COMP 204 – Principles of Computer Networks

Week 5

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Agenda

- Review this week's learning outcomes
- Presentation of this week's material
- Introduce homework problems
- Q & A session

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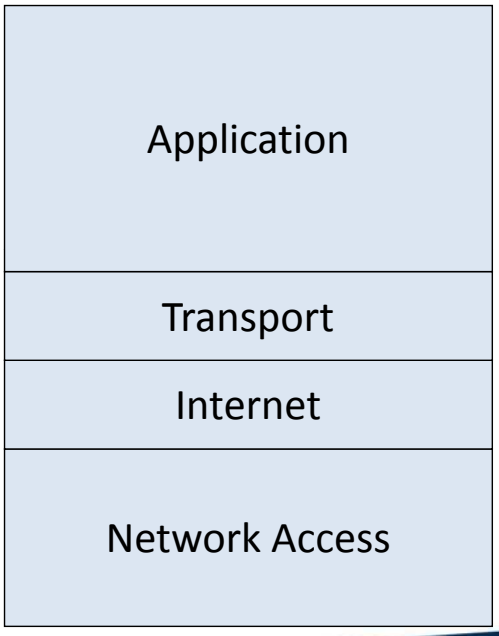
This Week's Outcomes

- List and describe several common logical network topologies.
- Contrast contention strategies in shared media access.
- Describe methods of encoding bits for physical media.
- Describe characteristics of common physical media.

Review – Application and Transport



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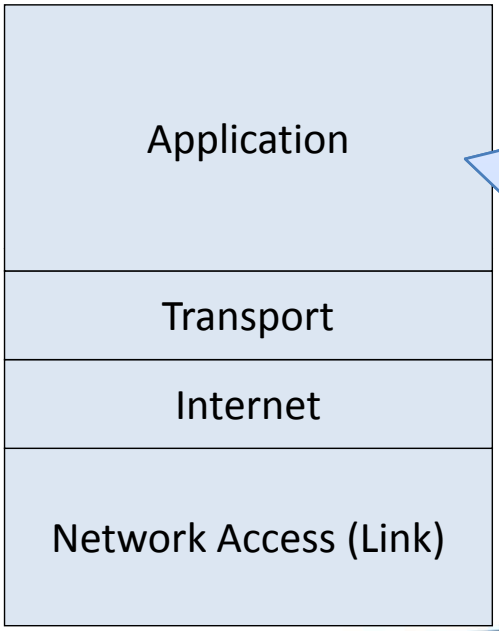
Review – Application Layer



OSI layers 5, 6, 7. User applications, services, and application layer protocols. "messages"

- Ex: browser, httpd, and HTTPD working together.
- App message -> app protocol -> transport layer.

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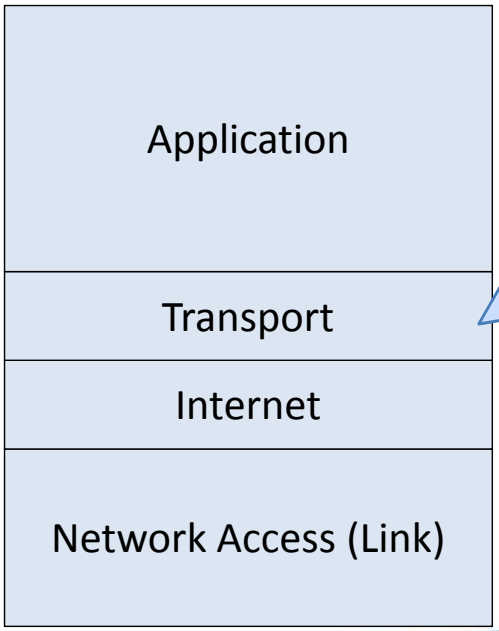
Review – Transport Layer



OSI layer 4. Typical examples are UDP and TCP. "segments"

- Port – specifies target service/app listening for messages
- UDP – "connectionless"
- TCP – "connection oriented"
- Header differences
- Handshaking in TCP

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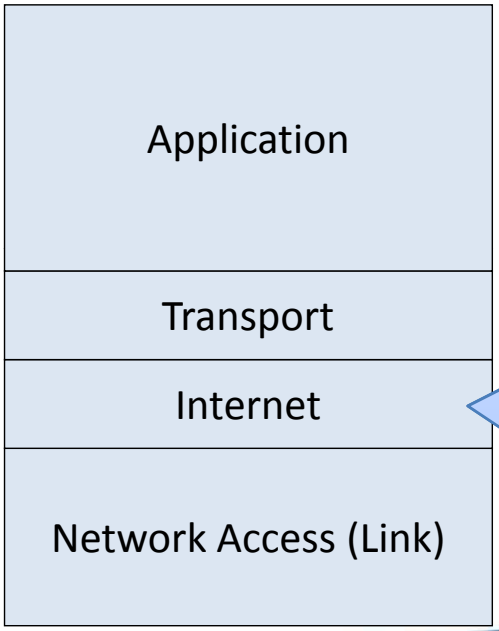
Review – Internet Layer



