

# Media and Access Method

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Network+ Module 2

# Transmission Media

- The stuff that carries signals from computer to computer or device on a network.
- Different media is used by different kinds of network.
- Is changing all the time. What is used today, will not be used tomorrow.

When designing a network, keep these things in mind when choosing media

- Cost
- Installation requirements
- Bandwidth needs
- Band usage (baseband/broadband)
- Attenuation
- Immunity from EMI
- Security\*

# Cost

- Unfortunately, cost is usually the number one determinate of media type.
- Administrators need to do cost benefit analysis on all segments of a network.

# Installation requirements

- Many forms of media can be installed by the network administrator.
- Some will require special training and or technicians
  - Fiber Optic
  - Twisted Pair (relatively easy, but requires some knowledge)
  - Wireless

# Bandwidth

- Bandwidth is the measure of the capacity of a medium to transmit data. (How much can it send, and how fast can it send it.)
- Usually measured in Bits Per Second
  - Kbps
  - Mbps
  - Gbps
- Bigger is better...but ya gotta pay to play!

# Band Usage

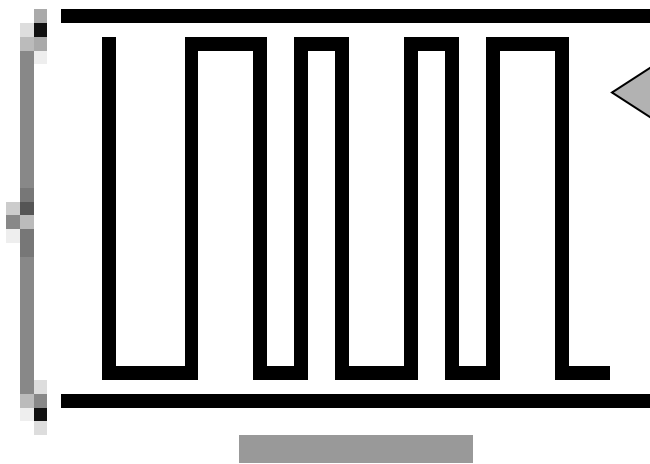
- Baseband
  - one channel is used for all communications.
  - Digital transmissions are electrical pulses or light
  - Bidirectional, but not at the same time (half duplex)
  - Most networks up to this point are broadband\*

# Band Usage

- Broadband
  - Multiple channels are used via multiplexing
  - Analog transmission are optical or electromagnetic
  - For full duplex transmission is sent over more than one frequency or more than one cable (one to send, one to receive)
  - Frequency domain multiplexing allows more than one piece of data to hang out on the cable at the same time using different frequencies\*

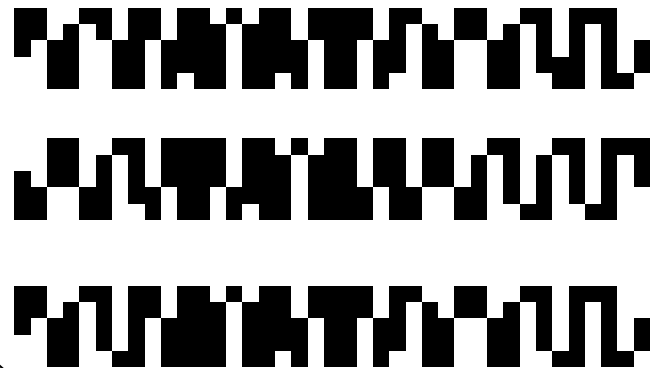


# Baseband vs Broadband



Baseband—one signal uses all bandwidth—limited

Broadband—can carry multiple signals over one cable—lots of bandwidth



# Simplex, Duplex, Half Duplex

- Simplex—Broadcast message that goes out to all the computers on the network, but they don't respond to it. One way communication.
- Half duplex—each device can send and receive, but not at the same time
- Full duplex—both devices can send and receive at the same time\*

# Attenuation

- Attenuation is the how much a signal weakens as it travels away from the origination point.
- Larger LANs are going to have greater attenuation problems.
- Sometimes solving big attenuation problems is cheaper by installing more expensive media.

