

Chapter 1: roadmap

- What *is* the Internet?
- What *is* a protocol?
- Network edge: hosts, access network, physical media
- Network core: packet/circuit switching, internet structure
- Performance: loss, delay, throughput
- **Security**
- Protocol layers, service models
- History



Network security

- **field of network security:**
 - how bad guys can attack computer networks
 - how we can defend networks against attacks
 - how to design architectures that are immune to attacks
- **Internet not originally designed with (much) security in mind**
 - *original vision:* “a group of mutually trusting users attached to a transparent network” ☺
 - security considerations in all layers!

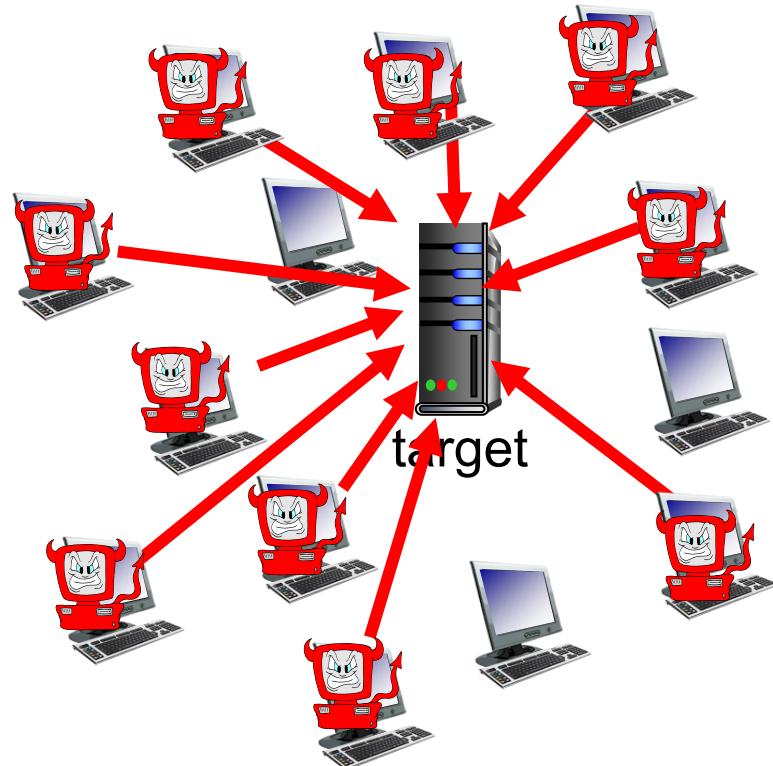
Bad guys: malware

- malware can get in host from:
 - *virus*: self-replicating infection by receiving/executing object (e.g., e-mail attachment)
 - *worm*: self-replicating infection by passively receiving object that gets itself executed
- **spyware malware** can record keystrokes, web sites visited, upload info to collection site

Bad guys: denial of service

Denial of Service (DoS): attackers make resources (server, bandwidth) unavailable to legitimate traffic by overwhelming resource with bogus traffic

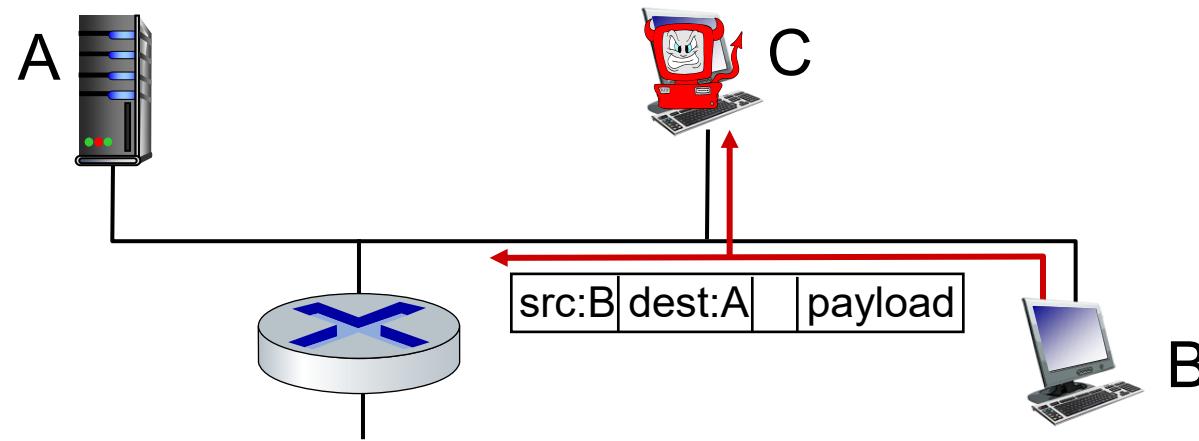
1. select target
2. break into hosts
around the network
(see botnet)
3. send packets to target
from compromised
hosts