How messages get from host to host. Layer 3. "packets"

- Ex: IP (Internet Protocol) and ICMP (Internet Control Message Protocol)
- Routing
- VLSM/CIDR for subnets

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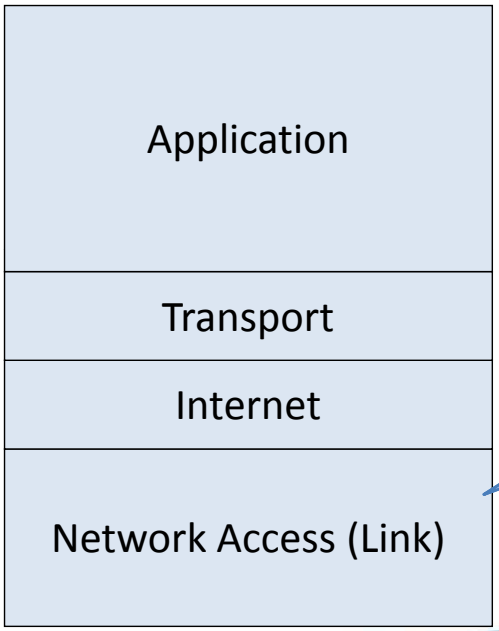
Network Access (Link) Layer



How messages get from device to device. OSI Layers 2 and 1. "Frames."

- Ex: Ethernet, PPP, ATM
- "Bits on a wire"

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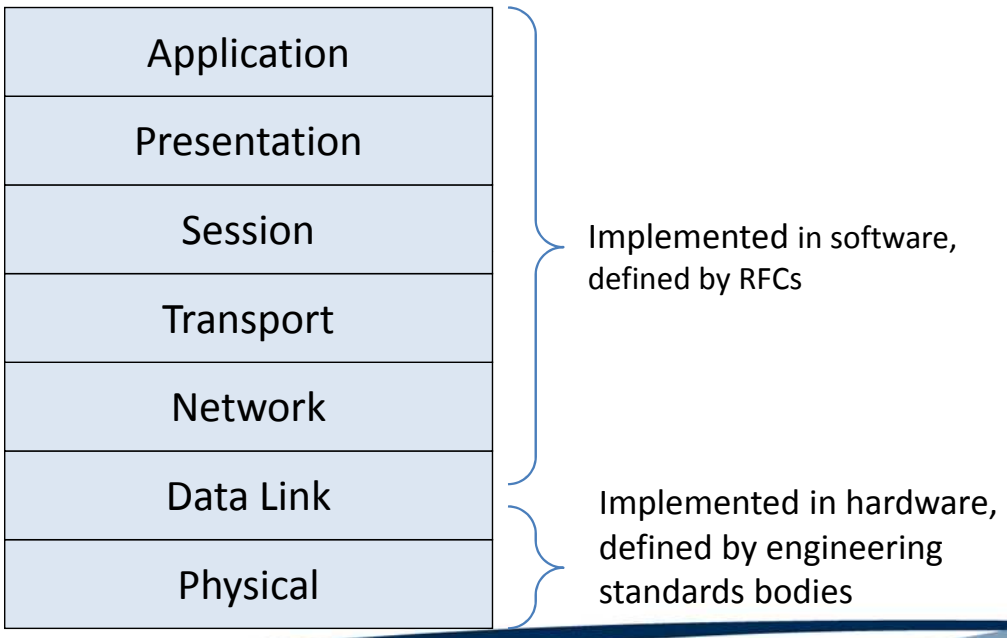
Chapter 7 and 8