# EMI

- Electromagnetic “noise” which can cause signal degradation.
- Also known as “cross talk” if the EMI comes from another cable sending network signals.
- Can be solved or lessened with shielding on cable types.

# Security

- Bounded media is more secure because in order to tap into it you have to be able to physically access it.
- Wireless is not as secure because eavesdropping is relatively easy.

# Cute Overload



# Learning Targets

- Three Cable Types
  - What their characteristics are
  - When to use which kinds of cables
  - Why some are better in different situations



# Three Main Types of Cable Media

- Coaxial Cable
  - Twisted-Pair Cable
  - Fiber Optic Cable
- 
- All have their plusses and minuses.

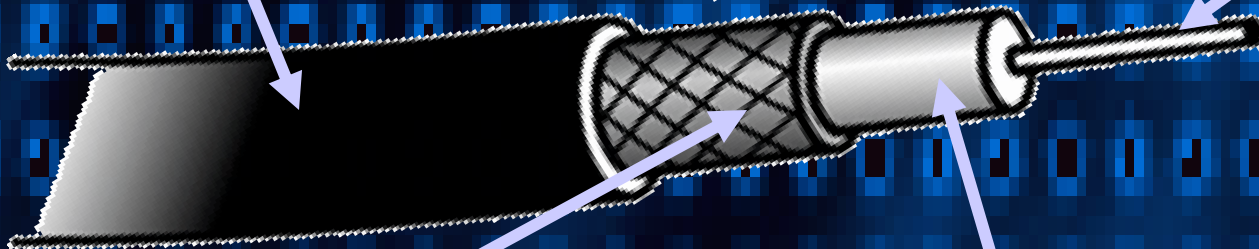


# Coaxial Cable

- Types
  - Thicknet
  - Thinnet

Insulation

Main Wire



Ground

Insulation

# Thicknet

- Very thick, but rarely used
- Uses a drop cable and a vampire tap to connect to the backbone (thicknet cable)



# Thinnet



- Light and flexible
- AKA RG-58
- Installation--Easy
- Cost--Inexpensive
- Range—185 meters (about 610 feet)
- Speed—2.5 (Arcnet) - 10Mbps (Potential, Ethernet)
- EMI—Shielded, so not very sensitive.
- Connectors—BNC T and BNC-Barrel
- Eavesdroppers can pick up signals\*

# BNC Connectors



***BNC Connector***



# Fire Codes

- PVC gives off poisonous gasses when heated or burned.
- Cables with PVC coatings cannot be installed in the plenum.
- Cable in the plenum must be “plenum rated.”\*

# STP vs UTP

- Cost-More than UTP
  - Install-Fairly easy
  - Speed-16Mbps, up to 500Mbps
  - Range-100m
  - EMI-Less sensitive than UTP
  - Sometimes known as IBM cable
- Cost-lowest
  - Install-relatively easy
  - Speed-10Mbps, up to 10000Mbps
  - Range-100m
  - EMI-Most sensitive of all cable type\*

# Installation and Connectors

- IBM Connectors

- DB9 Connects drop cable to NIC

- IBM Data Connector connects to main cable

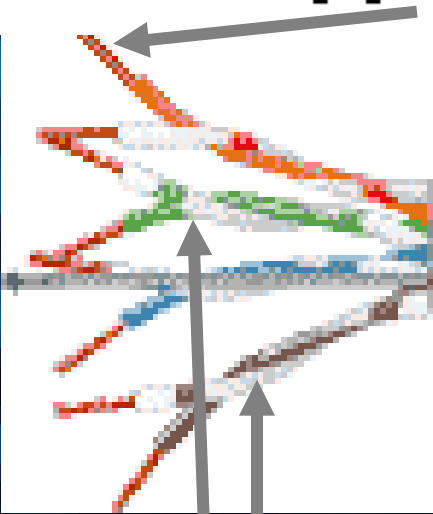


- Ethernet

- RJ45 connectors connect to NIC and network drops, hub, switch, or patch panels.\*

