802.11 Wireless LAN

- Provides network connectivity over wireless media
- An Access Point (AP) is installed to act as Bridge between Wireless and Wired Network
- The AP is connected to wired network and is equipped with antennae to provide wireless connectivity
802.11 Wireless LAN

Range (Distance between Access Point and WLAN client) depends on structural hindrances and RF gain of the antenna at the Access Point.

To service larger areas, multiple APs may be installed with a 20-30% overlap.

A client is always associated with one AP and when the client moves closer to another AP, it associates with the new AP (Hand-Off).

Three flavors:
- 802.11b
- 802.11a
- 802.11g
Before every data transmission

- Sender sends a Request to Send (RTS) frame containing the length of the transmission
- Receiver responds with a Clear to Send (CTS) frame
- Sender sends data
- Receiver sends an ACK; now another sender can send data

When sender doesn't get a CTS back, it assumes collision
WLAN : 802.11b

The most popular 802.11 standard currently in deployment.

Supports 1, 2, 5.5 and 11 Mbps data rates in the 2.4 GHz ISM (Industrial-Scientific-Medical) band
WLAN : 802.11a

- Operates in the 5 GHz UNII (Unlicensed National Information Infrastructure) band
- Incompatible with devices operating in 2.4GHz
- Supports Data rates up to 54 Mbps.
WLAN : 802.11g

- Supports data rates as high as 54 Mbps on the 2.4 GHz band
- Provides backward compatibility with 802.11b equipment
### IEEE 802 Standards Working Groups

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Categories of Wireless Networks

• **Base Station** :: all communication through an *access point*. Other nodes can be fixed or mobile.

• **Infrastructure Wireless** :: base station network is connected to the *wired* Internet.

• **Ad hoc Wireless** :: wireless nodes communicate directly with one another.

• **MANETs (Mobile Ad Hoc Networks)** :: ad hoc nodes are mobile.
Wireless LANs

(a) Wireless networking with a base station. (b) Ad hoc networking.
The 802.11 Protocol Stack

Part of the 802.11 protocol stack.
Wireless Physical Layer

- **802.11 Infrared**
  - Two capacities 1 Mbps or 2 Mbps.
  - Range is 10 to 20 meters and cannot penetrate walls.
  - Does not work outdoors.

- **802.11 FHSS (Frequence Hopping Spread Spectrum)**
  - The main issue is multipath fading.
  - 79 non-overlapping channels, each 1 Mhz wide at low end of 2.4 GHz ISM band.
  - Same pseudo-random number generator used by all stations.
  - Dwell time: min. time on channel before hopping (400msec).
Wireless Physical Layer

- **802.11 DSSS (Direct Sequence Spread Spectrum)**
  - Spreads signal over entire spectrum using pseudo-random sequence (similar to CDMA see Tanenbaum sec. 2.6.2).
  - Each bit transmitted using an 11 chips Barker sequence, PSK at 1Mbaud.
  - 1 or 2 Mbps.

- **802.11a OFDM (Orthogonal Frequency Divisional Multiplexing)**
  - Compatible with European HiperLan2.
  - 54Mbps in wider 5.5 GHz band → transmission range is limited.
  - Uses 52 FDM channels (48 for data; 4 for synchronization).
  - Encoding is complex (PSM up to 18 Mbps and QAM above this capacity).
  - E.g., at 54Mbps 216 data bits encoded into into 288-bit symbols.
  - More difficulty penetrating walls.
Wireless Physical Layer

• 802.11b HR-DSSS (High Rate Direct Sequence Spread Spectrum)
  – 11a and 11b shows a split in the standards committee.
  – 11b approved and hit the market before 11a.
  – Up to 11 Mbps in 2.4 GHz band using 11 million chips/sec.
  – Note in this bandwidth all these protocols have to deal with interference from microwave ovens, cordless phones and garage door openers.
  – Range is 7 times greater than 11a.
  – 11b and 11a are incompatible!!
Wireless Physical Layer

• 802.11g OFDM (Orthogonal Frequency Division Multiplexing)
  – An attempt to combine the best of both 802.11a and 802.11b.
  – Supports bandwidths up to 54 Mbps.
  – Uses 2.4 GHz frequency for greater range.
  – Is backward compatible with 802.11b.
In 802.11 wireless LANs, “seizing channel” does not exist as in 802.3 wired Ethernet.

Two additional problems:
- Hidden Terminal Problem
- Exposed Station Problem

To deal with these two problems, 802.11 supports two modes of operation: DCF (Distributed Coordination Function) and PCF (Point Coordination Function).

All implementations must support DCF, but PCF is optional.
(a) The hidden station problem. (b) The exposed station problem.
Wireless LAN Protocols

• MACA protocol solved hidden, exposed terminal:
  – Send Ready-to-Send (RTS) and Clear-to-Send (CTS) first
  – RTS, CTS helps determine who else is in range or busy (Collision avoidance).
  – Can a collision still occur?
Wireless LAN Protocols

- MACAW added ACKs and CSMA (no RTS at same time)

(a) A sending an RTS to B.  
(b) B responding with a CTS to A.
1-Persistent Physical Carrier

Sensing

• Station *senses* the channel when it wants to send.
• If idle, station transmits.
  – *Station does not sense channel while transmitting.*
• If the channel is busy, station defers until idle and then transmits.
• Upon collision, wait a *random time* using binary exponential backoff.
THANK YOU