Chapter 1: Introduction

* Data communication is the transfer of data from one device to another via some form of transmission medium.
* A data communications system must transmit data to the correct destination in an accurate and timely manner.
* The five components that make up a data communications system are the message, sender, receiver, medium, and protocol.
* Text, numbers, images, audio, and video are different forms of information.
* Data flow between two devices can occur in one of three ways: simplex, half-duplex, or full-duplex.
* A network is a set of communication devices connected by media links.
* In a point-to-point connection, two and only two devices are connected by a dedicated link. In a multipoint connection, three or more devices share a link.
* Topology refers to the physical or logical arrangement of a network. Devices may be arranged in a mesh, star, bus, or ring topology.
* A network can be categorized as a local area network (LAN), a metropolitan-area network (MAN), or a wide area network (WAN).
* A LAN is a data communication system within a building, plant, or campus, or between nearby buildings.
* A MAN is a data communication system covering an area the size of a town or city.
* A WAN is a data communication system spanning states, countries, or the whole world.
* An internet is a network of networks.
* The Internet is a collection of many separate networks.
* TCP/IP is the protocol suite for the Internet.
* There are local, regional, national, and international Internet service providers (ISPs).
* A protocol is a set of rules that governs data communication; the key elements of a protocol are syntax, semantics, and timing.
* Standards are necessary to ensure that products from different manufacturers can work together as expected.
* The ISO, ITU-T, ANSI, IEEE, and EIA are some of the organizations involved in standards creation.
* Forums are special-interest groups that quickly evaluate and standardize new technologies.
* A Request for Comment (RFC) is an idea or concept that is a precursor to an Internet standard.

Chapter 3: Data and Signals

* Data must be transformed into electromagnetic signals prior to transmission across a network.
* Data and signals can be either analog or digital.
* A signal is periodic if it consists of a continuously repeating pattern.
* Each sine wave can be characterized by its amplitude, frequency, and phase.
* Frequency and period are inverses of each other.
* A time-domain graph plots amplitude as a function of time.
* A frequency-domain graph plots each sine wave's peak amplitude against its frequency.
* By using Fourier analysis, any composite signal can be represented as a combination of simple sine waves.
* The spectrum of a signal consists of the sine waves that make up the signal.
* The bandwidth of a signal is the range of frequencies the signal occupies. Bandwidth is determined by finding the difference between the highest and lowest frequency components.
* Bit rate (number of bits per second) and bit interval (duration of 1 bit) are terms used to describe digital signals.
* A digital signal is a composite signal with an infinite bandwidth.
* Bit rate and bandwidth are proportional to each other.
* The Nyquist formula determines the theoretical data rate for a noiseless channel.
* The Shannon capacity determines the theoretical maximum data rate for a noisy channel.
* Attenuation, distortion, and noise can impair a signal.
* Attenuation is the loss of a signal's energy due to the resistance of the medium.
* The decibel measures the relative strength of two signals or a signal at two different points.
* Distortion is the alteration of a signal due to the differing propagation speeds of each of the frequencies that make up a signal.
* Noise is the external energy that corrupts a signal.
* We can evaluate transmission media by throughput, propagation speed, and propagation time.
* The wavelength of a frequency is defined as the propagation speed divided by the frequency.

Quiz

1. Before data can be transmitted, they must be transformed to electromagnetic signals.
2. A periodic signal completes one cycle in 0.001 s. What is the frequency? 1KHz
3. In a frequency-domain plot, the horizontal axis measures the frequency
4. In a time-domain plot, the horizontal axis is a measure of time
5. If the bandwidth of a signal is 5 KHz and the lowest frequency is 52 KHz, what is the highest frequency? 57 KHz
6. What is the bandwidth of a signal that ranges from 1 MHz to 4 MHz? 3MHz
7. As frequency increases, the period decreases.

