IOWA

CS3640

Overview (4): Network Security & History

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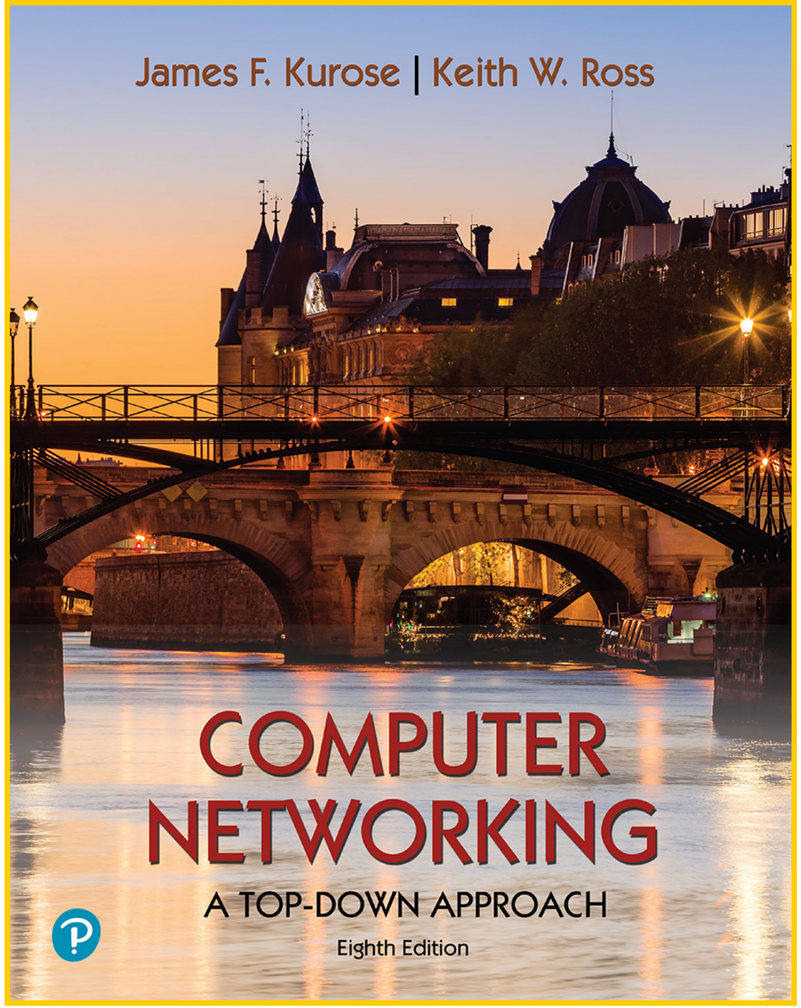
Lecture goals

