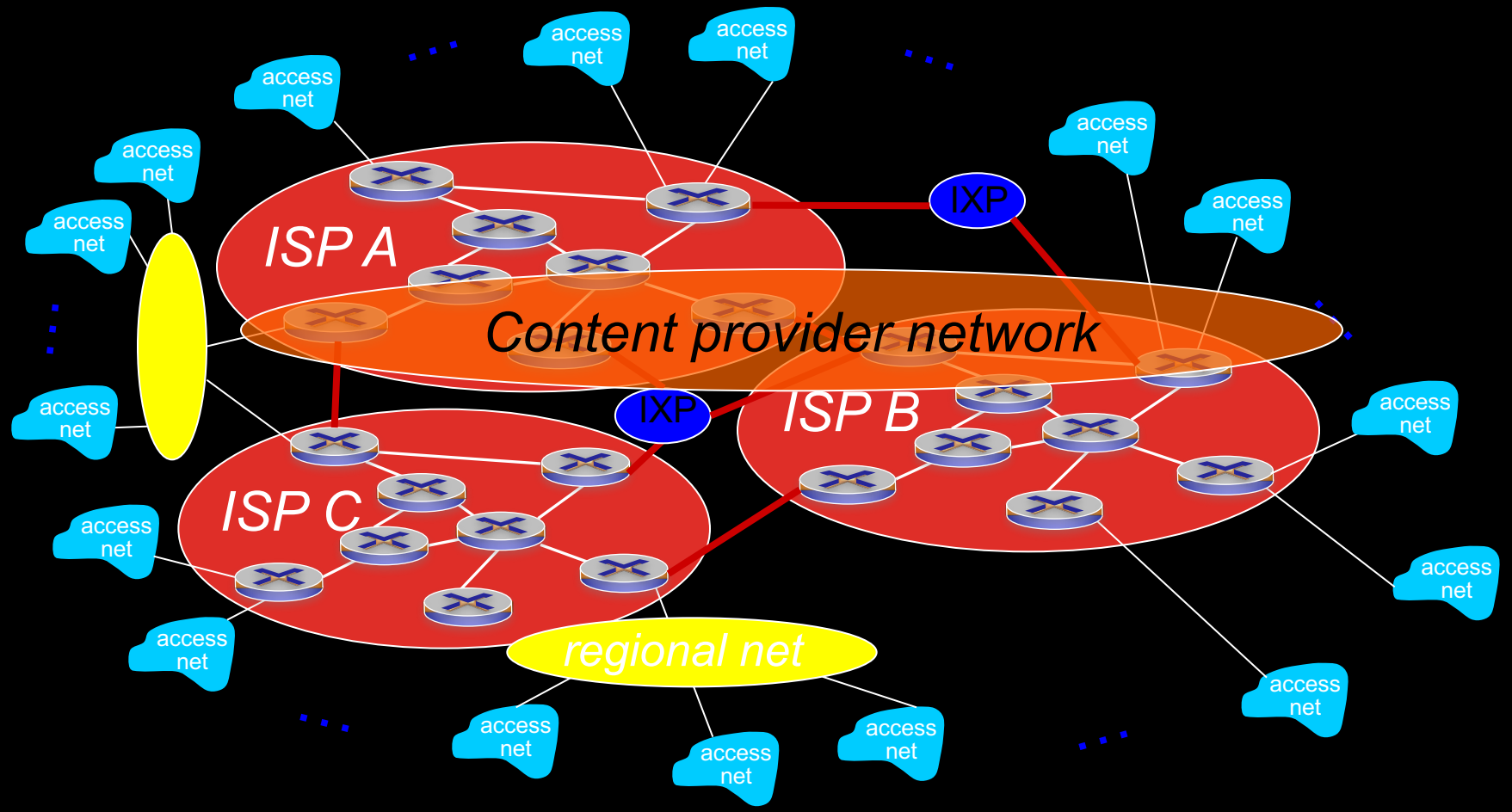


THE INTERNET – A PHYSICAL VIEW

- There isn't one view!
- Every individual network will have its own "map" and it will change frequently



THE INTERNET – A VIRTUAL VIEW



WHAT'S A PROTOCOL?

human protocols:

