

CS3640

---

# Overview (4): Network Security & History

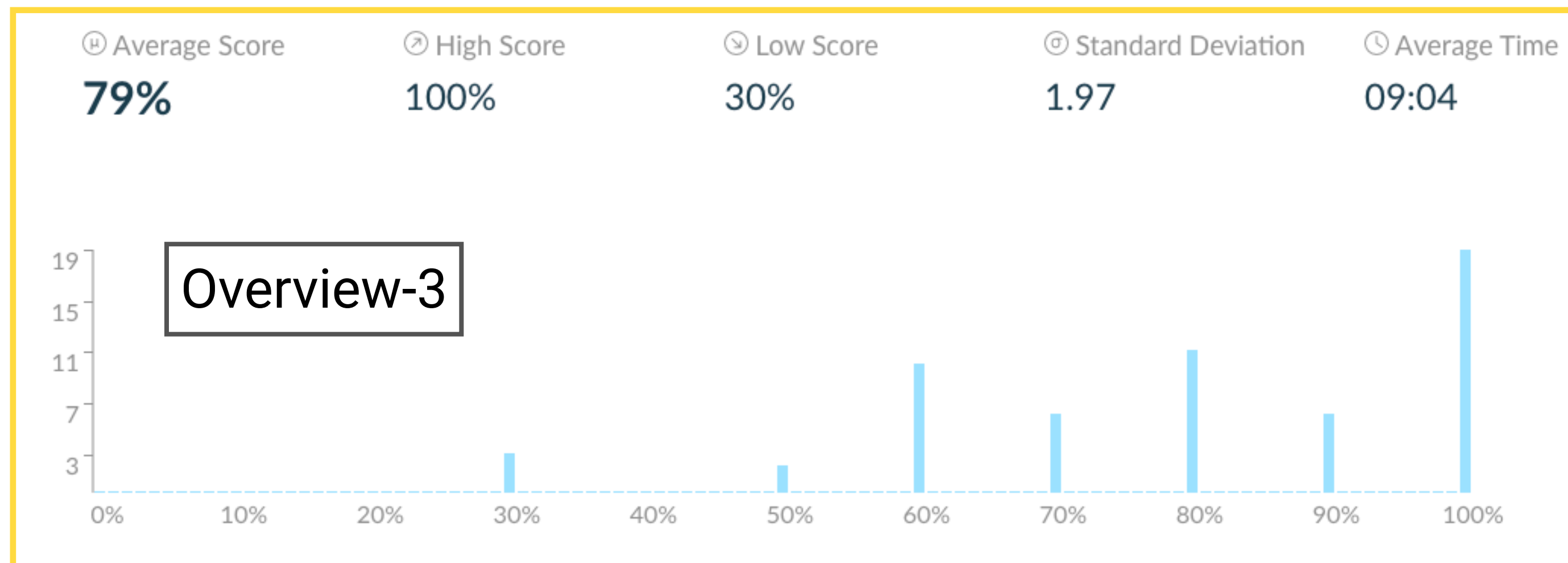
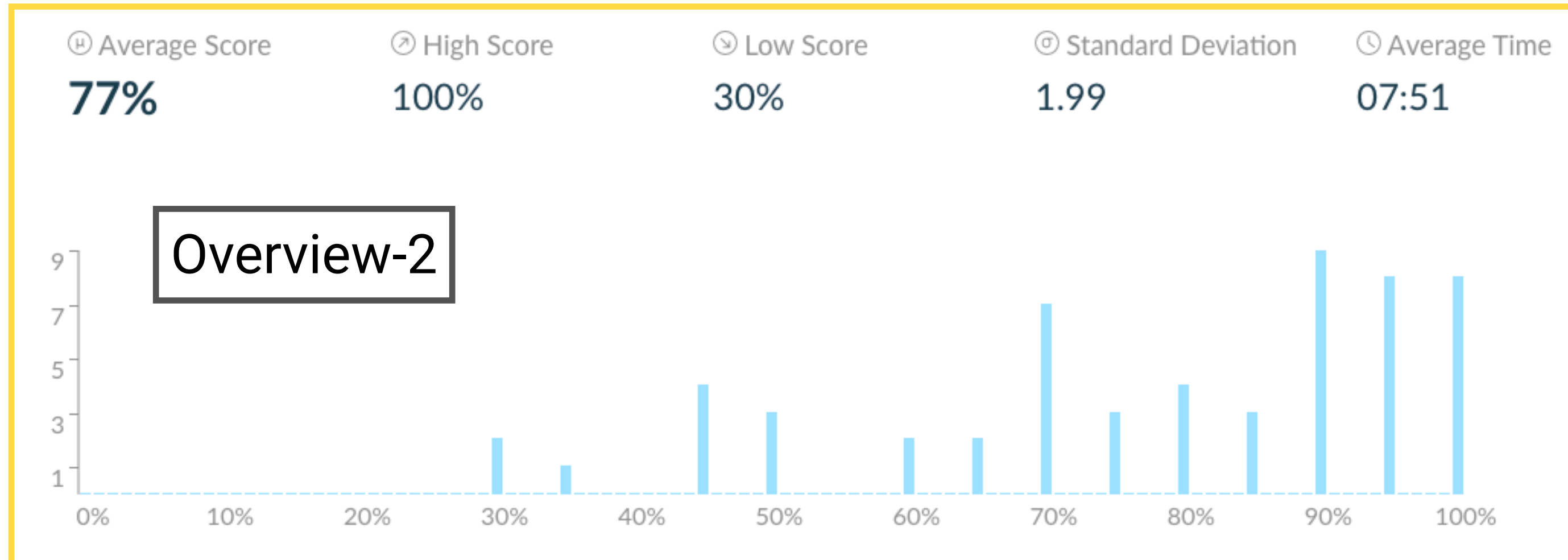
**Prof. Supreeth Shastri**

*Computer Science*

*The University of Iowa*



# Let us talk about the quiz



What is the **purpose** of spot quiz?