8. Given two sine waves *A* and *B*, if the frequency of *A* is twice that of *B*, then the period of *B* is twice that of *A*
9. A sine wave is periodic and continuous.
10. If the maximum amplitude of a sine wave is 2 V, the minimum amplitude is -2 V.
11. A signal is measured at two different points. The power is P_1 at the first point and P_2 at the second point. The dB is 0. This means P_2 equals P_1
12. Attenuation is a type of transmission impairment in which the signal loses strength due to the resistance of the transmission medium.
13. Distortion is a type of transmission impairment in which the signal loses strength due to the different propagation speeds of each frequency that makes up the signal.
14. Noise is a type of transmission impairment in which an outside source such as crosstalk corrupts a signal.
15. When propagation speed is multiplied by propagation time, we get the distance a signal or bit has traveled.
16. Data can be analog or digital
17. Analog data are continuous and take continuous values
18. Digital data have discrete states and take discrete values.
19. Signals can be analog or digital
20. Analog signals can have an infinite number of values in a range.
21. Digital signals can have only a limited number of values.
22. Frequency and period are inverse of each other.
23. Frequency is the rate of change with respect to time.
24. Phase describes the position of the waveform relative to time 0.
25. A sine wave in the time domain can be represented by one single spike in the frequency domain.
26. A single-frequency sine wave is not useful in data communications; we need to send a composite signal.
27. The bandwidth of a composite signal is the difference between the highest and the lowest frequencies contained in that signal.
28. A(n) digital signal is a composite analog signal with an infinite bandwidth.
29. Baseband transmission of a digital signal is possible only if we have a low-pass channel.
30. If the available channel is a bandpass channel, we cannot send a digital signal directly to the channel.
31. For a noiseless channel, the Nyquist bit rate formula defines the theoretical maximum bit rate.
32. For a noisy channel, we need to use the Shannon capacity to find the maximum bit rate.
33. Attenuation, distortion, noise can impair a signal.
34. The bandwidth-delay product defines the number of bits that can fill the link.

Chapter 4: Data Transmission

* Line coding is the process of converting binary data to a digital signal.
* The number of different values allowed in a signal is the signal level. The number of symbols that represent data is the data level.
* Bit rate is a function of the pulse rate and data level.
* Line coding methods must eliminate the dc component and provide a means of synchronization between the sender and the receiver.
* Line coding methods can be classified as unipolar, polar, or bipolar.
* NRZ, RZ, Manchester, and differential Manchester encoding are the most popular polar encoding methods.
* AMI is a popular bipolar encoding method.
* Block coding can improve the performance of line coding through redundancy and error correction.
* Block coding involves grouping the bits, substitution, and line coding.
* 4B/5B, 8B/10B, and 8B/6T are common block coding methods.
* Analog-to-digital conversion relies on PCM (pulse code modulation).
* PCM involves sampling, quantizing, and line coding.
* The Nyquist theorem says that the sampling rate must be at least twice the highest-frequency component in the original signal.
* Digital transmission can be either parallel or serial in mode.
* In parallel transmission, a group of bits is sent simultaneously, with each bit on a separate line.
* In serial transmission, there is only one line and the bits are sent sequentially.
* Serial transmission can be either synchronous or asynchronous.
* In asynchronous serial transmission, each byte (group of 8 bits) is framed with a start bit and a stop bit. There may be a variable-length gap between each byte.
* In synchronous serial transmission, bits are sent in a continuous stream without start and stop bits and without gaps between bytes. Regrouping the bits into meaningful bytes is the responsibility of the receiver.