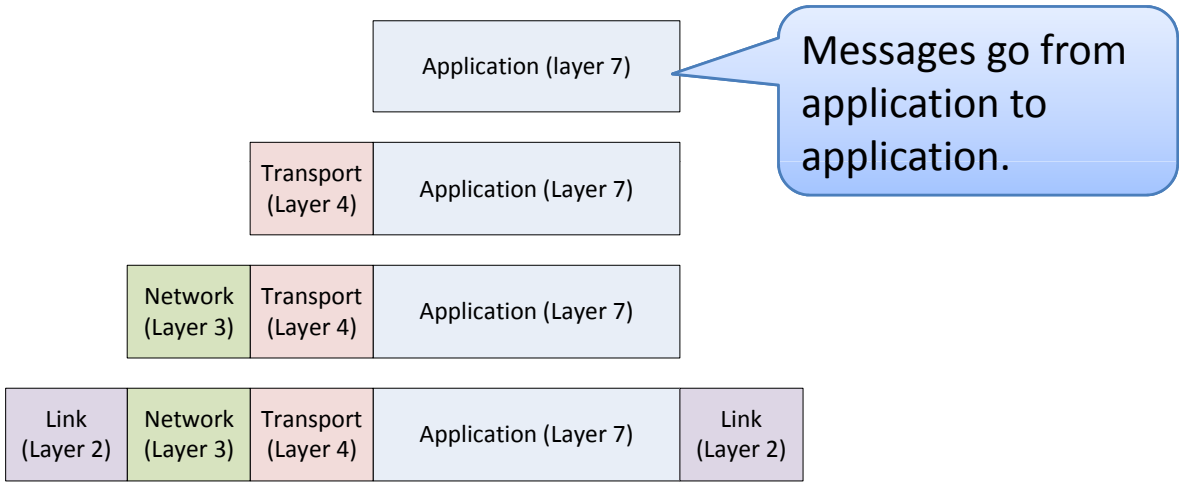
- Sending messages from device to device
- MAC (Media Access Control)
- Hardware addresses
- Physical media
- Signals and bits

Network Access



Data Link Layer (OSI 2)

- Gets *frames* to *devices*.



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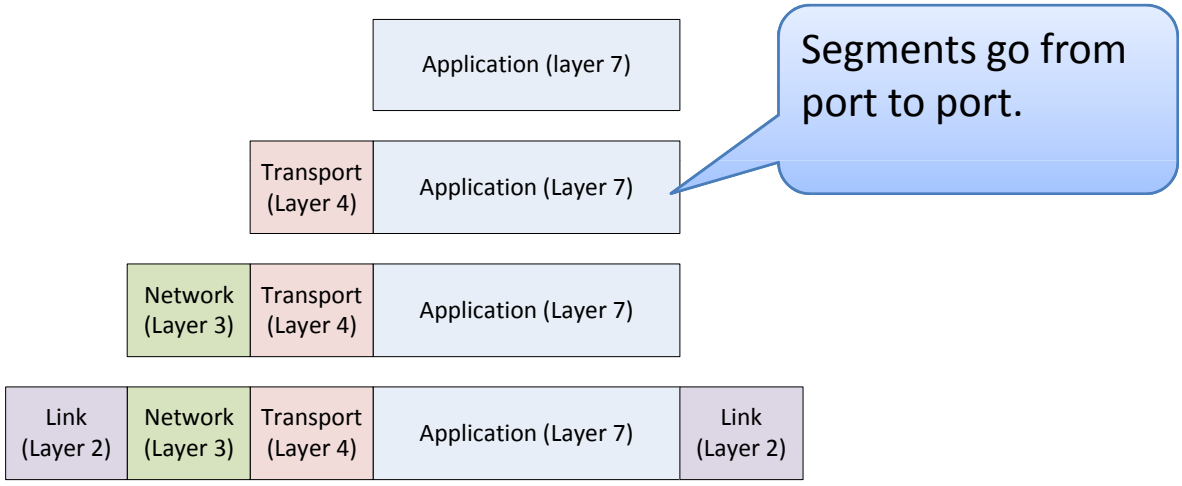

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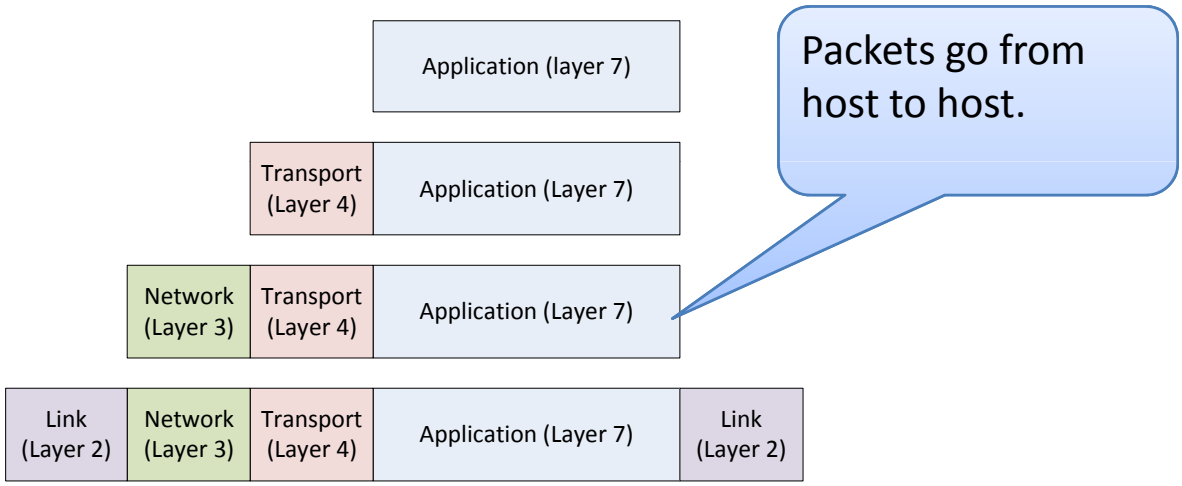