- Increase student engagement
- Improve our understanding of the lecture material
- Serve as a proxy for attendance

*I'd love to hear your feedback!*

**Zoom poll**

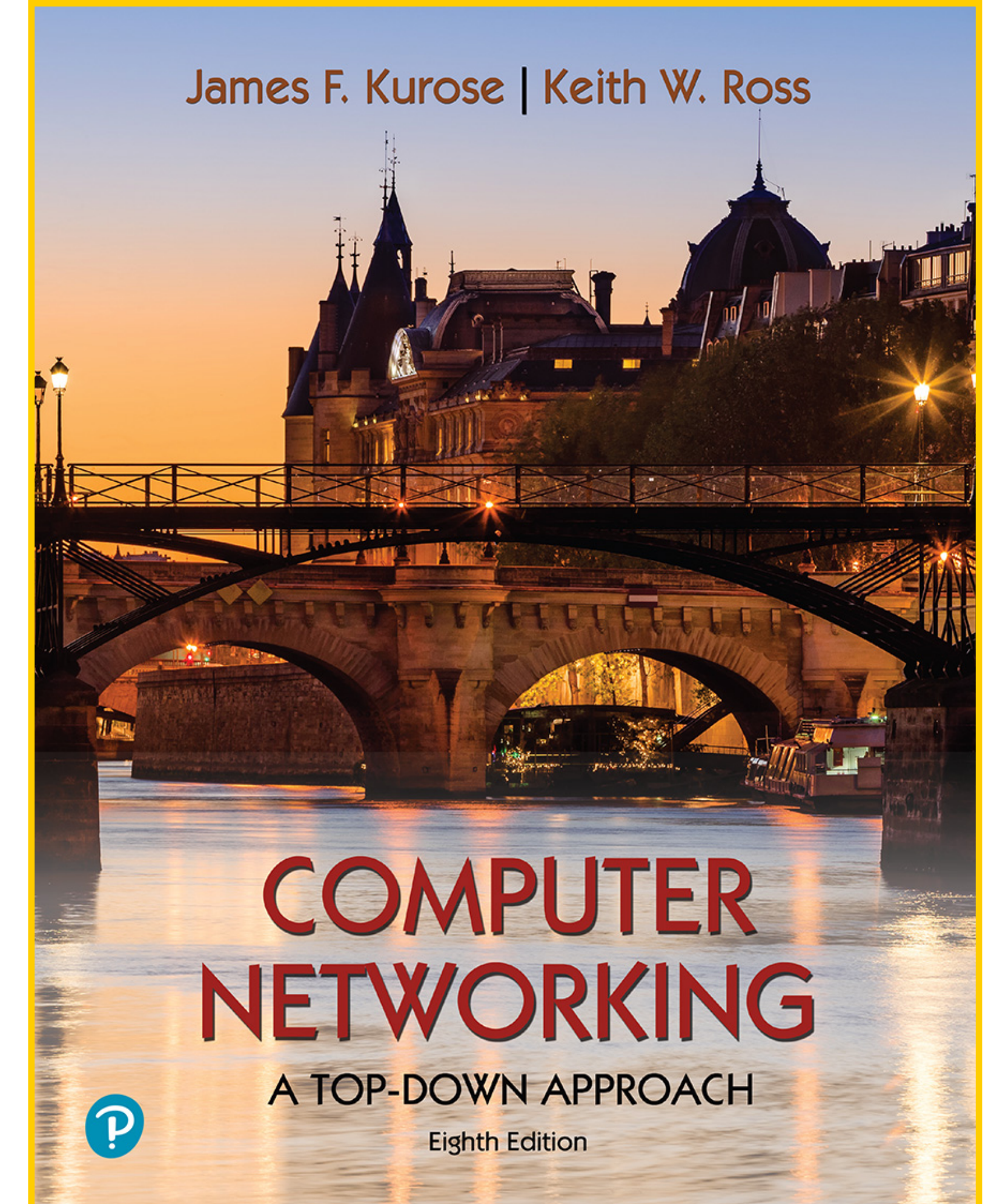


# Lecture goals

---

*Continuing our in-depth exploration into the structure and functionality of the Internet*

