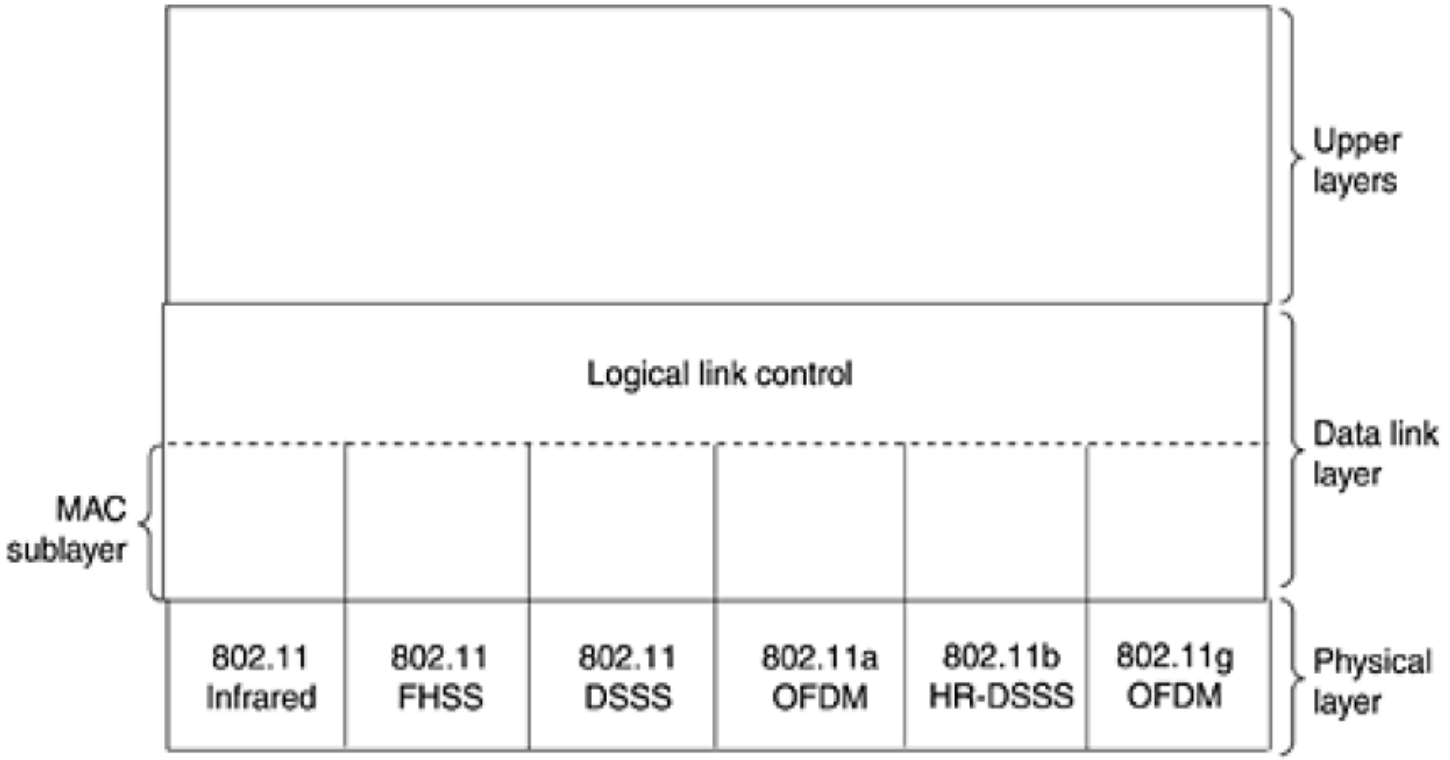
Wireless LANs

The 802.11 Protocol Stack

Figure 4-25. Part of the 802.11 protocol stack.



- The physical layer corresponds to the OSI physical layer fairly well, but the data link layer in all the 802 protocols is split into two or more sublayers.
  - the MAC (Medium Access Control) sublayer
  - Above it is the LLC (Logical Link Control) sublayer

- The 1997 IEEE 802.11 standard specifies three transmission techniques allowed in the physical layer.
- The infrared method uses much the same technology as television remote controls do.
- The other two use short-range radio, using techniques called **FHSS** (Frequency Hopping Spread Spectrum) and **DSSS** (Direct Sequence Spread Spectrum).
- All of these techniques operate at 1 or 2 Mbps and at low enough power that they do not conflict too much.