- "what's the time?"
- "I have a question"
- introductions

… specific messages sent

… specific actions taken when messages received, or other events

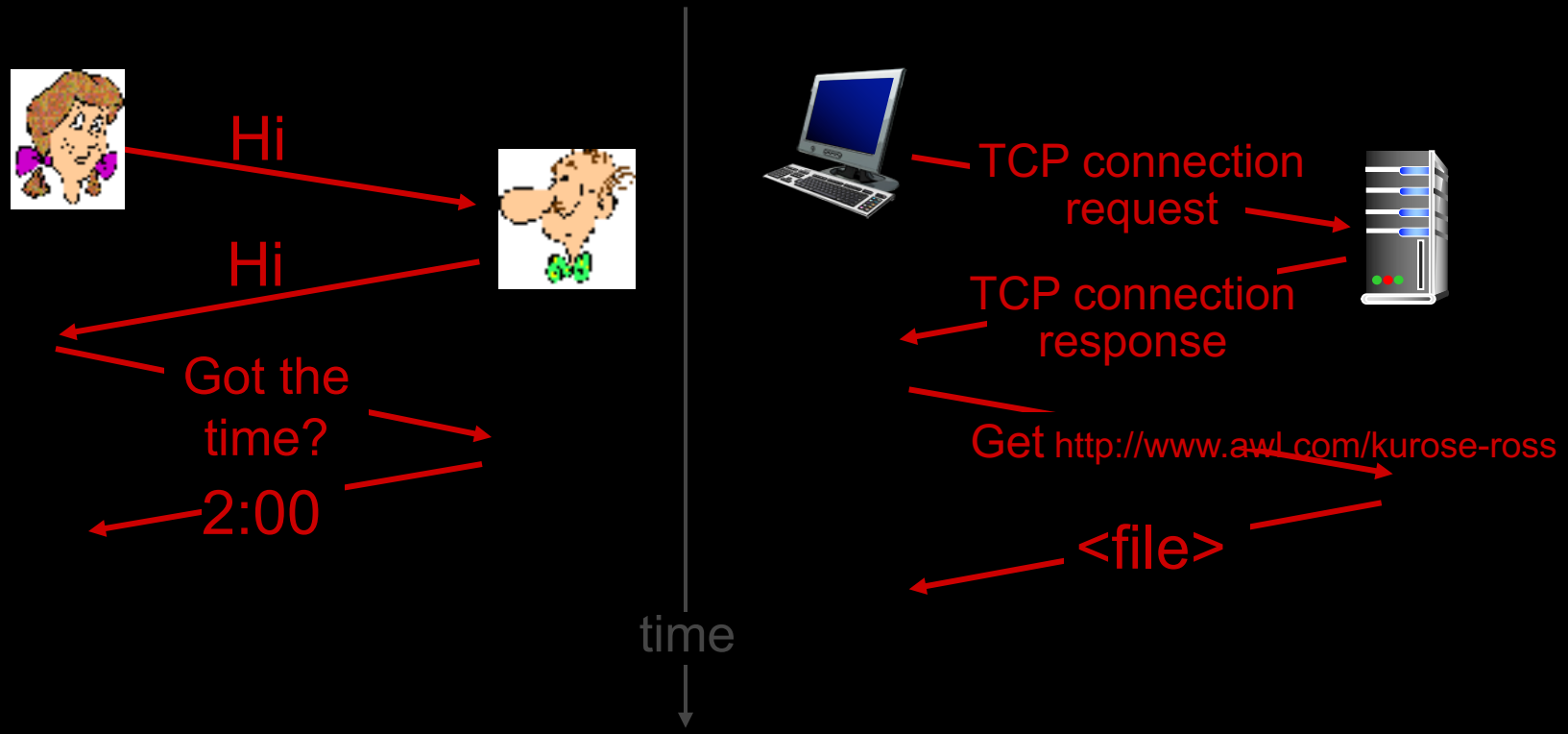
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt

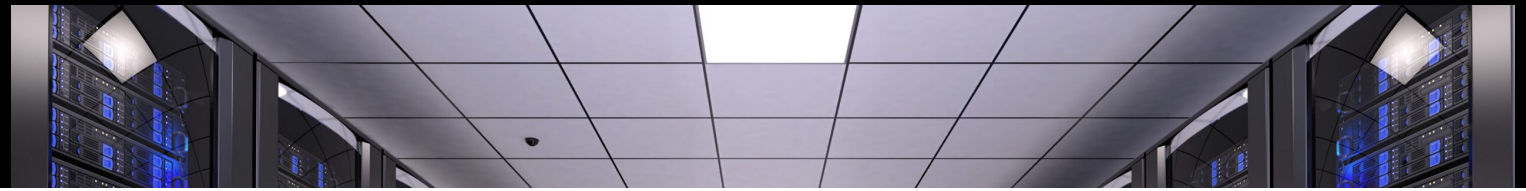
What's a protocol?

a human protocol and a computer network protocol:



Q: other human protocols?