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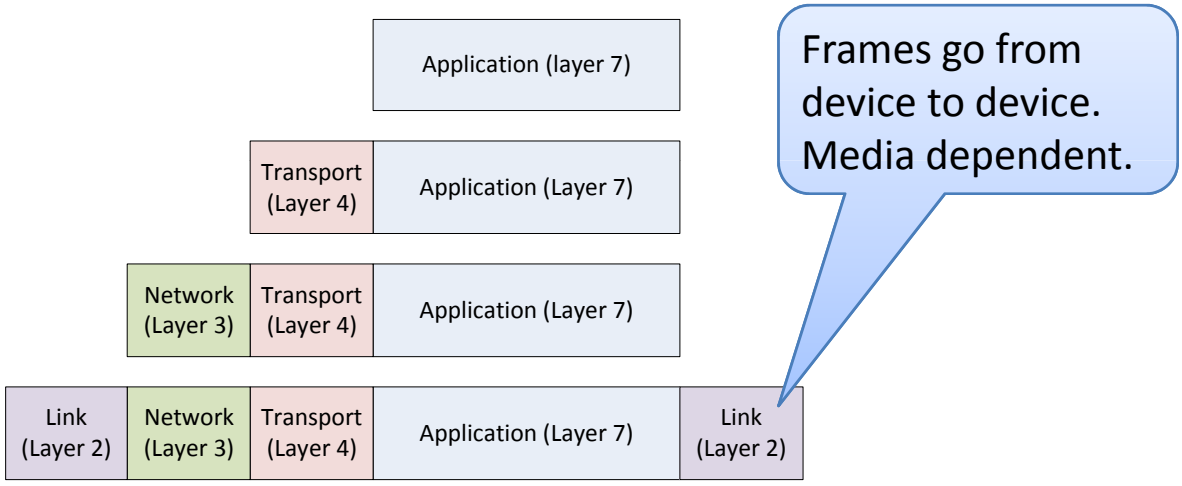
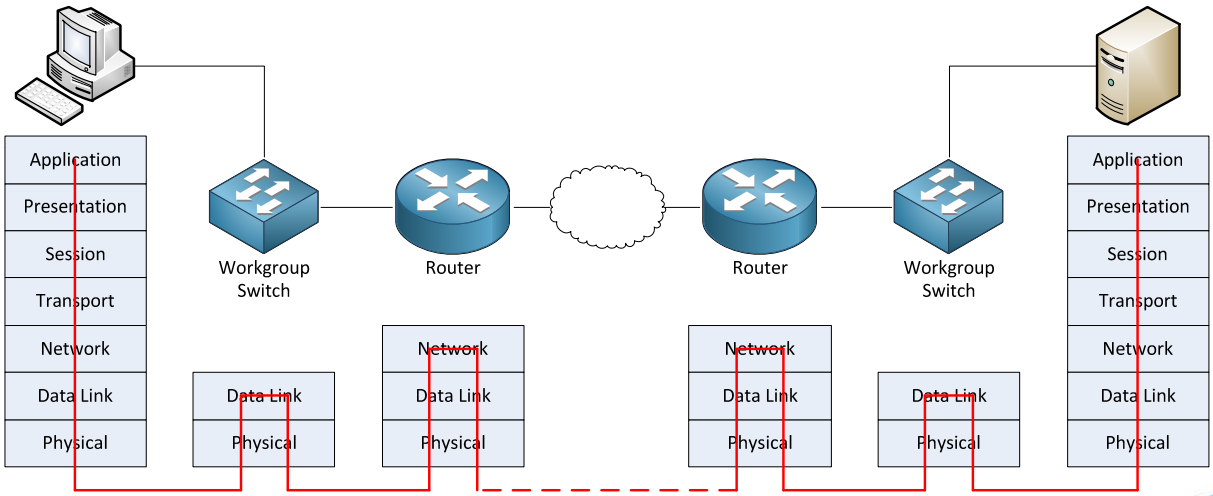


Data Link Layer (OSI 2)

- What is a device?
  - Any “thing” on the network that isn’t a wire.
    - Ex: hosts, switches, routers, access points, bridges, etc.
    - Typically, you plug the media (a cable, wire, strand, etc.) into a device.
- What operates at layer 2?
  - Typically switches and bridges.