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

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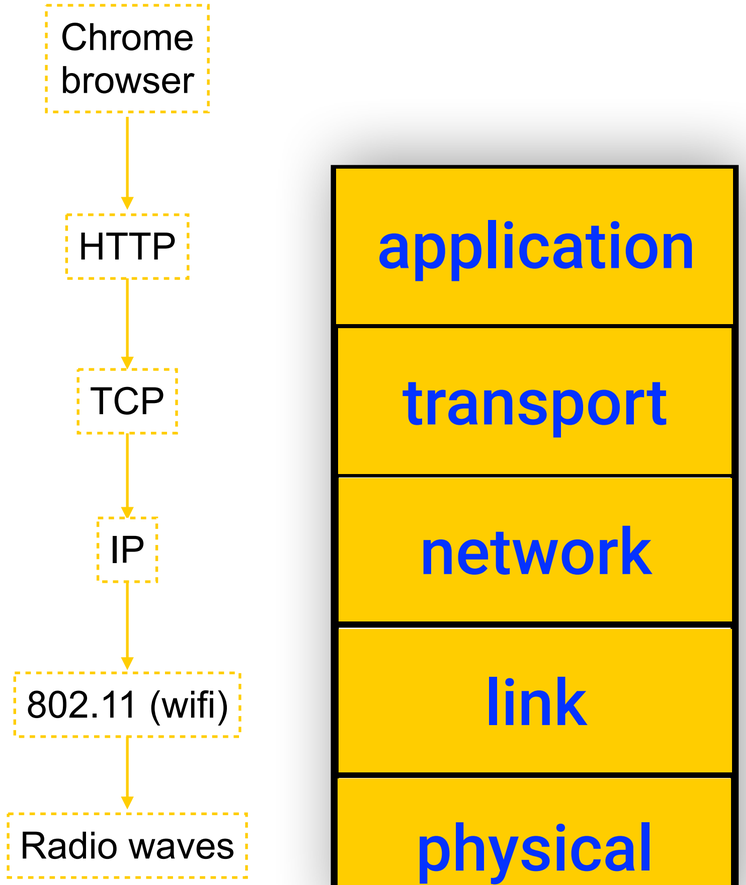
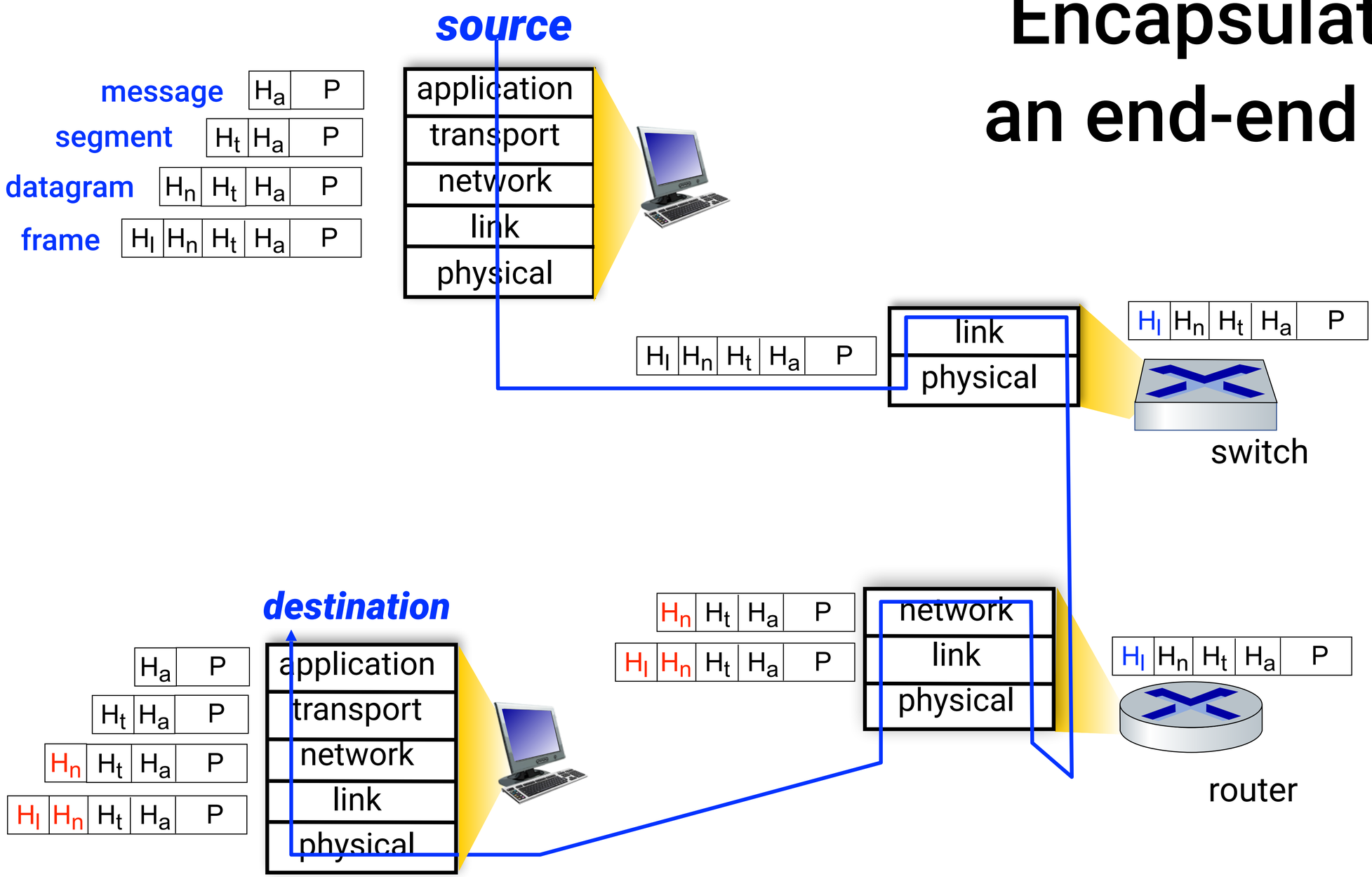
The five layer architecture of the Internet