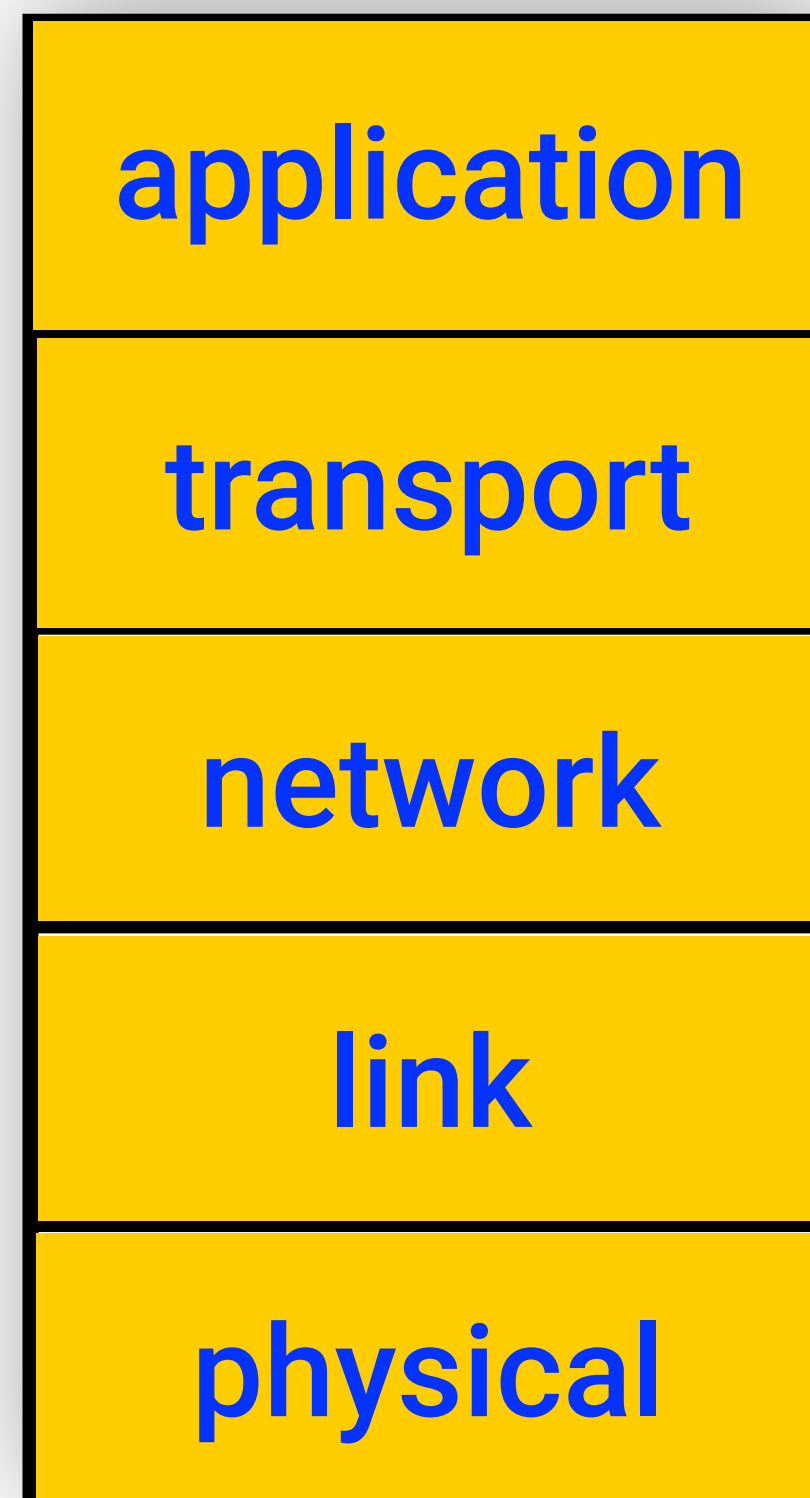
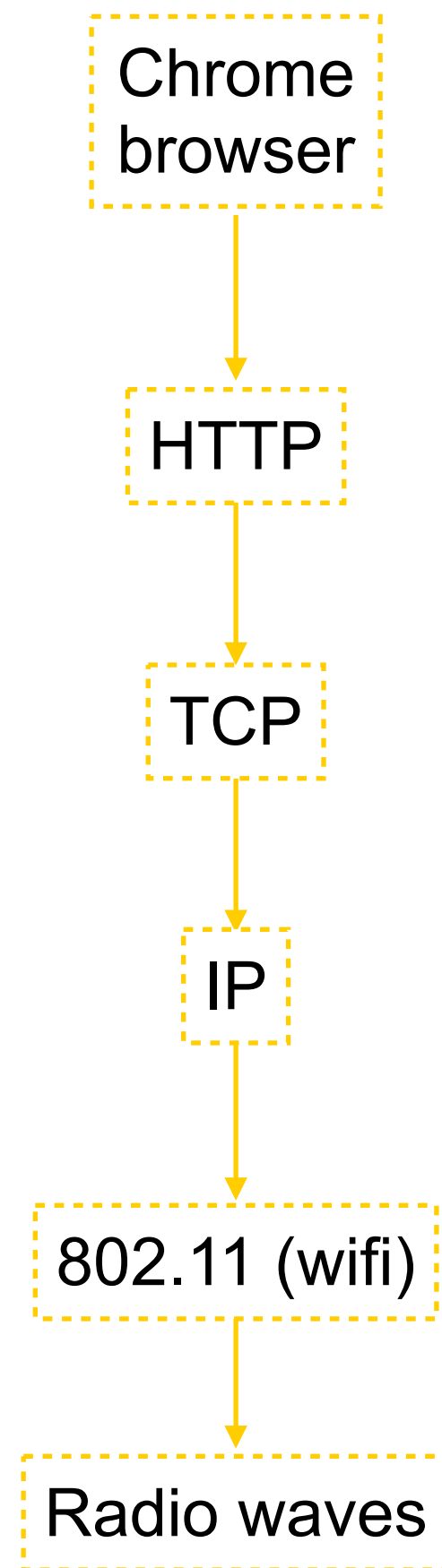
- *Revisit: protocol architecture*
- *Internet history and evolution*
- *Network security*