Quiz

1. Unipolar, bipolar, and polar encoding are types of line encoding.

2. RZ, Manchester, and Differential Manchester encoding has a transition at the middle of each bit.
3. Differential Manchester encoding has a transition at the beginning of each 0 bit.
4. PCM is an example of analog-to-digital conversion
5. If the frequency spectrum of a signal has a bandwidth of 500 Hz with the highest frequency at 600 Hz, what should be the sampling rate, according to the Nyquist theorem? 1200 samples/s
6. The Nyquist theorem specifies the minimum sampling rate to be twice the highest frequency of a signal.
7. Which of the following encoding methods does not provide for synchronization? NRZ-L
8. Which encoding method uses alternating positive and negative values for 1s? AMI
9. Which quantization level results in a more faithful reproduction of the signal? 32
10. Block coding can help in synchronization and error detection at the receiver.
11. In parallel transmission, bits are transmitted simultaneously, each across its own wire.
12. In asynchronous serial and synchronous serial transmission, bits are transmitted over a single wire, one at a time.
13. In asynchronous transmission, a start bit and a stop bit frame a character byte.
14. In asynchronous transmission, the gap time between bytes is variable.
15. Digital-to-digital conversion involves three techniques: line coding, block coding, and scrambling.
16. Line coding is the process of converting digital data to a digital signal.
17. Block coding provides redundancy to ensure synchronization and inherent error detection.
18. Block coding is normally referred to as *mB/nB* coding; it replaces each *m*-bit group with an *n*-bit group.
19. Scrambling provides synchronization without increasing the number of bits.
20. Two common scrambling techniques are B8ZS and HDB3
21. The most common technique to change an analog signal to digital data is called PCM
22. The first step in PCM is sampling
23. There are three sampling methods: ideal, natural, and flat-top
24. PCM finds the value of the signal amplitude for each sample; DM finds the change from the previous sample.
25. While there is (are) only one way(s) to send parallel data, there is (are) three subclass(es) of serial transmission.
26. In asynchronous transmission, we send 1 start bit (0) at the beginning and 1 or more stop bits (1s) at the end of each byte.
27. In synchronous transmission, we send bits one after another without start or stop bits or gaps. It is the responsibility of the receiver to group the bits.
28. The isochronous mode provides synchronization for the entire stream of bits must. In other words, it guarantees that the data arrive at a fixed rate.
29. A self-synchronizing digital signal includes timing information in the data being transmitted.
30. In decoding a digital signal, the receiver calculates a running average of the received signal power, called the baseline.
31. The data rate defines the number of data elements sent in 1s; the signal rate is the number of signal elements sent in 1s.
32. The signal rate is sometimes called the baud rate.
33. The data rate is sometimes called the bit rate.
34. In a unipolar scheme, all the signal levels are on one side of the time axis, either above or below.
35. In polar schemes, the voltages are on the both sides of the time axis. For example, the voltage level for 0 can be positive and the voltage level for 1 can be negative.
36. In NRZ-L, the level of the voltage determines the value of the bit.
37. In NRZ-I, the change or lack of change in the level of the voltage determines the value of the bit.
38. The idea of RZ and the idea of NRZ-L are combined into the Manchester scheme.
39. The idea of RZ and the idea of NRZ-I are combined into the differential Manchester scheme.
40. In Manchester and differential Manchester encoding, the duration of the bit is divided into two halves. The voltage remains at one level during the first half and moves to the other level in the second half. The transition at the middle of the bit provides synchronization.
41. In differential Manchester there is always a transition at the middle of the bit, but the bit values are determined at the beginning of the bit. If the next bit is 0, there is a transition; if the next bit is 1, there is none.
42. In Manchester and differential Manchester encoding, the transition at the middle of the bit is used for synchronization
43. The minimum bandwidth of Manchester and differential Manchester is twice that of NRZ.
44. In bipolar encoding, we use three levels: positive, zero, and negative.
45. The 2B1Q scheme uses data patterns of size 2 and encodes the 2-bit patterns as one signal element belonging to a four-level signal.
46. The MLT-3 scheme uses three levels (+V, 0, and -V) and three transition rules to move between the levels.
47. B8ZS substitutes eight consecutive zeros with 000VB0VB
48. HDB3 substitutes four consecutive zeros with 000V or B00V