# Twisted Pairs (UTP)

**Solid Copper Connectors**

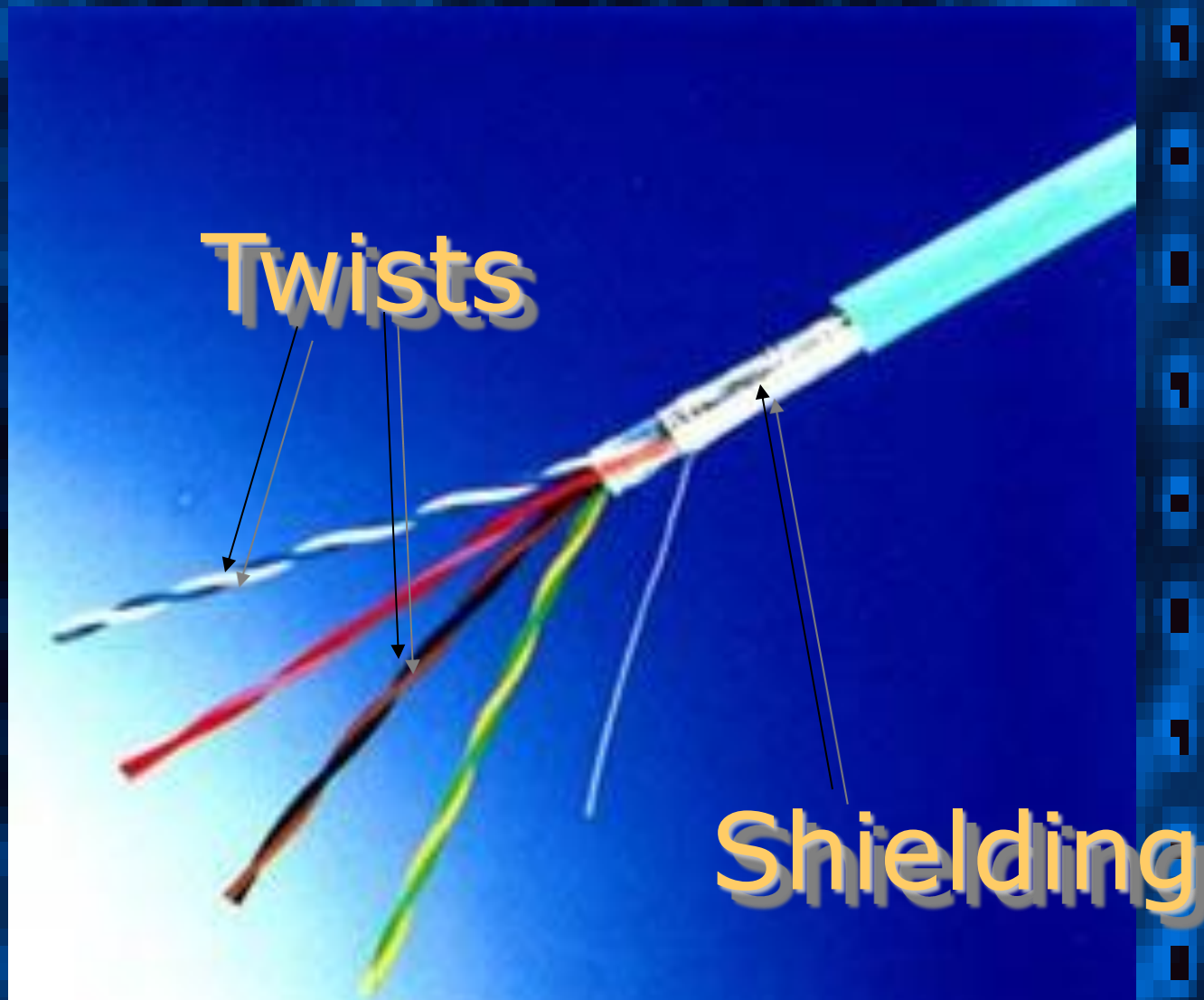


**Jacket**

**Twists reduce EMI & crosstalk**



# Twisted Pair (STP)



# Why Twists?

- Copper cabling very susceptible to EMI
- Twisting reduce crosstalk
- The more twists per foot, the more resistant to EMI\*

# UTP Cable Categories

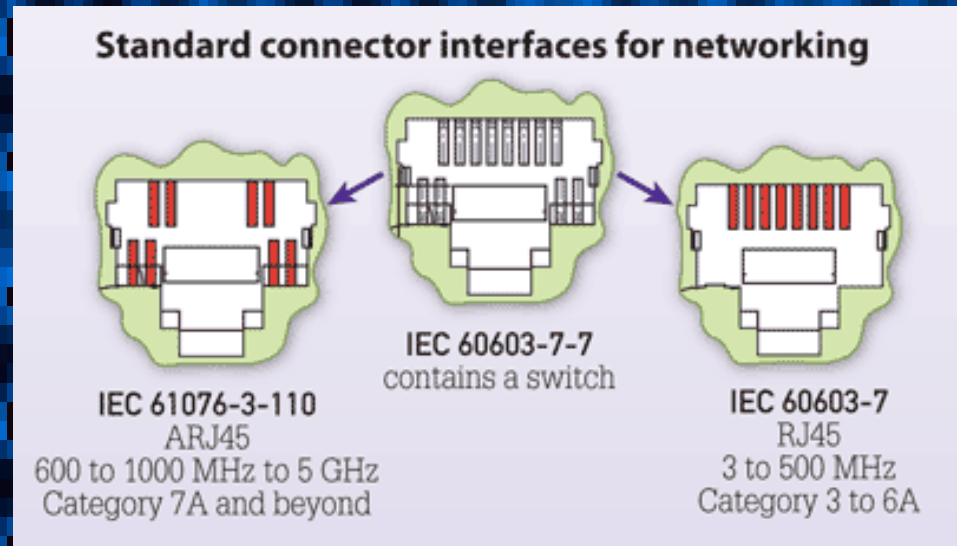
Category	Speed	Use
Cat1	1Mhz	POTS (plain old telephone) ISDN
Cat2	4Mhz	IBM Token Ring
Cat3	16Mhz	10BaseT, 100BaseT*
Cat4	20Mhz	10BaseT, 100BaseT-4
Cat5	100Mhz	10BaseT, 100BaseT*
Cat5e	100Mhz	Improved attenuation
Cat6	250Mhz	1000Base T2
Cat7	Proposed up to 600 Mhz over 100 ohm twisted pair	

# Cat 8

- ARJ45 plugs backwards compatible with RJ45 connectors



The ARJ45 series is based on the industry-standard RJ45 interface and provides enhanced mechanical properties to accommodate the higher transmission speeds.



# Cat 8

- Speed: 1200 Mhz
- Still twisted pair but uses
- 40Gbase-T (40Gbps)
- Class II Cabling which allows for the three different connectors to be used interchangeably

# Fiber Optic

- The most ideal material currently available for data transmission.
- No EMI problems at all
- Can run up to several KM without attenuation problems.\*

# Fiber Optic Cable

- Cost—Highest cost of any cable
- Installation—Expensive and difficult
- Bandwidth—100Mbps-200,000 Mbps
- Attenuation—Up to 10s of Km potential
- EMI—Completely insensitive to EMI or eavesdropping.