Chapter 1.6 - 1.7

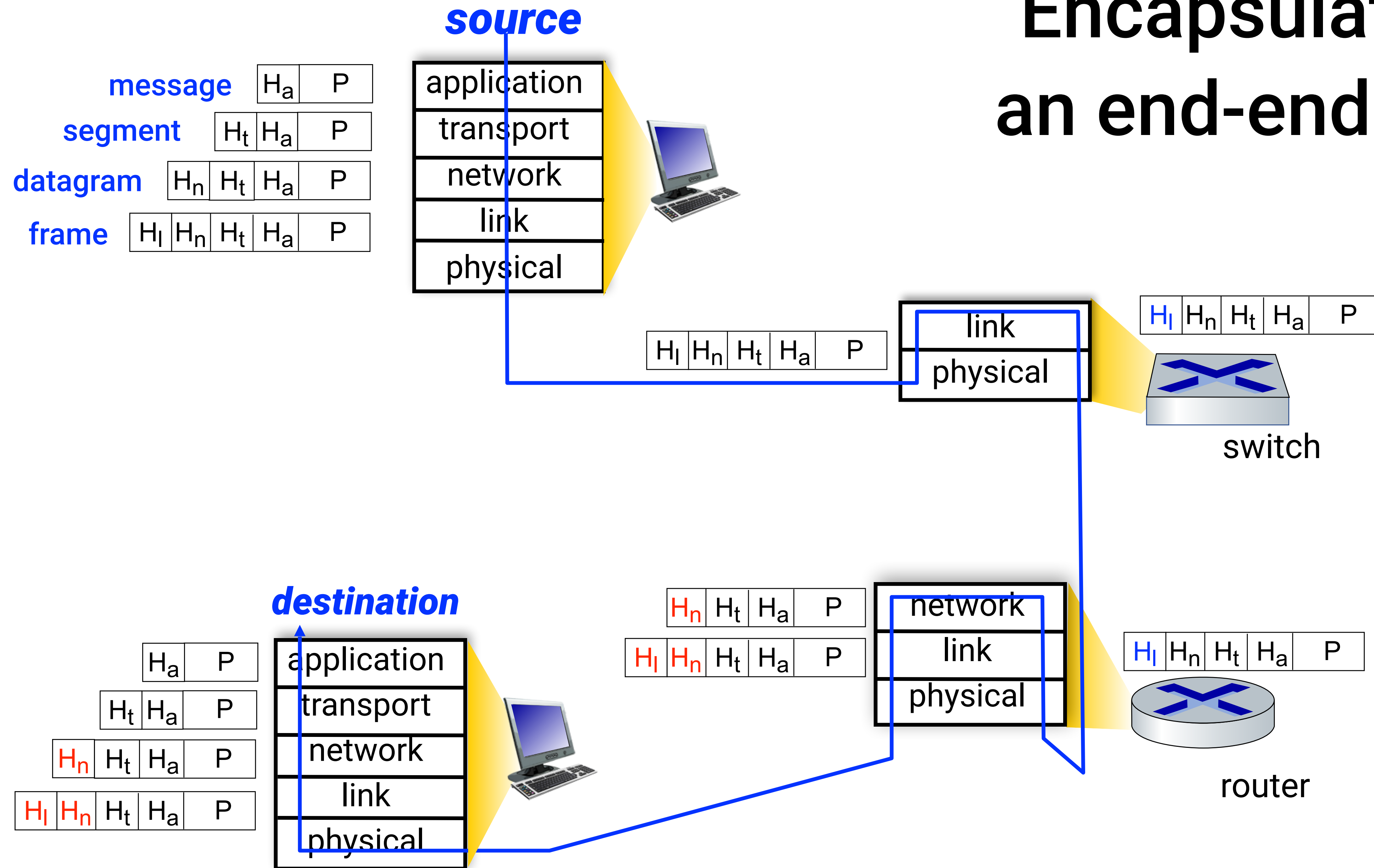


# The five layer architecture of the Internet



- **Application layer:** *supporting network applications. E.g., HTTP, SMTP, DNS*
- **Transport layer:** *process to process data transfer. E.g., TCP, UDP*
- **Network layer:** *routing of datagrams from source machine to destination. E.g., IP, IPv6*
- **Link layer:** *deliver data between neighboring network elements. E.g., Ethernet, 802.11 (WiFi)*
- **Physical layer:** *bits “on the wire”. E.g., 10BASE-T*

# Encapsulation: an end-end view



# Evolution of the Internet

1961 - 1972

1972 - 1980

1980 - 1990

1990 - 2000

2000 onwards

# Internet timeline

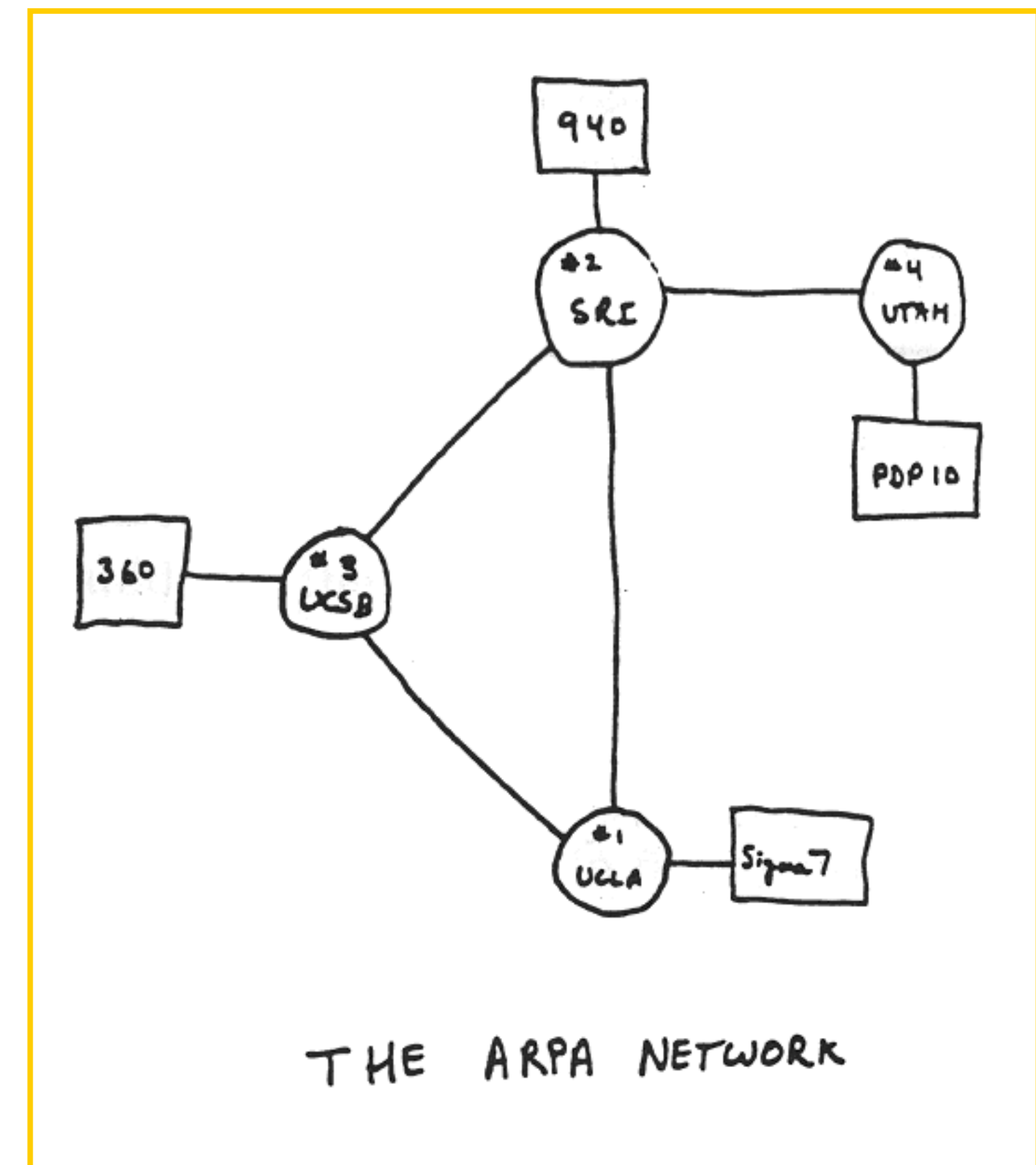
## Early development of packet switching