Bad guys: packet interception

packet “sniffing”:

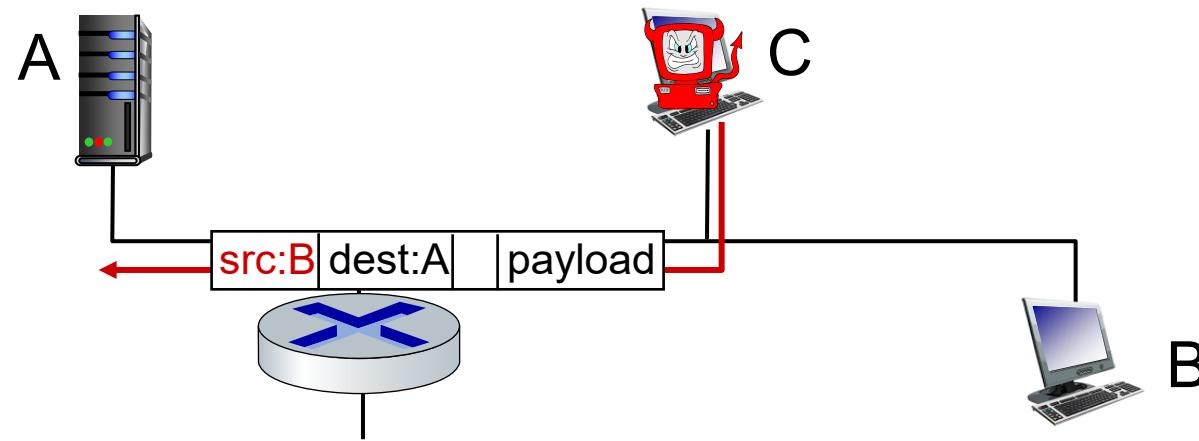
- broadcast media (shared Ethernet, wireless)
- promiscuous network interface reads/records all packets (e.g., including passwords!) passing by



Wireshark software used for our end-of-chapter labs is a (free) packet-sniffer

Bad guys: fake identity

IP spoofing: send packet with false source address



... lots more on security (throughout, Chapter 8)

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Protocol “layers” and reference models

*Networks are complex,
with many “pieces”:*

- hosts
- routers
- links of various media
- applications
- protocols
- hardware, software

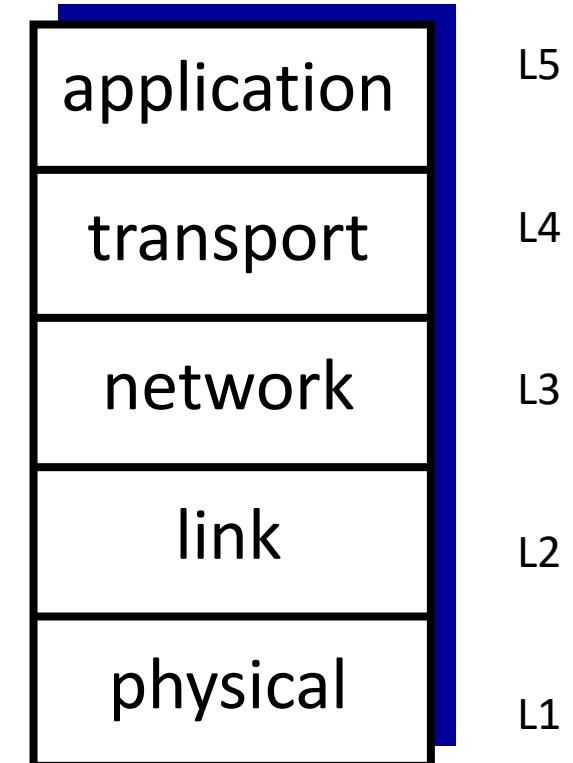
Question:

is there any hope of
organizing structure of
network?

.... or at least our
discussion of networks?