# Types of Fiber

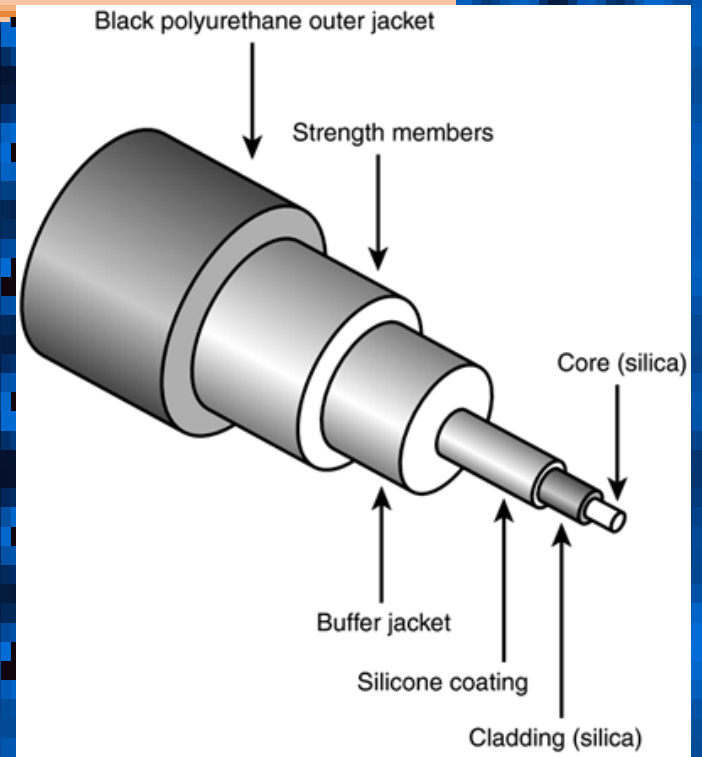
- Single-Mode—Small core that allows only one beam of light to shine through. Shines in a single beam like a flashlight using a laser light (not used much).
- Multi-mode—larger core that allows multiple lights to shine through. Light bounces around as it travels down the media. Uses LEDs to transmit data.
- Single mode is faster and can go over longer distances.
- Rate of transmission is determined by mode and whether glass or plastic fiber core is used (glass is faster)\*



# Fiber Architectures

- 10 GBASE-ER
  - Max cable length 40 KM
  - Uses SMF (single-mode fiber optic)
- 10 GBASE-SR
  - MMF (multi-mode fiber)
  - Max cable length 300 meters
- 10 GBASE-LR
  - Single mode fiber
  - Max cable length of 10 KM \*

# Fiber Optic Cable



# Review is good for the soul

- Which is the most expensive cabling?
  - Fiber optic
- Which is most susceptible to crosstalk?
  - UTP
- Hardest to install?
  - Fiber\*

# Review is good for the soul

- Max length of UTP cat five?
  - 100 meters
- Cable that works with BNC connectors?
  - Coaxial
- Insulation around a fiber cable
  - Cladding\*

# Review is good for the soul

- What type of band usage allows multiple signals over one channel?
  - Broadband
- What type of band usage allows only one signal?
  - Baseband\*

# Review is good for the soul

- What is often the most important consideration when choosing media types?
  - Cost
- What are the other considerations (5)?
  - Capacity (speed)
  - Installation Requirements
  - Range (attenuation)
  - EMI
  - Type of band (base or broad)\*

# Review is good for the soul

- What kind of connectors do UTP cables use?
  - RJ45
- What are the speed specs for UTP cable?
  - 10Mbps-100,000Mbps depending on category
- Which UTP cable category is most commonly used?
  - Cat 5e to Cat6\*

# Bounded vs Boundless Media

- Bounded is wired media (UTP, STP, fiber)
- Boundless refers to wireless media
- What are some kinds of boundless media in use today?