**1961:** Leonard Kleinrock develops a *queueing theoretical foundation* for packet-switching

**1964:** Paul Baran designs a packet-switching for voice communications in military networks

**1969:** Advanced Research Projects Agency creates the *first packet switched* computer network, ARPAnet

**1972:** *First public demonstration* of ARPAnet by Robert Kahn. ARPAnet has its own host-to-host protocol called Network Control Protocol (NCP) and 15 connected nodes.



1961 - 1972

1972 - 1980

1980 - 1990

1990 - 2000

2000 onwards

# Internet timeline

## Rise of new, proprietary computer networks

**1970s:** Multiple proprietary computer networks started emerging. E.g., ALOHAnet, GE ISN, IBM SNA

**1974:** Cerf and Kahn propose *internetworking*, an architecture for interconnecting autonomous networks

**1976:** Metcalfe develops the protocol and technology for *Ethernet*, a wire-connected broadcast network

**1980:** ARPAnet connects more than 200 hosts

Vinton Cerf and Robert Kahn's **internetworking** principles:

- minimalism
- best-effort service model
- stateless routing
- decentralized control



1961 - 1972

1972 - 1980

1980 - 1990

1990 - 2000

2000 onwards

# Internet timeline

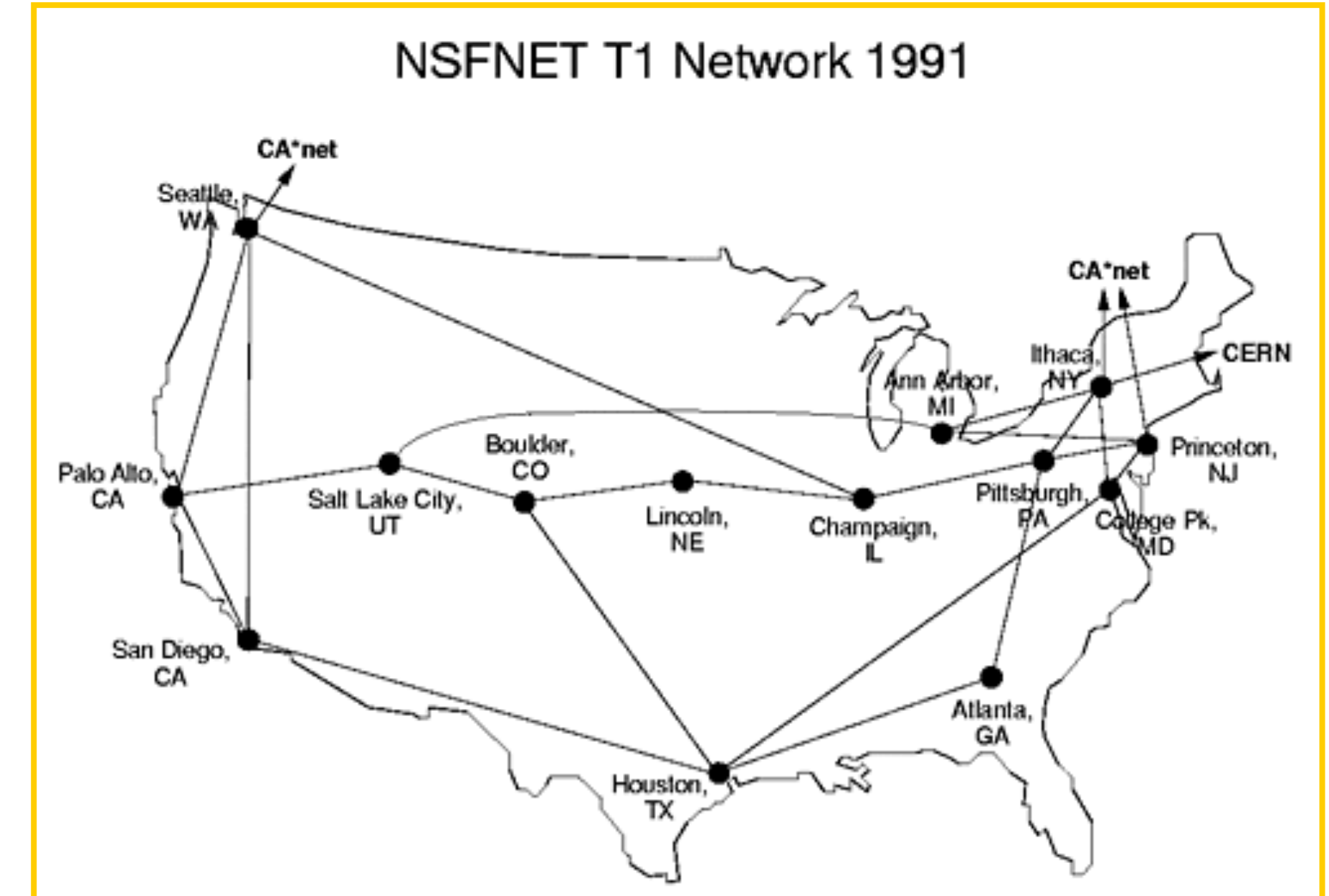
## Proliferation of networks and protocols