Chapter 5: Analog Transmission

* Digital-to-analog modulation can be accomplished using the following:
    *Amplitude shift keying (ASK)—the amplitude of the carrier signal varies.
    *Frequency shift keying (FSK)—the frequency of the carrier signal varies.
    *Phase shift keying (PSK)—the phase of the carrier signal varies.
    *Quadrature amplitude modulation (QAM)—both the phase and amplitude of the carrier signal vary.
* QAM enables a higher data transmission rate than other digital-to-analog methods.
* Baud rate and bit rate are not synonymous. Bit rate is the number of bits transmit-ted per second. Baud rate is the number of signal units transmitted per second. One signal unit can represent one or more bits.
* The minimum required bandwidth for ASK and PSK is the baud rate.
* The minimum required bandwidth (BW) for FSK modulation is BW =f c1 .f c0 + N baud , where f c1 is the frequency representing a 1 bit, f c0 is the frequency representing a 0 bit, and N baud is the baud rate.
* A regular telephone line uses frequencies between 600 and 3000 Hz for data communication.
* ASK modulation is especially susceptible to noise.
* Because it uses two carrier frequencies, FSK modulation requires more bandwidth than ASK and PSK.
* PSK and QAM modulation have two advantages over ASK:
    *They are not as susceptible to noise.
    *Each signal change can represent more than one bit.
* Trellis coding is a technique that uses redundancy to provide a lower error rate.
* The 56K modems are asymmetric; they download at a rate of 56 Kbps and upload at 33.6 Kbps.
* Analog-to-analog modulation can be implemented by using the following:
    * Amplitude modulation (AM)
    * Frequency modulation (FM)
    * Phase modulation (PM)
* In AM radio, the bandwidth of the modulated signal must be twice the bandwith of the modulating signal.
* In FM radio, the bandwith of the modulated signal must be 10 times the bandwidth of the modulating signal.

Quiz

1. ASK, PSK, FSK, and QAM are examples of digital to analog conversion
2. AM and FM are examples of analog-to-analog conversion
3. In QAM, both amplitude and phase of a carrier frequency are varied.
4. If the baud rate is 400 for a QPSK signal, the bit rate is 800bps.
5. If the bit rate for an ASK signal is 1200 bps, the baud rate is 1200
6. If the bit rate for an FSK signal is 1200 bps, the baud rate is 1200
7. If the bit rate for a 16-QAM signal is 4000 bps, what is the baud rate? 1000
8. If the baud rate for a 64-QAM signal is 2000, what is the bit rate? 12000
9. Given an AM radio signal with a bandwidth of 10 KHz and the highest-frequency component at 705 KHz, what is the frequency of the carrier signal? 700KHz
10. Digital-to-analog conversion is the process of changing one of the characteristics of an analog signal based on the information in the digital data.
11. Which of the following is not a digital-to-analog conversion? AM (ASK, PSK, and FSK are)
12. In ASK, the amplitude of the carrier signal is varied to create signal elements. Both frequency and phase remain constant.
13. In FSK, the frequency of the carrier signal is varied to represent data. Both peak amplitude and phase remain constant.
14. In PSK, the phase of the carrier is varied to represent two or more different signal elements. Both peak amplitude and frequency remain constant.
15. A constellation diagram shows us the amplitude and phase of a signal element, particularly when we are using two carriers (one in-phase and one quadrature).
16. Quadrature amplitude modulation (QAM) is a combination of ASK and PSK
17. QAM uses two carriers, one in-phase and the other quadrature.
18. Analog-analog conversion is the representation of analog information by an analog signal.
19. Analog-to-analog conversion is needed if the available bandwidth is band-pass
20. Which of the following is not an analog-to-analog conversion? QAM (AM, PM and FM are)
21. In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal.
22. In FM transmission, the frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal. The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.
23. In PM transmission, the phase of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
24. In OOK, the peak amplitude of one signal level is 0; the other is the same as the amplitude of the carrier frequency.

25. How many carrier frequencies are used in BASK? 1
26. How many carrier frequencies are used in BFSK? 2
27. How many carrier frequencies are used in BPSK? 1
28. How many carrier frequencies are used in QPSK? 2
29. The constellation diagram of BASK has 2 dots.
30. The constellation diagram of BPSK has 2 dots.
31. The constellation diagram of QPSK has 4 dots.
32. The constellation diagram of 16-QAM has 16 dots
33. The Federal Communications Commission (FCC) allows 10 kHz for each AM station.
34. The Federal Communications Commission (FCC) allows 100 kHz for each FM station.