Internet protocol stack

- ***application***: supporting network applications
 - IMAP, SMTP, HTTP
- ***transport***: process-process data transfer
 - TCP, UDP
- ***network***: routing of datagrams from source to destination
 - IP, routing protocols
- ***link***: data transfer between neighboring network elements
 - Ethernet, 802.11 (WiFi), PPP
- ***physical***: bits “on the wire”



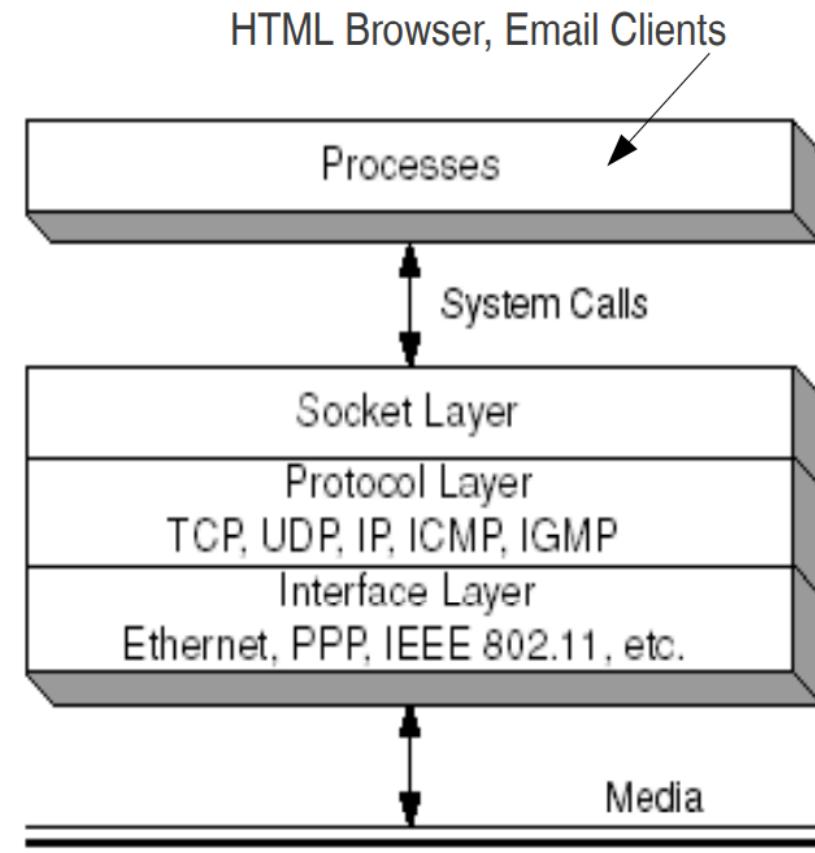
Why layering?

dealing with complex systems:

- explicit structure allows identification, relationship of complex system's pieces
 - layered *reference model* for discussion
- modularization eases maintenance, updating of system
 - change in layer's service *implementation*: transparent to rest of system
 - e.g., change in gate procedure doesn't affect rest of system