**1983:** *TCP/IP* deployed as the standard network protocol on ARPAnet

**1980s:** Protocols are designed and deployed for name resolution (DNS), file transfer (FTP), emails (SMTP), etc.,

**1986:** New national *backbone networks* emerged. For example, the NSFnet

**1990:** the network of networks reaches 100K connected hosts



1961 - 1972

1972 - 1980

1980 - 1990

1990 - 2000

2000 onwards

# Internet timeline

## Commercialization and the Internet explosion

**1991:** ARPAnet decommissioned, and NSFnet lifted its *restrictions* on its use for commercial purposes

**1991:** Tim Berners-Lee builds and demonstrates the *world wide web (www)* and its four key components: HTML, HTTP, web server, and web browser

**1995:** *Commercial ISPs* emerge after NSFnet is decommissioned

**1998 - 2000:** the browser war, the dot-com bubble, and four killer apps (email, www, IM, p2p file share)

### World Wide Web

The WorldWideWeb (W3) is a wide-area [hypermedia](#) information retrieval initiative aiming to give universal access to a large universe of documents.

Everything there is online about W3 is linked directly or indirectly to this document, including an [executive summary](#) of the project, [Mailing lists](#) , [Policy](#) , November's [W3 news](#) , [Frequently Asked Questions](#) .

#### [What's out there?](#)

Pointers to the world's online information, [subjects](#) , [W3 servers](#), etc.

#### [Help](#)

on the browser you are using

#### [Software Products](#)

A list of W3 project components and their current state. (e.g. [Line Mode](#) ,X11 [Viola](#) , [NeXTStep](#) , [Servers](#) , [Tools](#) , [Mail robot](#) , [Library](#) .)

#### [Technical](#)

Details of protocols, formats, program internals etc

#### [Bibliography](#)

Paper documentation on W3 and references.

#### [People](#)

A list of some people involved in the project.

#### [History](#)

A summary of the history of the project.

#### [How can I help ?](#)

If you would like to support the web..

#### [Getting code](#)

Getting the code by [anonymous FTP](#) , etc.

World's first website.

Courtesy: <http://info.cern.ch/hypertext/WWW/TheProject.html>



**1961 - 1972**

**1972 - 1980**

**1980 - 1990**

**1990 - 2000**

**2000 onwards**

# Internet timeline

## Hyper connectivity and innovation

**2000s:** High-speed connectivity in access networks: broadband, 3G/4G, and WiFi technologies

**2005 - 2010:** Cloud computing, Social networks, Software Defined Networking (SDN)

**2010 onwards:** New end devices (smart phones) and new traffic (video) overtake the traditional fixed devices and text-based traffic

**2017:** The Internet has more than 18B devices connected

# Network Security



# Network security (or lack thereof)

*The Internet was not originally designed with security in mind*

- **Why?** *The original operating setup of the Internet: a group of mutually trusting users attached to a transparent network*
- **What changed?** *Growth of the Internet, and commercialization – both of which invalidated the original working conditions/assumptions*
- **How does it impact?** *All the layers of networking stack have vulnerabilities. The networking community has been playing catch up.*
- **So, why not stop-drop-and-learn network security?** *Sure, but the first step is to develop expertise in networking and protocols*