- **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

Internet timeline

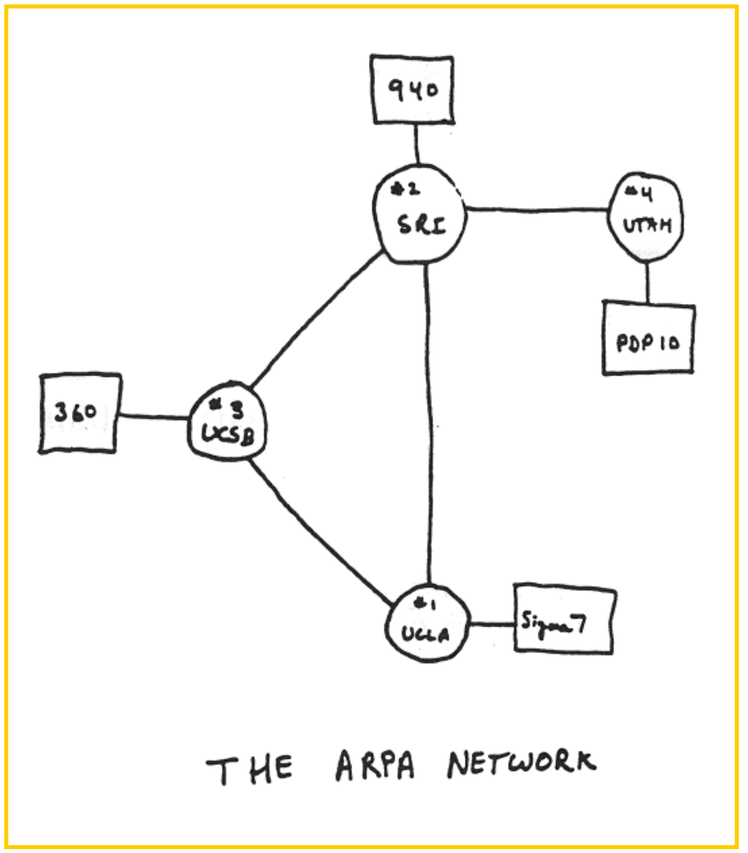
Early development of packet switching

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.



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 ***internetting***, 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 **internetting** principles:

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

Internet timeline

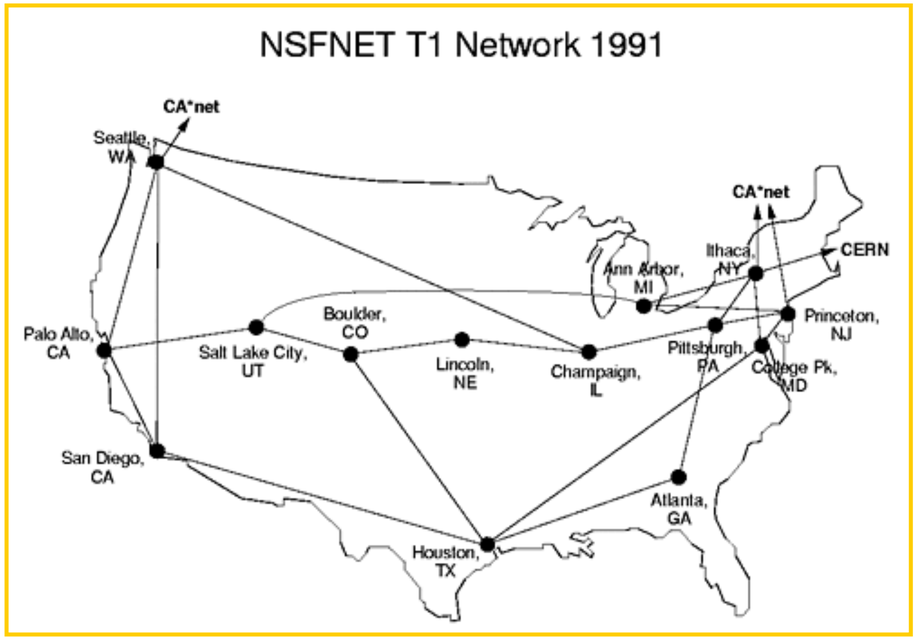
Proliferation of networks and protocols

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



Internet timeline

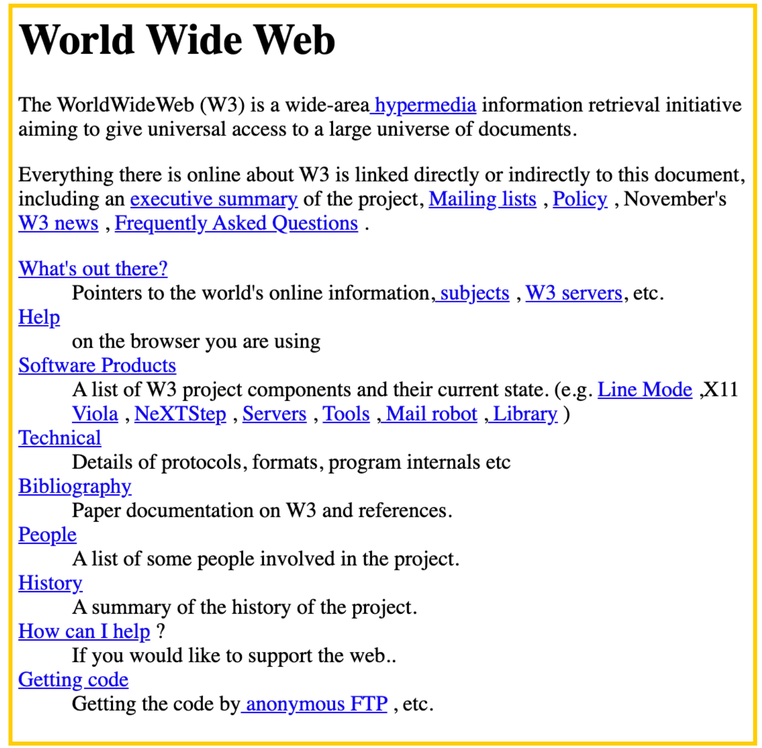
Commercialization and the Internet explosion

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

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

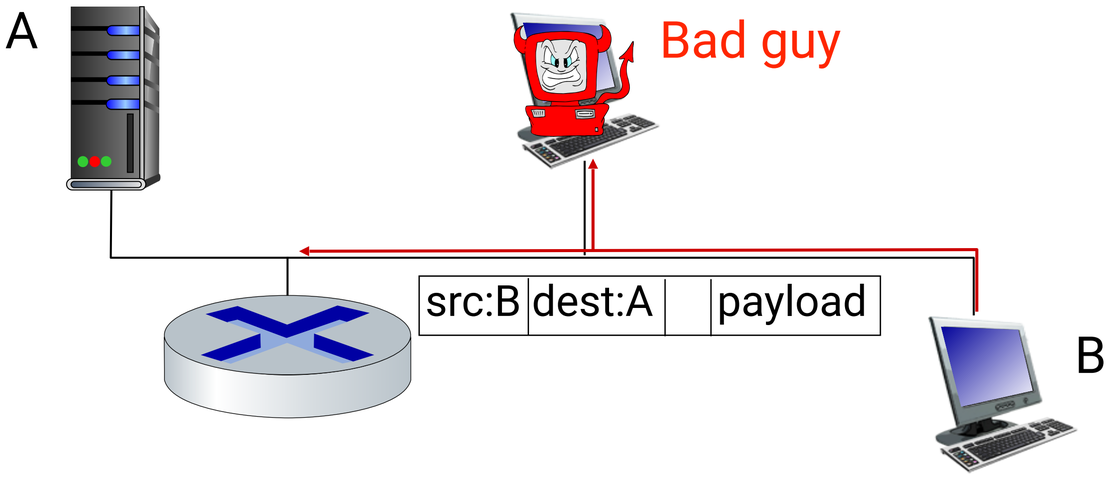
- ***Why?*** *The original operating setup of the Internet: a group of* ***mutually trusting*** *users attached to a* ***transparent*** *network*
- ***What changed?*** *Growth of the Internet, and commercialization — both of which invalidated the original working conditions/assumptions*
- ***How does 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*