Data Link Layer (OSI 2)



Data Link Layer (OSI 2)

- So, what happens in a layer 2 device?
  - Accept a frame on one medium
  - Decapsulate frame into a packet
  - Construct a new frame for the next medium
  - Place the new frame on the physical medium

This happens even if the receiving and sending medium are of the same kind.

Data Link Layer (OSI 2)

- Why have layer 2?
  - Alternative would be to have the network layer (3) know about every possible kind of media.
  - IP would need to change every time a new kind of network technology was released.

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Frames

- What is a frame?
  - We're very close to the hardware so we need to have something that indicates the beginning and the end of the frame.
    - In written English, a sentence begins with a capital letter and ends with some kind of punctuation.
    - In networks, a special bit pattern indicates the beginning and ending of a frame. Devices pay attention to these so they can look at what's between them.

Frames

- What is a frame?
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    - In written English, a se ce begins with a capital letter and ends with so e kind of punctuation.
    - In networks, a special bit pattern indicates the beginning and ending of a frame. Devices pay attention to these so they can look at what's between them.

This bit pattern *cannot* appear in the data. (Why?) Preventing this is a job for "encoding."

Frames

- What is a frame?
  - General elements in a frame:
    - Header:
      - Frame start pattern
      - Address (to and from)
      - Type of layer 3 data
      - Quality fields
    - Data (from layer 3)
    - Trailer:
      - Error detection
      - Frame stop pattern

2 layers of layer 2

- Layer 2 is split into an upper and lower layer
  - Upper layer: Talks to the network layer. Logical Link Control (LLC) lets multiple layer 3 protocols operate on the same network interface and media (i.e. same interface can support IPv4, IPv6, ICMP, and IPX simultaneously).
  - Lower layer: addressing (source / destination device) and delimiting according to media type.

Media Access Method (MAC)

- MAC regulates how the media is used
  - Controlled: only one device transmits at a time, no collisions, typically token-passing.
    - FDDI
    - Token Ring

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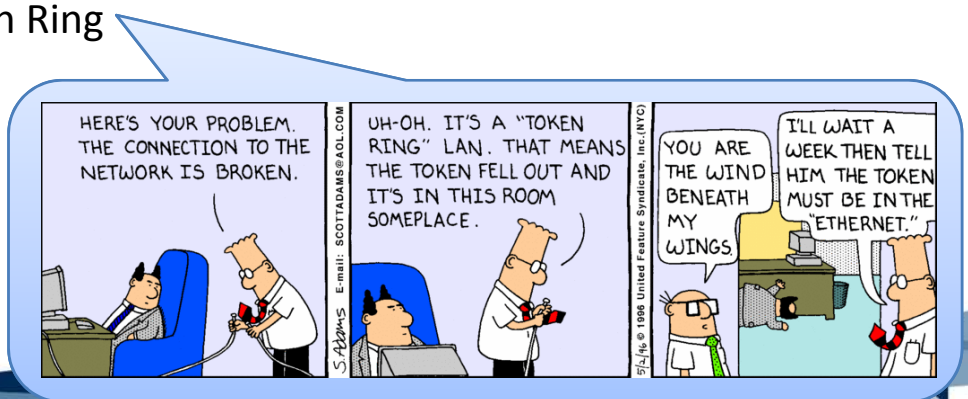

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Media Access Method (MAC)

- MAC regulates how the media is used
  - Controlled: only one device transmits at a time, no collisions, typically token-passing.
    - FDDI
    - Token Ring
  - Contention-based: devices transmit at any time, collisions happen, must detect or avoid collisions.
    - Ethernet
    - Wireless

Media Access Method (MAC)

- MAC regulates how the media is used
  - Contention based
    - CSMA/CD (carrier sense multiple access, collision detection) – devices listen until there's no traffic, then transmit something. Then they listen again to see if somebody else also transmitted. If a collision happened, use random exponential backoff timers.
    - Used with shared-media Ethernet (bus-based)

Media Access Method (MAC)