Networking Code Organization

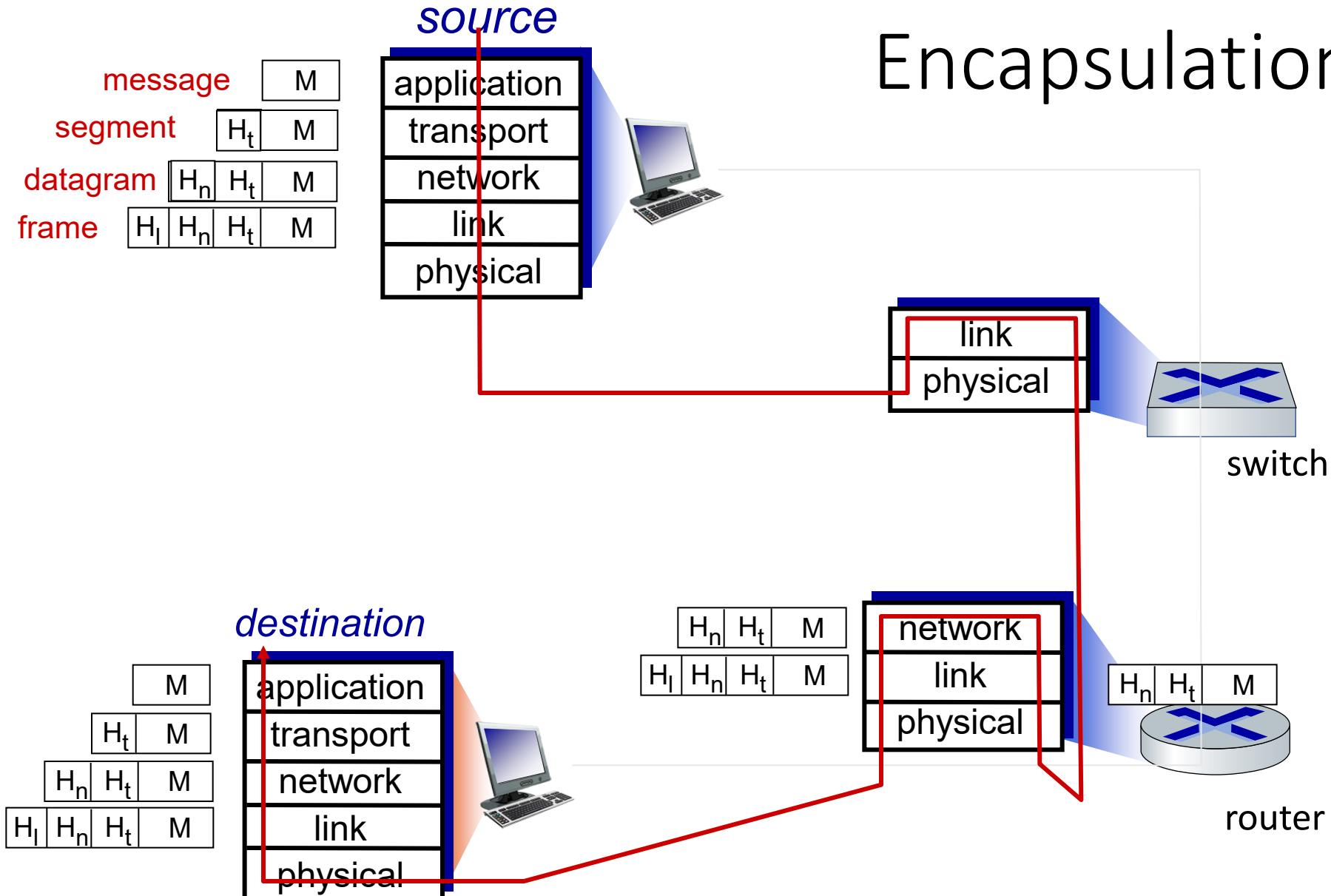
- Applications are mostly implemented as a user space processes.
- The network protocols are implemented in system kernel.
 - Socket layer
 - Protocol Layer
 - Interface layer