# Boundless or Wireless Networking

- Options
  - Infrared
  - Radio Frequency
  - Satellite
  - Microwave
  - Laser
  - Narrow Band Radio
- Most commonly used is infrared (Bluetooth PANs) and Radio Frequency (802.11's)

# 802.11s

- Original 802.11—Wireless LANs which provide 1 or 2 Mbps transmission using the 2.4GHz band using frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS)
- 802.11a—Provide up to 54Mbps in the 5Ghz band. Uses orthogonal frequency division multiplexing encoding

# 802.11s

- 802.11b—Provides 11Mbps transmission in the 2.4Ghz band. Uses only DSSS
- 802.11g—Applies to wireless LANs and provides up to 108Mbps in the 2.4GHz band.
- 802.11n—A newer modulation technique that runs in the 2.4 GHz or 5GHz range at 200-450 Mbps and has a current range of less than 165 feet.
- 80211ac—Gigabit Wi-fi!

# 802.11s

- 5 GHz mandatory
- Works on the 80MHz-160MHz channel bandwidths
- Single stream 450 Mbps
- Up to 866.7 Mbps using 160 MHz channel bandwidth
- Uses MIMO
  - Single user Multiple Input, Multiple Output
- Also uses MU-MIMO
  - Multi User Multiple Input, Multiple Output

# 802.11s

- Dual stream 900 Mbps
- Three stream 1.3 Gbps
- Works on 5Ghz frequency, so less crowded
- More channels (8x 802.11n)
- Backwards compatible with 802.11a and n
- Beamforming allows direct beaming of data from one device to another

# Wireless Network Security Protocols

- WEP—Wired Equivalent Privacy
  - Not really WEP
  - Vulnerable to passive and active attacks
  - Uses a stream cipher algorithm which is easy to crack with the right software
- WPA—Wi-Fi Protected Access
  - Different keys are distributed to each user, or you can use a pre-shared key (PSK)