- In 1999, two new techniques were introduced to achieve higher bandwidth. These are called **OFDM** (Orthogonal Frequency Division Multiplexing) and **HR-DSSS** (High Rate Direct Sequence Spread Spectrum)
- They operate at up to 54 Mbps and 11 Mbps, respectively.
- In 2001, a second OFDM modulation was introduced, but in a different frequency band from the first one.

The 802.11 Physical Layer

- Each of the five permitted transmission techniques makes it possible to send a MAC frame from one station to another.
- They differ, in the technology used and speeds achievable.

Infrared

- The infrared option uses transmission at 0.85 or 0.95 microns.
- Two speeds are permitted: 1 Mbps and 2 Mbps. At 1 Mbps.
- Encoding scheme : Gray Code
- Infrared signals cannot penetrate walls, so cells in different rooms are well isolated from each other.
- due to the low bandwidth, this is not a popular option.

FHSS (Frequency Hopping Spread Spectrum)

- FHSS (Frequency Hopping Spread Spectrum) uses 79 channels, each 1-MHz wide, starting at the low end of the 2.4-GHz band.
- A pseudorandom number generator is used to produce the sequence of frequencies hopped to.
- The amount of time spent at each frequency, the **dwell time, is** an adjustable parameter, but must be less than 400 msec.

- FHSS' randomization provides more security.
- Over longer distances, multipath fading can be an issue, and FHSS offers good resistance to it.
- It is also relatively insensitive to radio interference, which makes it popular for building-to-building links.
- Its main disadvantage is its low bandwidth.

DSSS (Direct Sequence Spread Spectrum)

- **DSSS** (Direct Sequence Spread Spectrum), is also restricted to 1 or 2 Mbps.
- The scheme used has some similarities to the **CDMA** (Code Division Multiple Access) system.
- Each bit is transmitted as 11 chips, using what is called a **Barker sequence.**
- It uses phase shift modulation at 1 Mbaud, transmitting 1 bit per baud when operating at 1 Mbps and 2 bits per baud when operating at 2 Mbps.
- For years, the FCC (Federal Communications Commission) required all wireless communications equipment operating in the ISM(Industrial Scientific and Medical) bands (2 to 6 GHz) in the U.S. to use spread spectrum,
- But in May 2002, that rule was dropped as new technologies emerged.

OFDM (Orthogonal Frequency Division Multiplexing)

- The first of the high-speed wireless LANs, 802.11a, uses OFDM to deliver up to 54 Mbps in the wider 5-GHz ISM band.
- As the term FDM suggests, different frequencies are used—52 of them, 48 for data and 4 for synchronization.
- Since transmissions are present on multiple frequencies at the same time, this technique is considered a form of spread spectrum.

- Splitting the signal into many narrow bands has some key advantages over using a single wide band, including better immunity to narrowband interference and the possibility of using noncontiguous bands.
- A complex encoding system is used, based on phaseshift modulation for speeds up to 18 Mbps and on QAM above that.
- At 54 Mbps, 216 data bits are encoded into 288-bit symbols.
- The technique has a good spectrum efficiency in terms of bits/Hz and good immunity to multipath fading.

HR-DSSS (High Rate Direct Sequence Spread Spectrum)

- It is called **802.11b**
- Data rates supported by 802.11b are 1, 2, 5.5, and 11 Mbps.
- The two slow rates run at 1 Mbaud, with 1 and 2 bits per baud, respectively, using phase shift modulation.
- The two faster rates run at 1.375 Mbaud, with 4 and 8 bits per baud, respectively, using **Walsh/Hadamard codes.**
- The data rate may be dynamically adapted during operation to achieve the optimum speed possible under current conditions of load and noise.
- In practice, the operating speed of 802.11b is nearly always 11 Mbps.
- Although 802.11b is slower than 802.11a, its range is about 7 times greater, which is more important in many situations.

802.11g: OFDM

- An enhanced version of 802.11b, **802.11g,** was approved by IEEE in November 2001 .
- It uses the OFDM modulation method of 802.11a but operates in the narrow 2.4-GHz ISM band along with 802.11b.
- In theory it can operate at up to 54 MBps.
- IEEE 802.11 committee has produced three different highspeed wireless LANs: 802.11a, 802.11b, and 802.11g