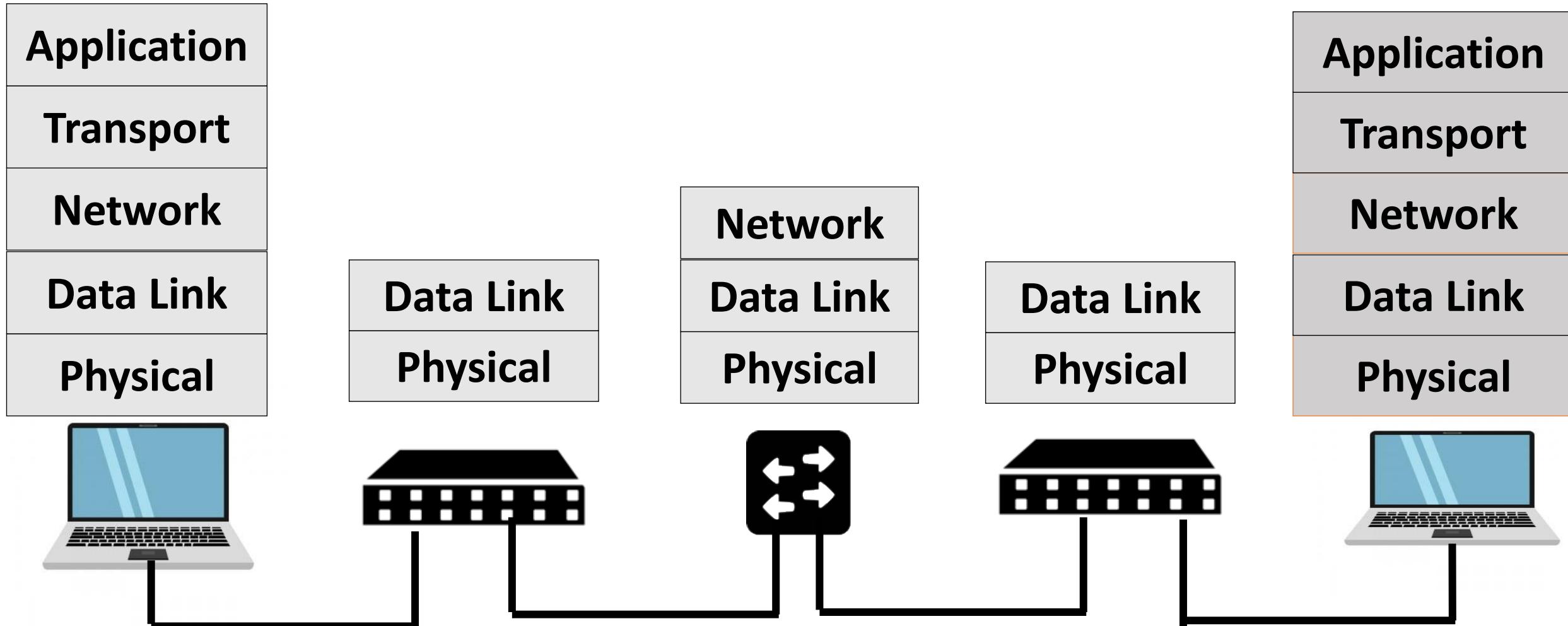
Network Configurations Files

- When a host is configured to boot locally, network configuration parameters are stored in files.
- When the system boots up, parameters are read from the files and used to configure the daemons and the network interface.
- A parameter may be changed by editing the corresponding configuration file.
- Examples in Linux
 - /etc/hosts
 - /etc/services
 - /etc/network/interfaces

Encapsulation



Communication between two remote Machine



Top Down Vs Bottom Up Approach



Chapter 1: summary

We've covered a “ton” of material!

- Internet overview
- what's a protocol?
- network edge, access network, core
 - packet-switching versus circuit-switching
 - Internet structure
- performance: loss, delay, throughput
- layering, service models
- security
- **History – You can read!**

You now have:

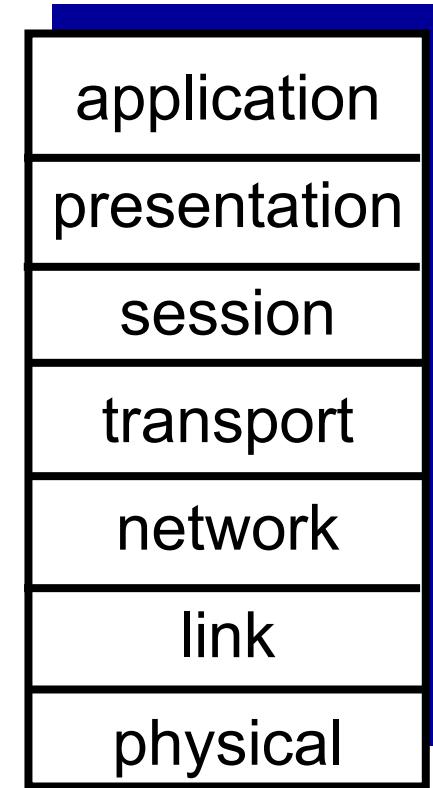
- context, overview, vocabulary, “feel” of networking
- more depth, detail, *and fun* to follow!

Additional Chapter 1 slides

ISO/OSI reference model

Two layers not found in Internet protocol stack!

- *presentation*: allow applications to interpret meaning of data, e.g., encryption, compression, machine-specific conventions
- *session*: synchronization, checkpointing, recovery of data exchange
- Internet stack “missing” these layers!
 - these services, *if needed*, must be implemented in application
 - needed?



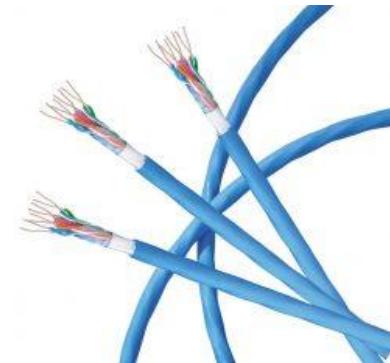
The seven layer OSI/ISO reference model

Links: physical media

- **bit**: propagates between transmitter/receiver pairs
- **physical link**: what lies between transmitter & receiver
- **guided media**:
 - signals propagate in solid media: copper, fiber, coax
- **unguided media**:
 - signals propagate freely, e.g., radio

Twisted pair (TP)

