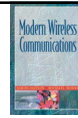




Modern Wireless Communication

Simon Haykin, Michael Moher

CH01-1



Chapter 1 Introduction

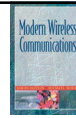
CH01-2



Contents

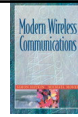
- 1.1 Background
- 1.2 Communication Systems
- 1.3 Physical Layer
- 1.4 The Data-Link Layer
 - 1.4.1 FDMA
 - 1.4.2 TDMA
 - 1.4.3 CDMA
 - 1.4.4 SDMA

CH01-3



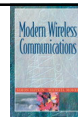
1.1 Background

CH01-4



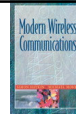
- In 1864, James Clerk Maxwell Formulated the electromagnetic theory of light and predicted the existence of radio waves
- In 1894, Maxwell and Hertz, Oliver Lodge demonstrated wireless communications
- In 1906, Reginald Fessenden conducted the first radio broadcast using the technique that came to be known as amplitude modulation (AM) radio.

CH01-5

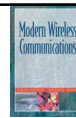


- Spread Spectrum techniques made their first appearance before and during World War II.
- In 1946, the first public mobile telephone systems were introduced in five American cities.
- In 1947, the first microwave relay system consisting of seven towers became operational.
- In 1958, a new era in wireless communications was initiated with the launch of the SCORE (Signal Communication by Orbital Relay Equipment).

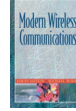
CH01-6



- In 1981, the first analog cellular system, “Nordic Mobile Telephone (NMT)”, was introduced and this was soon followed by the Advanced Mobile Phone Service (AMPS) in North America in 1983.
- In 1988, the first digital cellular system “Global System for Mobile (GSM)” was introduced into Europe.



1.2 Communication Systems



- Physical Layer
 - Provides the physical mechanism for transmitting *bits* between any *pair of nodes*.
- Data-link Layer
 - Layer for *error correction* or *detection*.
 - Responsible for *sharing* the transmission medium for different users.
- Network Layer
 - Determine *routing* of the information
 - Determine the *quality of service*
 - *Flow control*



1.3 Physical Layer

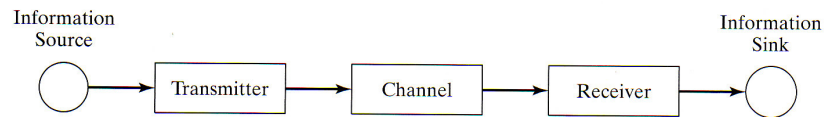
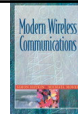


FIGURE 1.1 Block diagram of a communication system linking a source of information to a user of the information.

Transmitter:

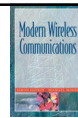
- In wireless system
 - Transmitter *shape* the signal for efficient use of transmission medium resources.
 - Due to the power limitation, transmitter must use *robust* and *power efficient* modulation techniques.
 - As the medium is shared with other users, the design should *minimize* the *interference*.



Channel:

- In wireless system, the channel impairments include:
 - *Channel distortion* in form of multipath.
 - *Time-varying nature*
 - *Receiver noise*

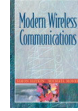
CH01-13



Receiver

- In wireless system:
 - Estimation of the *time-varying nature* of the channel is necessary for implementing compensation techniques.
 - *Error-correction technique* to improve the reliability.
 - Maintain *synchronization*.

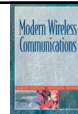
CH01-14



1.4 The Data-Link Layer

1.4.1 FDMA

CH01-15



- Multiple access strategy:
 - Sharing the physical resources among the different users.
 - For wireless system, *radio spectrum* is the physical resource.
 - Four multiple access strategies for radio spectrum
 - FDMA (Frequency-division multiple access)
 - TDMA (Time-division multiple access)
 - CDMA (Code-division multiple access)
 - SDMA (Space-division multiple access)

CH01-16

- Radio spectrum is divided into a number of channels.
- Each pair of users is assigned a different channel.
- Different channel is assigned for each direction of transmission.

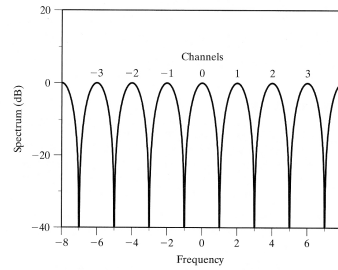


FIGURE 1.2 A frequency-domain representation of FDMA.

CH01-17

1.4 The Data-Link Layer

1.4.2 TDMA

CH01-18

- Designed for point-to-multipoint architecture.
- Multiple UTs communicate with single BS.
- Using analog modulation with a simple push-to-talk protocol.
- TDMA is suited only to data applications

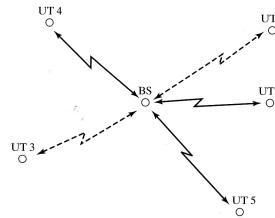


FIGURE 1.3 Point-to-multipoint network architecture.

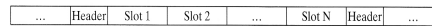
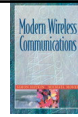


FIGURE 1.4 TDMA frame structure with N slots per frame.

1.4 The Data-Link Layer

1.4.3 CDMA



- Cellular system
- UTs in each cell communicate with a BS located at the center of the cell.
- FDMA or TDMA can be used within a cell

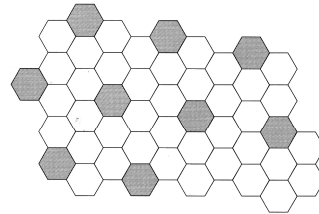
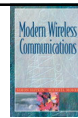


FIGURE 1.5 Hexagonal pattern of cells used in a cellular telephone system.

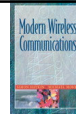
CH01-21



1.4 The Data-Link Layer

1.4.4 SDMA

CH01-22



- Improvements of SDMA:
 - Reduce the total power needed to be transmitted.
 - Reduce the amount of interference
 - Receiver would receive a stronger signal
- *Multibeam* antennas are used to separate radio signals by pointing them along different direction.