# Wireless Network Security Protocols

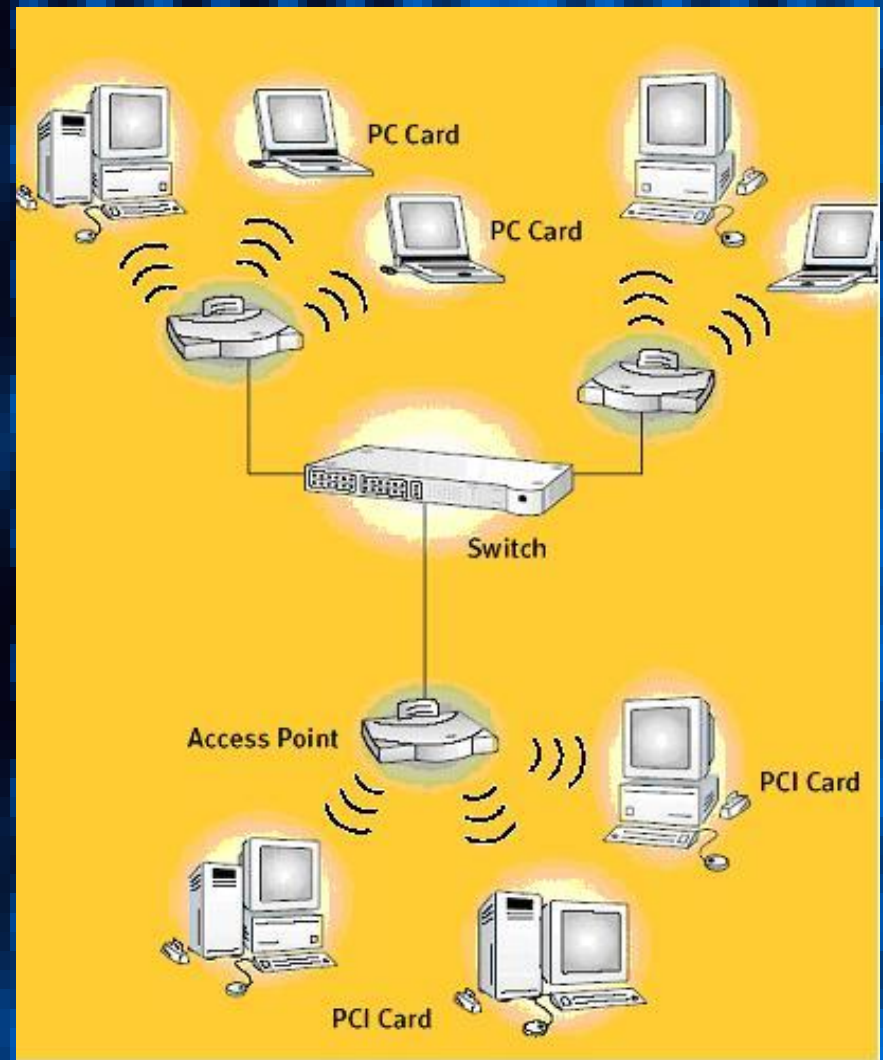
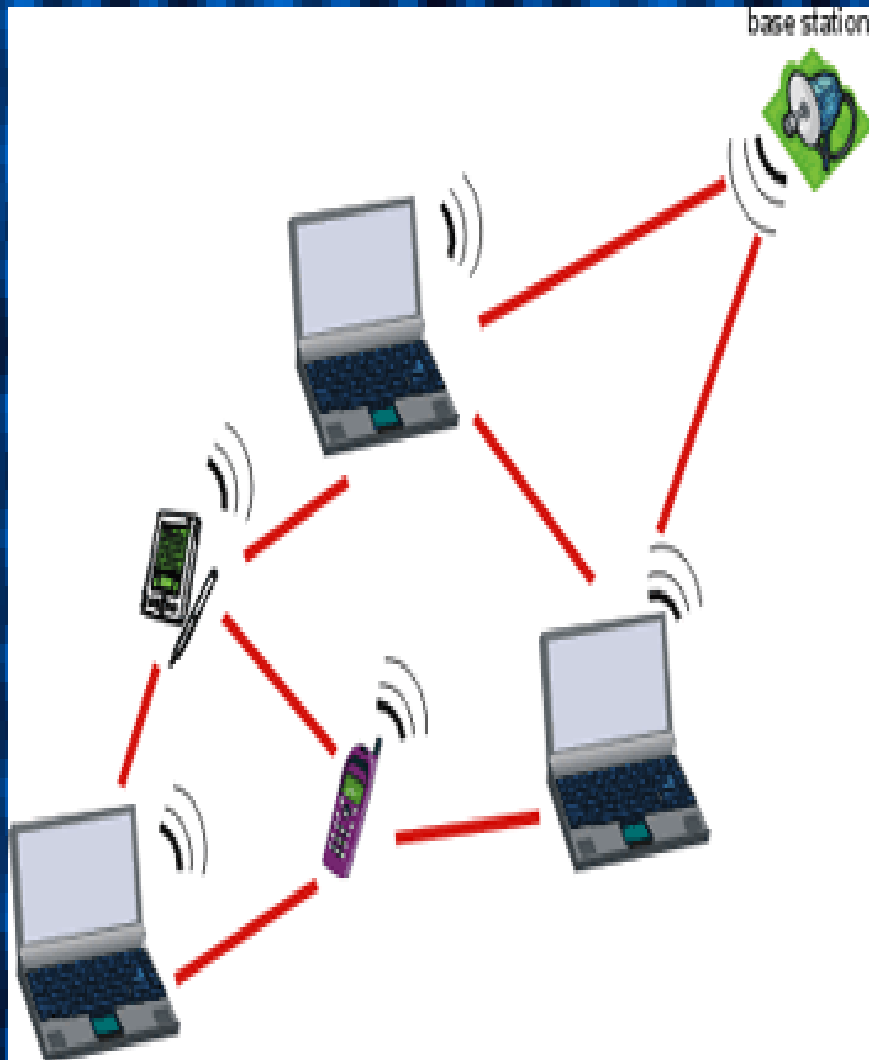
- WPA2—Implemented with 802.11i in an effort to truly make wireless as secure as wired networking
- EAP (extensible authentication protocol)
  - Works with WPA and WPA-2 to really secure the networks Both are used in Windows and Apple networks.
  - Uses a server and works with Apples and PCs
- Security using PSK (pre-shared key)
  - Good for home offices, small businesses that don't have servers
  - A passphrase is required to access the network (8-63 characters)
  - Vulnerable to password hacking\*