WHAT IS A SERVER



```
def main():
    server_sock = socket.socket(socket.AF_INET,socket.SOCK_STREAM);
    try:
        server_sock.bind(("",6543));
        server_sock.listen();
    except OSError:
        print("Sorry, I could not bind or listen on port 6543.");

    i=0;
    print("Socket is now listening on port 6543");
    while (True):
        (client_sock, (ip, port)) = server_sock.accept();
        i+=1;
        print("Got client connection from",ip," and port",port,", id=",i);
        t = threading.Thread(target=processConnection, args=[client_sock, i]);
        t.start();
```

DOES ANYONE KNOW THE TIME?

HOW DID THIS USED TO WORK?

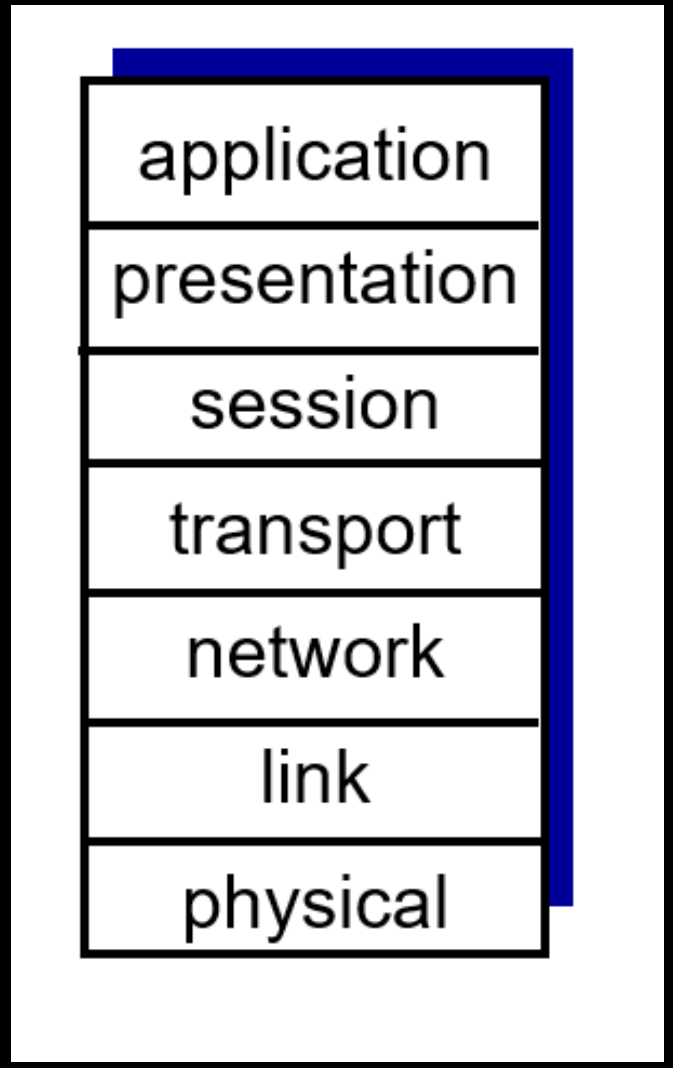
- The Plain Old Telephone System
  - A single copper wire used to be connected from your phone to the person you were calling.
  - To establish a call, you needed to speak to an operator
- Infrastructure was limited and EXPENSIVE!
- Over the years we found way to adapt, first eliminating operators, then multiplexing calls on that same single wire.

SO WHAT ARE WE REALLY TALKING ABOUT? NETWORKING!