- two insulated copper wires
 - Category 5: 100 Mbps, 1 Gbps Ethernet
 - Category 6: 10Gbps Ethernet



Links: physical media

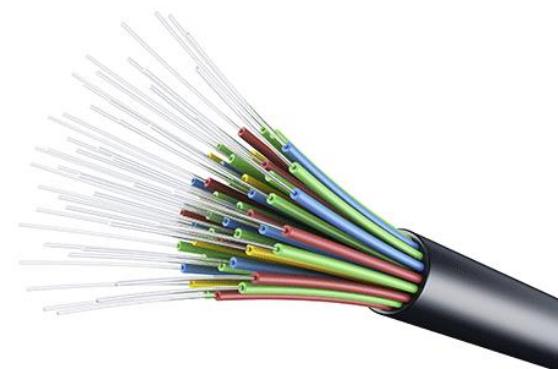
Coaxial cable:

- two concentric copper conductors
- broadband:
 - multiple frequency channels on cable
 - 100's Mbps per channel



Fiber optic cable:

- glass fiber carrying light pulses, each pulse a bit
- high-speed operation:
 - high-speed point-to-point transmission (10's-100's Gbps)
- low error rate:
 - repeaters spaced far apart
 - immune to electromagnetic noise



Links: physical media

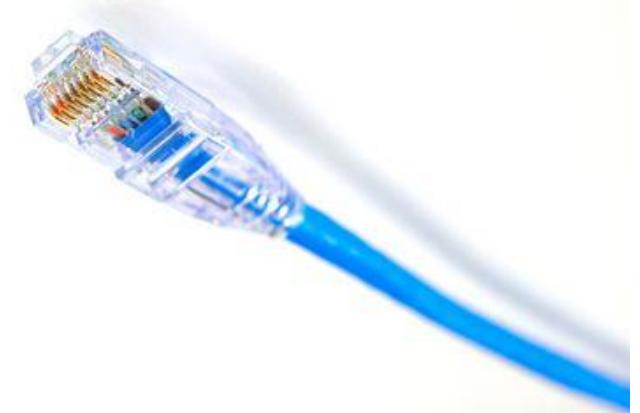
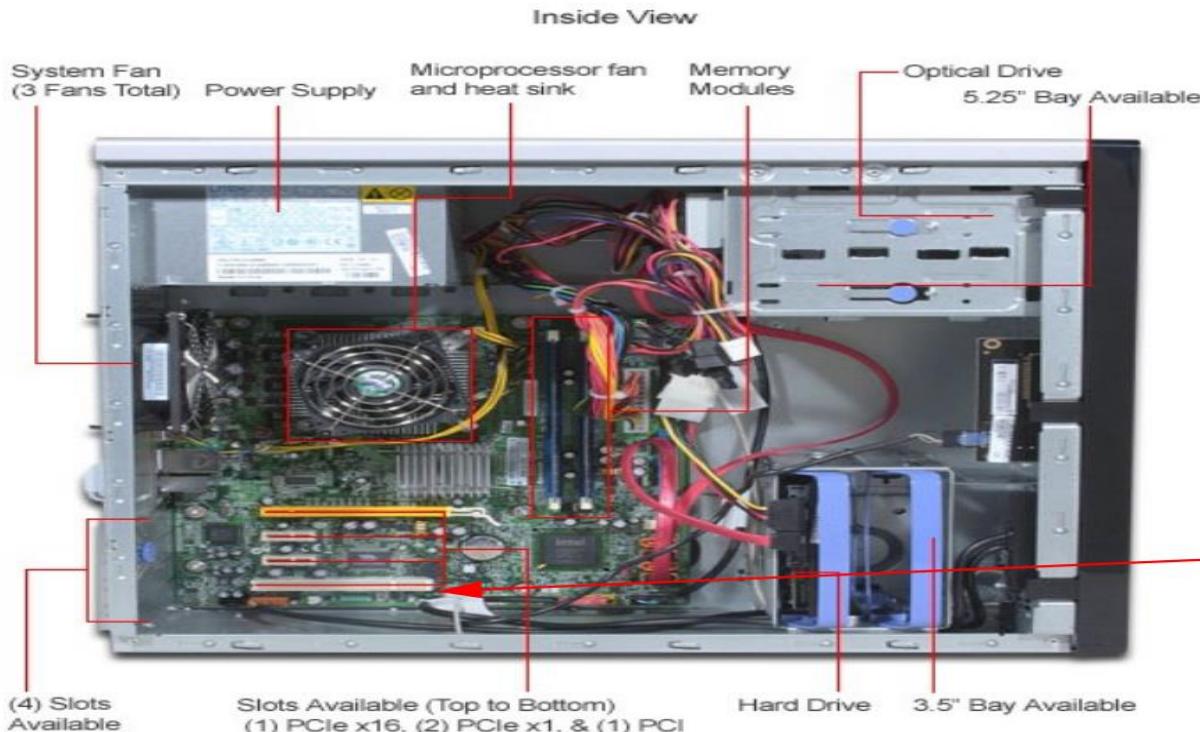
Wireless radio