# Wireless Network Topology

- Ad-hoc
  - No single access points
  - Devices connect to each other
  - Mesh—all wireless nodes are in direct communication with each other.
- Infrastructure
  - One access points
  - Star—the topology is similar to a star in that one or more devices connect to a single access point



# Ad Hoc vs Infrastructure



# Other Types of Wireless

- Radio—Travels at 10GHz to 1GHz
- Microwave—Requires line of site between microwave towers, connects buildings with regular LANs, require licensing approval
- Satellite—Expensive! Most companies must lease satellite space
- Infrared—10Mbps-16Mbps, uses either broadcast or point to point\*

# Moving Data on the Physical Layer

- It takes more than just a NIC and cables to transmit data.
- Different networks use different methods of transmission.
- Each of these methods have their pros and cons.\*

# Three Main Types of Access Methods

- Contention
- Polling
- Token Passing

# Contention

- Any computer can transmit at any time
- In other words, packets “make a run for it” and hope they don’t run into anyone else.
- If other computers are transmitting at the same time there could be problems.
- Used in Ethernet LANs\*

# Two Types of Contention

- CSMA/CD—Carrier Sensing Multiple Access with Collision Detection
- CSMA/CA—Carrier Sensing Multiple Access with Collision Avoidance\*

# CSMA/CD



- Used in Ethernet LANs
- Listens to the network as they are transmitting
- If a signal is detected, transmission stops
- Good for less busy networks.
- As the network gets busier, the collisions increase.\*

# CSMA/CA

- Used in Appletalk LANs
- Listens before transmitting to avoid collisions.
- If a transmission is detected on the network, waits for a given time period and then listens again.\*





# Polling

- Asks around before sending on the network.
- Polling causes a LOT of broadcast traffic, which can slow down the network.\*



# Token Passing

- Used in Token Ring LANs
- A frame called a “token” is passed around the lab.
- Each computer must wait until it receives the token before it can transmit.\*

# Token Passing



# Networks that use Token Passing

- Token Ring--Most common. See 802.5 for information on Token Ring Networks
- ARCNet 802.4—Not used often, but a few still out there
- FDDI—Very fast demand priority fiber standard using a double token ring configuration

# Token Benefits

- Equal access to all computers
- Able to use demand priority
- Very busy networks—keeps from bogging down
- When carrying time critical data that is imperative it be received

# Auto-reconfiguration

- Computers on a token network receive transmissions every 7 seconds.
- If a computer dies, it is removed from the network. When it comes back, it won't receive packets.
- If 7 seconds pass and it hasn't received a packet it sends out a "beacon" packet with its address and the address of its nearest upstream neighbor
- By doing this, the network can determine where the problem is and *usually* automatically reconfigure the network to include that computer.\*

# Contention vs Token

- Good for low usage LANs
- Much lower cost
- Less reliable
- Good for high usage LANs
- Greater cost
- More reliable

# Review

- Name the three types of access methods?
- Which is used in Ethernet?
- What is the difference between CSMA/CA and CSMA/CD?
- In token ring, if a computer has data to transmit it must do what?
- Which is better, token or contention?



# Review some more

- Polling adds a lot of \_\_\_\_\_ traffic to a network.
- More expensive, token or contention?
- More reliable, token or contention?
- Does the data travel with the token?
- Types of LANs that use token.
- Types of LANs that use contention