- MAC regulates how the media is used
  - Contention b
    - CSMA/CD (
      detection)
      transmit so
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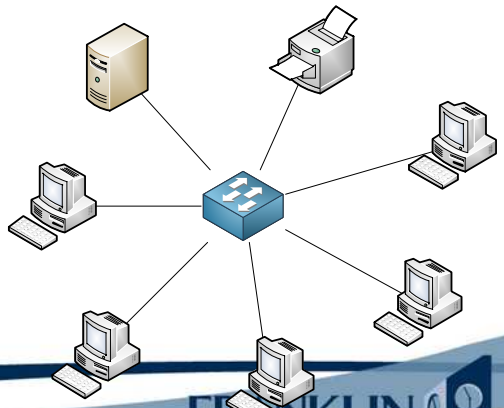
      Most wired Ethernet today uses switches (no shared media) and/or full-duplex (send and receive simultaneously), so there is no contention!
      hen
      if
      ff timers.
    - Used with shared-media Ethernet (bus-based)

Media Access Method (MAC)

- MAC regulates how the media is used
  - Contention based
    - CSMA/CA (carrier sense multiple access, collision avoidance) – Uses a handshake to ensure the channel is clear. Listen for traffic. If idle, then transmit RTS (request to send). Listen for the receiver to transmit back a CTS (clear to send). If CTS is not received use random backoff, otherwise send the data.
    - Used in 802.11 (wireless)

Media Access Method (MAC)

- MAC regulates how the media is used
  - Non-shared media: connections are point-to-point. If media is full duplex, then no contention. Half duplex must deal with only two parties.
  - Switches store and forward frames using internal buffers. Thus, no collisions. Hubs transmitted all frames to all devices, thus collisions were common.



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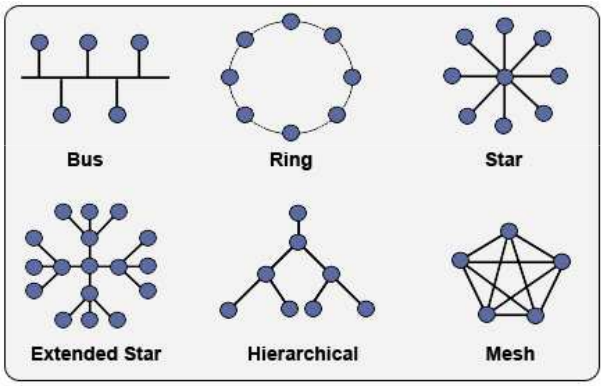
Topologies

- Ring vs. bus vs. star vs. point-to-point



Source: http://learn-networking.com/network-design/a-guide-to-network-topology

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Topologies

- Logical vs. Physical
  - Physical: how the wires are connected
  - Logical: "virtual" connections regardless of physical layout. Depends on the MAC.

Token Ring is a logical ring, but often a physical star, as is the older ARCNET.

Ethernet Framing

Preamble	Destination	Source	Type	Data	CRC
8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

Synchronization and delimiters.

Ethernet Framing

Preamble	Destination	Source	Type	Data	CRC
8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

MAC address of the next-hop recipient device. Usually expressed as a hexadecimal number.

Ethernet Framing

Preamble	Destination	Source	Type	Data	CRC
8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

MAC address of the source device. Usually expressed as a hexadecimal number.

Ethernet Framing

Preamble	Destination	Source	Type	Data	CRC
8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

Layer 3 protocol type. IPv4 is 0x800, IPv6 is 0x86DD. See http://en.wikipedia.org/wiki/Ethertype

Ethernet Framing

Preamble	Destination	Source	Type	Data	CRC
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The data passed down from layer 4. MTU helps layer 4 fit in this space.

Ethernet Framing

Preamble	Destination	Source	Type	Data	CRC
8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

Cyclical redundancy check. Detects errors. Common algorithm.

Wireless and PPP Framing

- Discussed in your textbook.
- Also, carefully read pp 267 through 273 to see how every bit (pun intended) moves through a network from source to destination, undergoing transformations along the way.

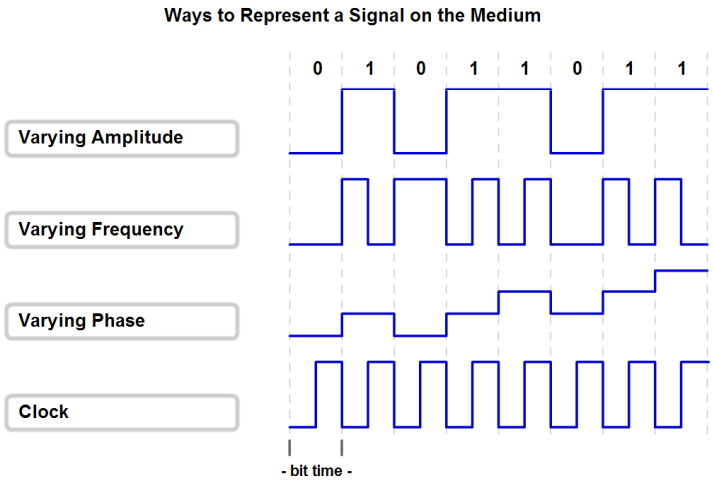
Physical Layer (OSI 1)

- Physical medium and signaling
  - Medium: the thing through which you transmit
  - Signaling: the stuff traveling through the medium.