1

The bad guys can sniff your packets

2

The bad guys can masquerade as someone you trust

3

The bad guys can **break** into your host

4

The bad guys can **attack** network infrastructure

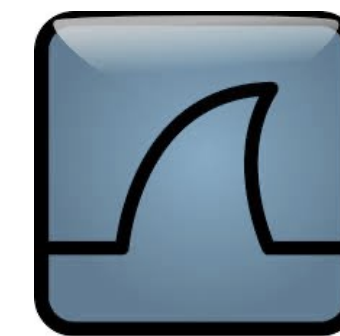
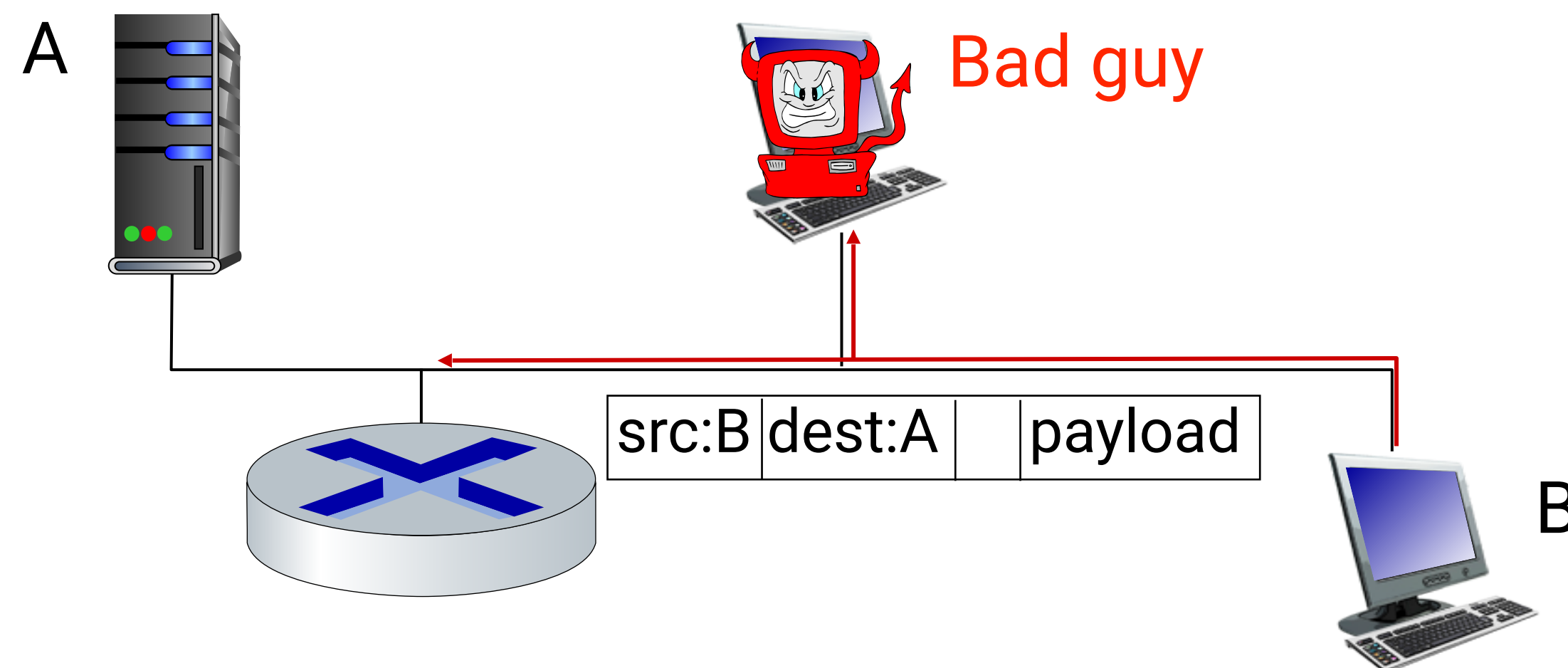


1

## The bad guys can sniff your packets

**Packet sniffer:** *a passive receiver that records a copy of every packet that flies by in the network*

- *Could be deployed in any type of network (wired, wireless) and any portion of the network (broadcast LANs, outside of an access network, in the backbone etc)*
- *they capture packets in promiscuous mode, and their presence is difficult to detect*



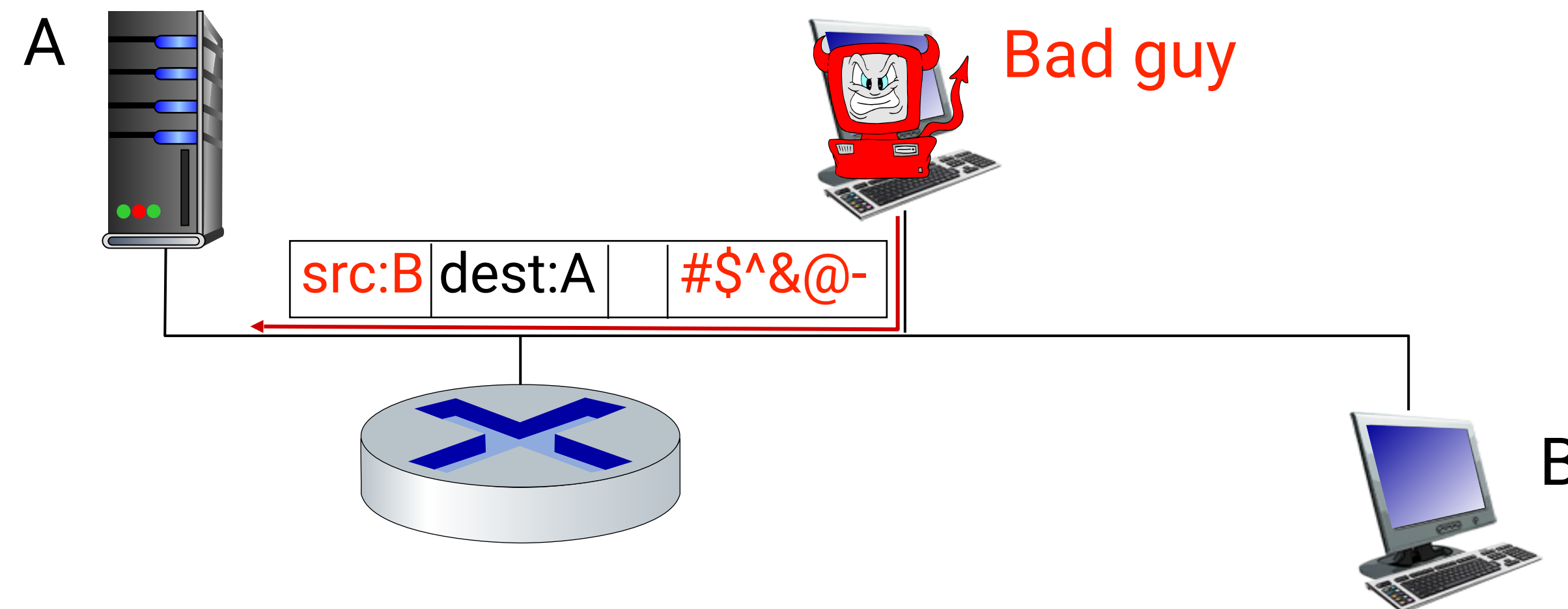
**Wireshark:** an open-source software for packet-sniffing

## 2

The bad guys can masquerade as someone you trust

**IP spoofing:** *ability to inject packet into the Internet with a false source address*

- *It is trivial to create and inject handcrafted packets into the network!*
- *This circles back to the assumptions of the original Internet*
  - ▶ *Anyone can send packets to anyone on the Internet (contrast that w/ telephone network)*
  - ▶ *User identity is taken at declared face value rather than authenticated by default*