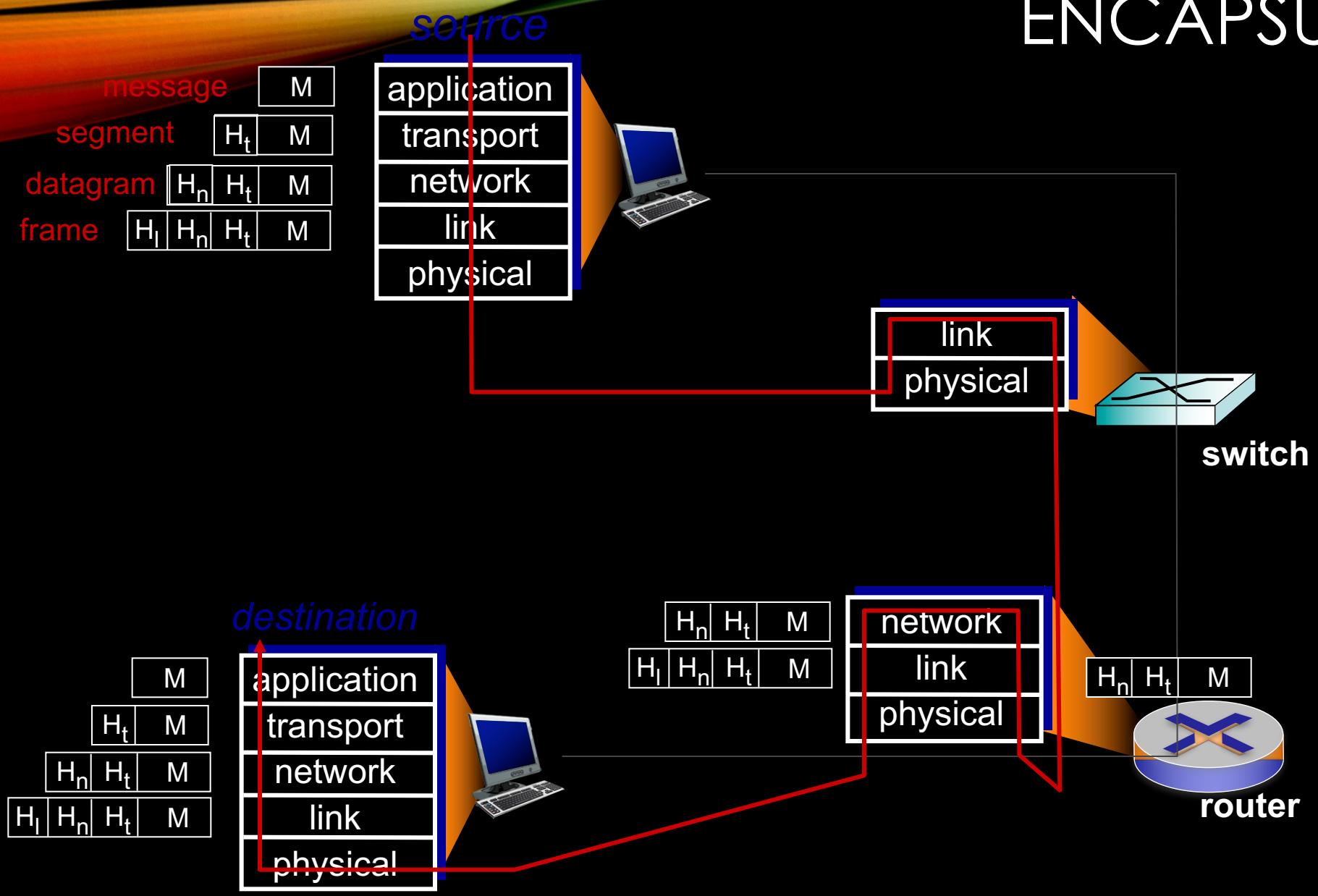
- Physical layer networking – Providing physical connectivity between devices
- Network layer networking – Providing the ability to find and route information on a global scale
- Application layer networking – Providing the ability to speak

OSI?

- The Open Systems Interconnect model was intended to allow changes to be made to one layer without impacting other layers.
- 7 Layers – like a cake from Brooklyn!
- Each layer encapsulates the information from the previous layer
- Today we use this as a reference model



ENCAPSULATION



WIRESHARK

WHAT IS THIS TCP/IP THAT I KEEP HEARING ALL ABOUT?

- TCP/IP is a suite of protocols which all Internet connected devices agree to support. These are BASIC protocols for connecting to the internet
- TCP is a transport control protocol for making “reliable” connections
- IP is a network layer protocol used for addressing devices globally
- IP Version 4 is the current standard
- Glacial speed migration to IP Version 6 is underway

WHAT DO I NEED TO KNOW?

- Without networks, computers today are pretty much useless!
- Networking involves a LOT of different disciplines
  - Physical infrastructure
  - Network routing
  - Application programming
  - Real-time systems
  - CyberSecurity

WHY DO I CARE?

- Imagine the current pandemic without an efficient way to communicate.
- Imagine your daily life without the Internet

WHAT CAN I DO?

- Write code for applications that are connected
- Consider that your code will be accessible from anywhere in the world (security implications)
- Design systems for interconnection

HELP PEOPLE CONNECT!!!

QUESTIONS?