Medium	Signal type
Copper wires	High/low electrical voltages
Fiber optic cables	Light (on/off)
Wireless	Radio waves

Physical Layer (OSI 1)

- Signaling and encoding
  - Signaling: how bits are represented



Physical Layer (OSI 1)

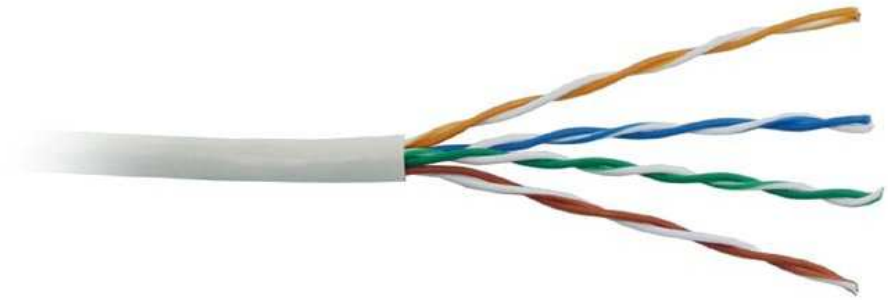
- Signaling and encoding
  - Encoding: grouping bits (using one pattern to represent another).
    - Why?? Helps distinguish frames from data. Certain bit patterns can be reserved. Keeps signals from generating too much heat, etc.
    - Ex: 4B/5B encoding: all possible 4 bit combinations are encoded in 5 bits with balanced 0/1 ratios. Certain 5 bit patterns are reserved for synchronization. Other bit patterns are just invalid. See p. 290.

Data Capacity

- Bandwidth vs. throughput vs. goodput
  - Bandwidth: theoretical amount of data per unit time. Includes physical medium and signaling properties
  - Throughput: what you can actually measure in transmitted bits.
  - Goodput: usable data bits at the application layer. Accounts for protocol overhead and retransmissions.

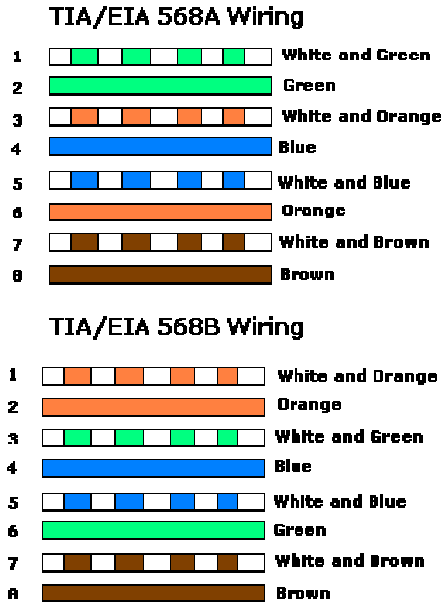
Physical Media: UTP

- Unshielded Twisted Pair
  - Most common copper medium for LAN



Physical Media: UTP

- Unshielded Twisted Pair
  - Two different wiring schemas
    - EIA 568A
    - EIA 568B



Source: http://www.movvam.com/tech/Oth/cat5-network.htm

Physical Media: UTP

- Unshielded Twisted Pair
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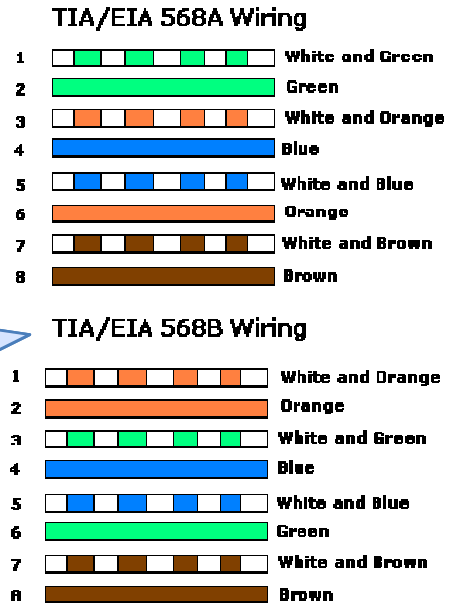

When both ends of a patch cable have the same schema, it's a straight through cable. When they have differing schemas, it's a crossover cable.