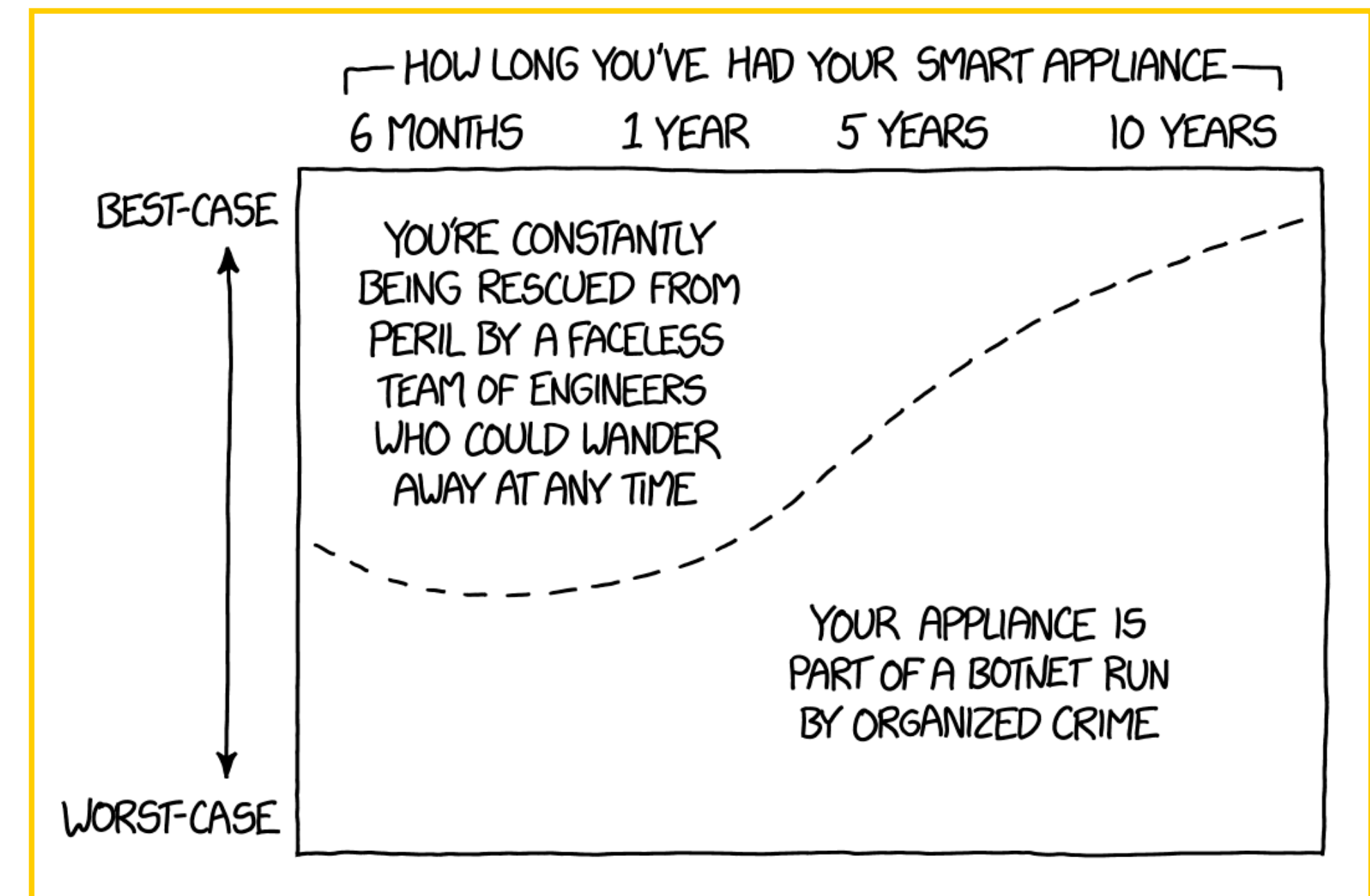


### 3

## The bad guys can **break** into your host

**Malware:** *malicious software installed on a host system without permission*

- Examples include viruses, spyware, ransomware, wipers and so on
- **Self-replicating** i.e., once they infect a host, they extract contact information and spread themselves to other hosts
- **Botnets.** A collection of compromised hosts that could be directed to participate in network attacks orchestrated by bad guys



Courtesy: XKCD

# 4

## The bad guys can attack network infrastructure

**Denial of Service (DoS):** *a class of network attacks, where a network server, host, router, or software is rendered unusable for legitimate user*

1. **Vulnerability attack.** *Send a well-crafted message to a vulnerable application or OS running on a networked machine. Causes the network service to stop or crash.*
2. **Bandwidth flooding.** *Send a deluge of packets to the targeted network system. Makes the target's access link clogged.*
3. **Connection flooding.** *Open a large number of TCP connections at the target system. Causes resource exhaustion at the target.*

# Course Structure

---

<b>Overview</b>	<i>2 weeks</i>	The Internet; Network edge/core & packet switching; Network protocols
<b>Applications layer</b>	<i>2.5 weeks</i>	Principles; Web and HTTP; Email; P2P applications; Socket programming
<b>Transport layer</b>	<i>2 weeks</i>	Data transfer service; UDP; TCP; Congestion control
<b>Network layer</b>	<i>2 weeks</i>	Routing and forwarding; IP; Routing algorithms; OSPF and BGP
<b>Link layer</b>	<i>2 weeks</i>	MAC protocols; LANs and ethernet; Datacenter networking
<b>Research topics</b>	<i>1.5 weeks</i>	Software Defined Networking; Cloud computing
<b>Tech interviews</b>	<i>2 weeks</i>	1-on-1 with instructor; more details coming up soon



# Spot Quiz (ICON)