- signal carried in electromagnetic spectrum
- no physical “wire”
- broadcast and “half-duplex” (sender to receiver)
- propagation environment effects:
 - reflection
 - obstruction by objects
 - interference

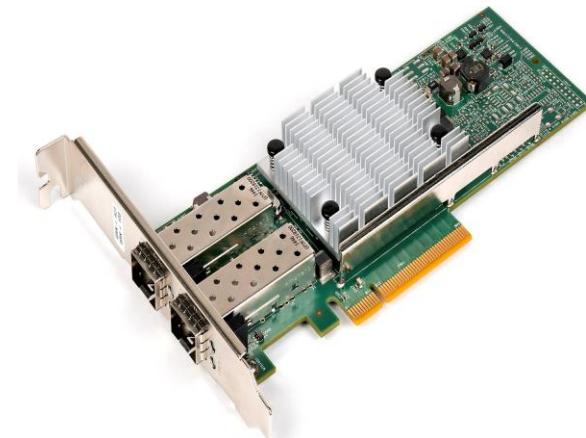
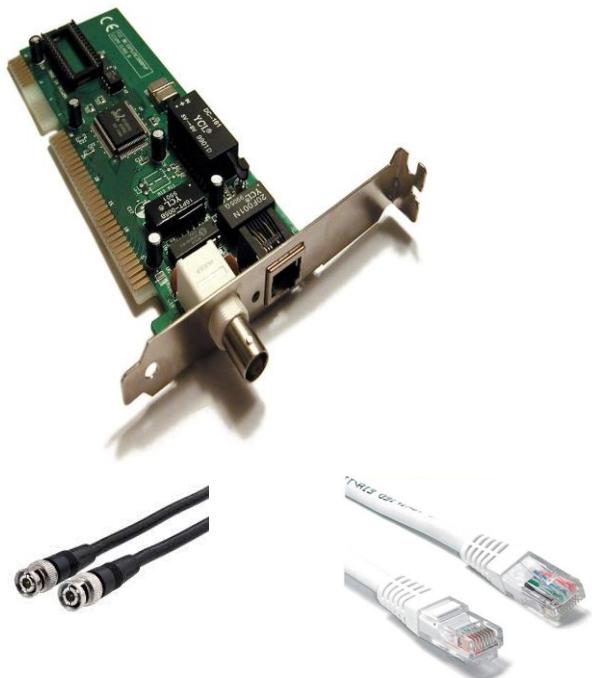
Radio link types:

- **Wireless LAN (WiFi)**
 - Up to 100's Mbps
- **wide-area** (e.g., cellular)
 - 4G cellular: ~ 10's Mbps
- **satellite**
 - up to 45 Mbps per channel
 - 270 msec end-end delay
 - geosynchronous versus low-earth-orbit

