Principles of Data Communications

Reference Book: Data Communications and Networking by Behrouz A. Forouzan

Efficiency of Standard Ethernet

- The efficiency of the Ethernet is defined as the ratio of the time used by a station to send data to the time the medium is occupied by this station.
- The practical efficiency of standard Ethernet has been measured to be $\mathit{Efficiency} = \frac{1}{(1+6.4a)}$.
- "a" is the number of frames that can fit on the medium. It can be calculated as a = (propagation delay)/(transmission delay) because the transmission delay is the time it takes a frame of average size to be sent out and the propagation delay is the time it takes to reach the end of the medium.
- Note that as the value of parameter a decreases, the efficiency increases. This means that if the length of the media is shorter or the frame size longer, the efficiency increases.

Ethernet used coaxial cables, but eventually changed to twisted pair cables

- 10BASE5: Thicknet: Max of 10Mbps, limited to 500 meters
- 10BASE2: Thinnet: Max of 10Mbps, limited to 185 meters
- 10BASE-T: STP/UTP: 10 Mbps, 100 meters
- 10BASEF: FiberEthernet: Star Topology, optical fiber 10Mbps

Fast Ethernet (100 Mbps)

- Earlier Ethernet (Standard Ethernet) - 10Mbps
- Upgrade to 100Mbps
- Make it compatible with standard Ethernet
- same 48-bit address
- same frame format

Fast Ethernet (100 Mbps)

Access Method

- Drop the bus topology and use a passive hub and star topology but make the max. size of the network 250m instead of 2500m as in standard ethernet.
- Use a link layer switch; full duplex connection to each host to make the transmission medium private for each host.
- The shared medium is changed to many point-to-point media, and there is no need for contention.

Autonegotiation

- A new feature added to Fast Ethernet is called autonegotiation.
- Autonegotiation allows two devices to negotiate the mode or data rate of operation.
- It was designed particularly to allow incompatible devices to connect to one another. For example, a device with a maximum data rate of 10 Mbps can communicate with a device with a 100 Mbps data rate (but which can work at a lower rate).

GIGABIT ETHERNET

- 1000Mbps
- The IEEE committee calls it the Standard 802.3z.

Goals

- Upgrade the data rate to 1 Gbps.
- Make it compatible with Standard or Fast Ethernet.
- Use the same 48-bit address.
- Use the same frame format.
- Keep the same minimum and maximum frame lengths.
- Support autonegotiation as defined in Fast Ethernet

10 GIGABIT ETHERNET

- 10 Gbps
- Standard 802.3ae

Ethernet Type	**Bandwidth Capacity**
Ethernet	10Mbps
Fast Ethernet	100Mbps
Gigabit Ethernet	1000Mbps or 1 Gbps
10-Gigabit Ethernet	10Gbps
100-Gigabit Ethernet	100Gbps

Wireless LAN: IEEE 802.11

Media

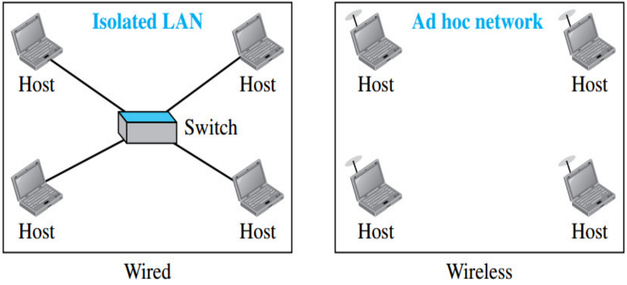
- IEEE 802.3 Ethernet: Uses Coaxial cable, TP, OFC
- IEEE 802.11 WLAN: Transmit signals through air

Media Access Method

- IEEE 802.3 Ethernet: CSMA/CD
- IEEE 802.11 WLAN: CSMA/CA

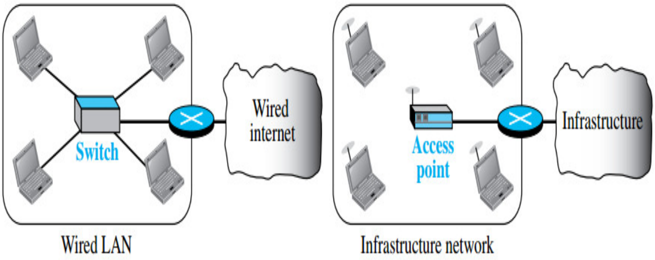
Wired LAN, Wireless LAN

Isolated LANs: wired versus wireless

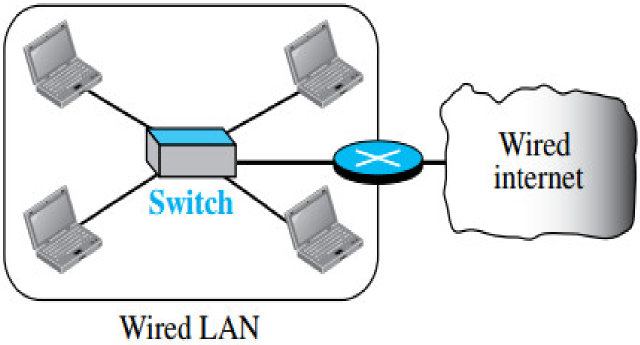


Wired LAN, Wireless LAN

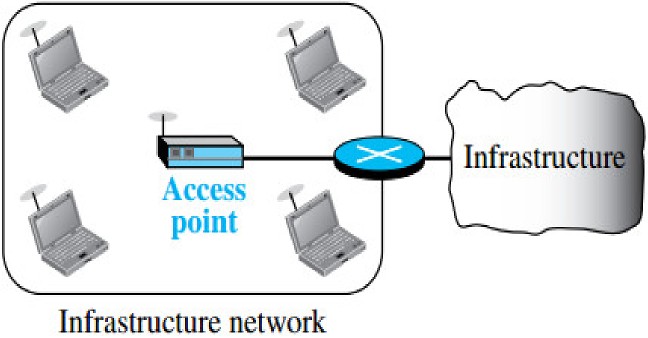
Connection of a wired LAN and a wireless LAN to other networks