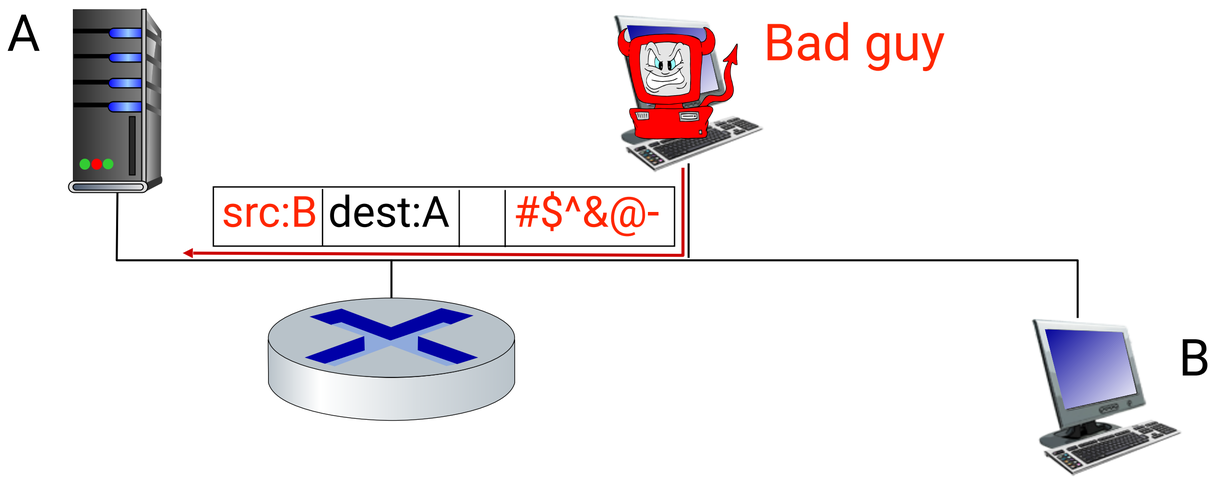


Wireshark: an open-source software for packet-sniffing

2 The bad guys can **masquerade as someone** you trust

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

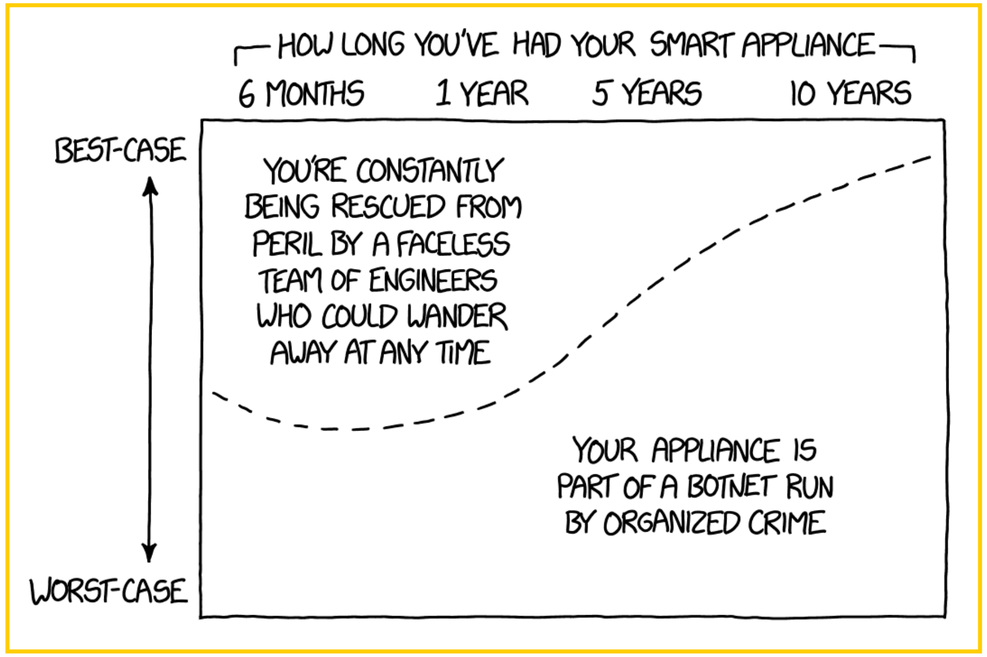
- *It is trivial to create and inject handcrafted packets into the network!*
- *This circles back to the assumptions of the original Internet*
  - *Anyone can send packets to anyone on the Internet (contrast that w/ telephone network)*
  - *User identity is taken at declared face value rather than authenticated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

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

Spot Quiz (ICON)