Network Interface Card (NIC) inside computer

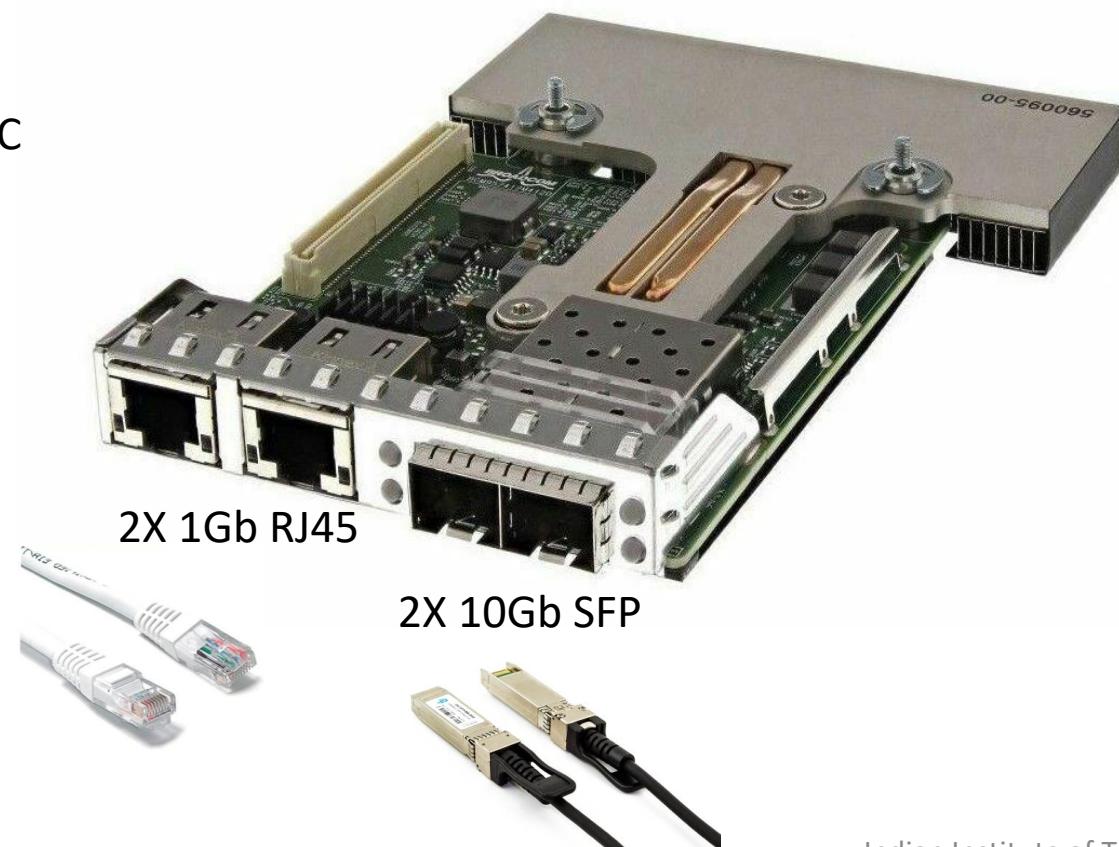


NIC and connector



NIC Cont..

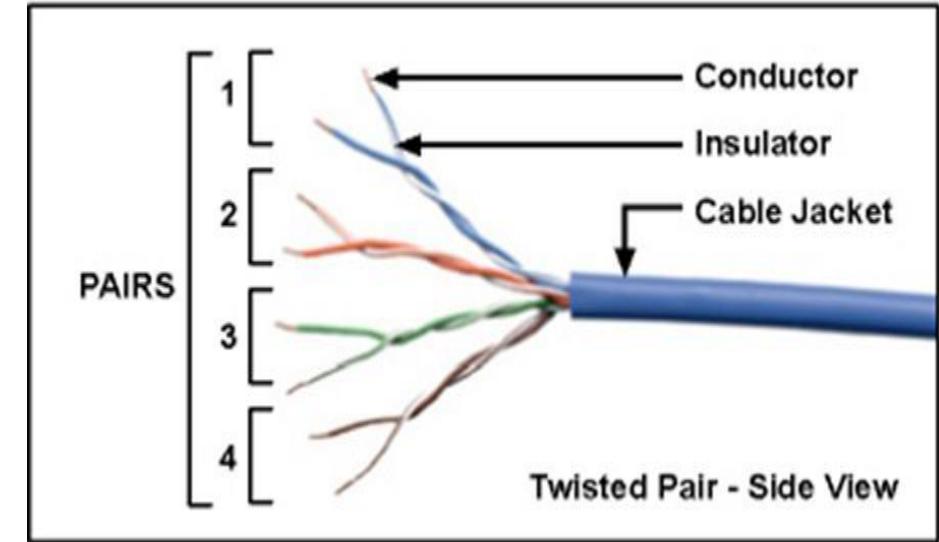
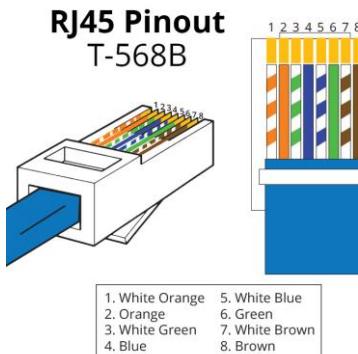
Quad Port NIC



Crimping LAN/Ethernet cables



Cable/Network Crimping tool



Network cable