Wired LAN, Wireless LAN



Wired LAN, Wireless LAN



Wired LAN, Wireless LAN

Wired LAN, Wireless LAN

- The wireless LAN is sometimes referred to as an infrastructure network, and the connection to the wired infrastructure, such as the Internet, is done via a device called an access point (AP).
- Note that the role of the access point is completely different from the role of a link-layer switch in the wired environment.
- An access point is gluing two different environments together: one wired and one wireless.
- Communication between the AP and the wireless host occurs in a wireless environment; communication between the AP and the infrastructure occurs in a wired environment.

Characteristics

There are several characteristics of wireless LANs that either do not apply to wired LANs or the existence of which is negligible and can be ignored.

- Attenuation
  - The strength of electromagnetic signals decreases rapidly because the signal disperses in all directions; only a small portion of it reaches the receiver.
- Interference
  - Another issue is that a receiver may receive signals not only from the intended sender, but also from other senders if they are using the same frequency band.
- Multipath Propagation
  - A receiver may receive more than one signal from the same sender because electromagnetic waves can be reflected back from obstacles such as walls, the ground, or objects.
  - The result is that the receiver receives some signals at different phases (because they travel different paths). This makes the signal less recognizable.

- Error
  - We can expect that errors and error detection are more serious issues in a wireless network than in a wired network.
  - If we think about the error level as the measurement of signal-to-noise ratio (SNR), we can better understand why error detection and error correction and retransmission are more important in a wireless network.
  - If SNR is high, it means that the signal is stronger than the noise (unwanted signal), so we may be able to convert the signal to actual data. On the other hand, when SNR is low, it means that the signal is corrupted by the noise and the data cannot be recovered.

CSMA/CA

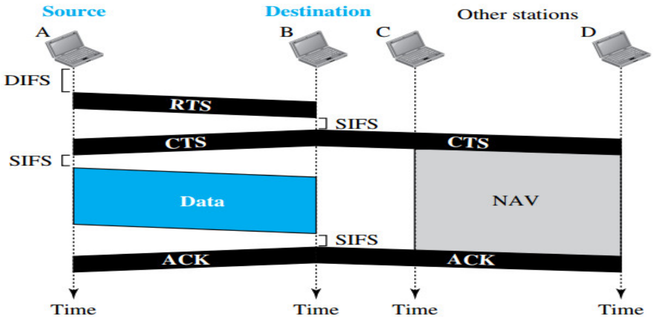
- CSMA
  - Before a node transmits data, it checks or listens to the medium.
  - When the medium is not busy, node sends data.
  - If it detects the medium is busy: Wait.
- CSMA/CA
  - Avoid Collision: Prevent Collisions before they happen
  - Communication in wireless network takes more steps: RTS/CTS exchange

CSMA/CA

- Laptop- wants to send some data; check if the channel is clear. If not, wait for a random amount of time and try again.
- If channel is clear, laptop sends RTS (Request to Send) to Wireless Access Point (WAP) to ask for an opportunity to transmit.
- If busy WAP Returns No, Plz wait.
- CTS: Clear to Send (go ahead with txion)

CSMA/CA

CSMA/CA and NAV



CSMA/CA

- Before sending a frame, the source station senses the medium by checking the energy level at the carrier frequency.
  - The channel uses a persistence strategy with backoff until the channel is idle.
  - After the station is found to be idle, the station waits for a period of time called the distributed interframe space (DIFS); then the station sends a control frame called the request to send (RTS).
- After receiving the RTS and waiting a period of time called the short interframe space (SIFS), the destination station sends a control frame, called the clear to send (CTS), to the source station. This control frame indicates that the destination station is ready to receive data.

CSMA/CA

- The source station sends data after waiting an amount of time equal to SIFS.
- The destination station, after waiting an amount of time equal to SIFS, sends an acknowledgment to show that the frame has been received. Acknowledgment is needed in this protocol because the station does not have any means to check for the successful arrival of its data at the destination. On the other hand, the lack of collision in CSMA/CD is a kind of indication to the source that data have arrived.

Network Allocation Vector

- How do other stations defer sending their data if one station acquires access?
- In other words, how is the collision avoidance aspect of this protocol accomplished?
- The key is a feature called NAV.
- When a station sends an RTS frame, it includes the duration of time that it needs to occupy the channel.
- The stations that are affected by this transmission create a timer called a network allocation vector (NAV) that shows how much time must pass before these stations are allowed to check the channel for idleness.
- Each time a station accesses the system and sends an RTS frame, other stations start their NAV.
- In other words, each station, before sensing the physical medium to see if it is idle, first checks its NAV to see if it has expired.

THANK YOU