Source: http://www.movvam.com/tech/Oth/cat5-network.htm

Physical Media: UTP

- Unshielded Twisted Pair
  - Two different wiring schemas
    - EIA 568A
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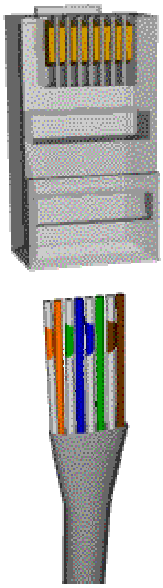

EIA 568B being inserted into an RJ45 connector.

Source: http://www.movvam.com/tech/Oth/cat5-network.htm

Physical Media: UTP

- Patch panels

Source: http://www.rackmountsolutions.net/Patch%20Panels.asp

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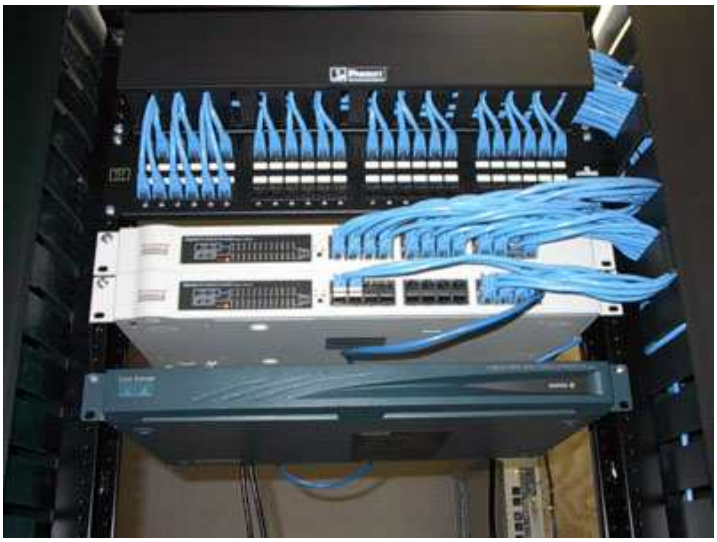
Physical Media: UTP

- Patch panels



Source: http://mikebrandon.net/photos.htm

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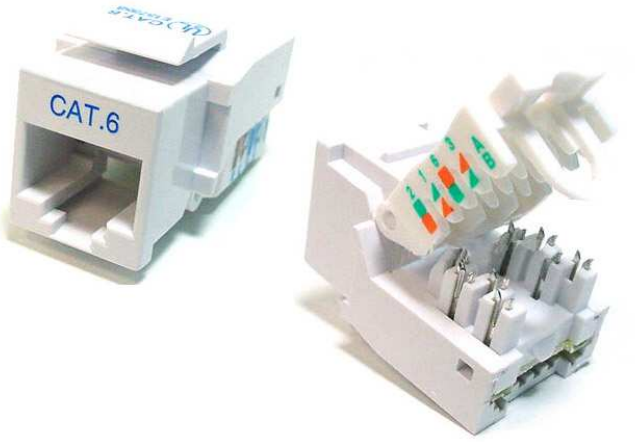
Physical Media: UTP

- Wall jacks



Source: http://www.optimization-world.com/details/prodid/230.html

Other Physical Media

- Textbook also covers
  - Fiber optic cables
  - Wireless

This Week's Outcomes

- List and describe several common logical network topologies. ✓
- Contrast contention strategies in shared media access. ✓
- Describe methods of encoding bits for physical media. ✓
- Describe characteristics of common physical media. ✓

Self Quiz

- What is the difference between the Link and Physical layers?
- What does MAC do? What two kinds of MAC are there?
- What is signaling? What is encoding? Why would we encode rather than send unencoded bits?

Self Quiz

- What is the difference between bandwidth, throughput, and goodput?
- What is the difference between a physical and a logical topology?
- What kinds of physical topologies have shared media? Describe three different topologies.

Self Quiz

- Why does a frame need a header and a trailer while the other PDUs (protocol data units) need only a header?
- Why are collisions on current Ethernet networks a thing of the past?
- Name several layer 2 devices.

Due this week

- Homework 4
- Lab 2
- Participation 5

Next week

- Chapter 9 and 10 – Deeper into Ethernet, ARP and RARP, network design, cabling.

Q & A

- Questions, comments, concerns?