Chapter 12: Multiple Access

* The Point-to-Point Protocol (PPP) was designed to provide a dedicated line for users who need Internet access via a telephone line or a cable TV connection.
* A PPP connection goes through these phases: idle, establishing, authenticating (optional), networking, and terminating.
* At the data link layer, PPP employs a version of HDLC.
* The Link Control Protocol (LCP) is responsible for establishing, maintaining, configuring, and terminating links.
* Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP) are two protocols used for authentication in PPP.
* PAP is a two-step process. The user sends authentication identification and a password. The system determines the validity of the information sent.
* CHAP is a three-step process. The system sends a value to the user. The user manipulates the value and sends its result. The system verifies the result.
* Network Control Protocol (NCP) is a set of protocols to allow the encapsulation of data coming from network layer protocols; each set is specific for a network layer protocol that requires the services of PPP.
* Internetwork Protocol Control Protocol (IPCP), an NCP protocol, establishes and terminates a network layer connection for IP packets.

Quiz

1. In pure ALOHA each station sends a frame whenever it has a frame to send.
2. In pure ALOHA, the vulnerable time is two times the frame transmission time.
3. The maximum throughput for pure ALOHA is 18.4 percent.
4. In slotted ALOHA, each station is forced to send only at the beginning of the time slot.
5. In slotted ALOHA, the vulnerable time is the same as the frame transmission time.
6. The maximum throughput for pure ALOHA is 36.8 percent.
7. The vulnerable time for CSMA is the the same as propagation time.
8. In the 1-persistent method, after the station finds the line idle, it sends its frame immediately. If the line is not idle, it continuously senses the line until it finds it idle.
9. In the nonpersistent method, a station that has a frame to send senses the line. If the line is idle, it sends immediately. If the line is not idle, it waits a random amount of time and then senses the line again.
10. In the p-persistent method, after the station finds the line idle it sends or refrain from sending based on the outcome of a random number generator. If the line is busy, it tries again.
11. We have categorized access methods into three groups.
12. In random access methods, no station is superior to another station and none is assigned the control over another.
13. In CSMA, the chance of collision can be reduced if a station senses the medium before trying to use it.
14. CMSA requires that each station first listen to the medium before sending.
15. CSMA/CD augments the CSMA algorithm to detect collision.
16. In CSMA/CD, a station monitors the medium after it sends a frame to see if the transmission was successful. If so, the station is finished. If, however, there is a collision, the frame is sent again.
17. To avoid collisions on wireless networks, CSMA/CA was invented.
18. In CSMA/CA, collisions are avoided through the use of three strategies: the interframe space, the contention window, and acknowledgments.
19. In controlled access methods, the stations consult one another to find which station has the right to send.
20. In controlled access methods, a station cannot send unless it has been authorized by other stations.
21. We discussed three popular controlled-access methods.
22. In the reservation method, a station needs to make a reservation before sending data. Time is divided into intervals.

23. In the reservation method, time is divided into intervals. In each interval, a reservation frame precedes the data frames sent in that interval.
24. In the polling method, all data exchanges must be made through the primary device even when the ultimate destination is a secondary device.
25. In the polling method, the primary device controls the link; the secondary devices follow its instructions.
26. In the token passing method, the stations in a network are organized in a logical ring.
27. In the token passing method, each station has a predecessor and a successor.
28. In the token passing method, a special packet called a token circulates through the ring.
29. Channelization is a multiple-access method in which the available bandwidth of a link is shared in time, frequency, or through code, between different stations.
30. We discussed three channelization protocols.
31. In FDMA, the available bandwidth is divided into frequency bands.
32. In FDMA , each station is allocated a band to send its data. In other words, each band is reserved for a specific station, and it belongs to the station all the time.
33. In TDMA, the stations share the bandwidth of the channel in time.
34. In TDMA, each station is allocated a time slot during which it can send data. Each station transmits its data in its assigned time slot.
35. In TDMA, each station transmits its data in its assigned time slot.
36. In CDMA, the stations use different codes to achieve multiple access.
37. CDMA is based on coding theory and uses sequences of numbers called chips.
38. In CDMA, the sequences are generated using orthogonal codes such the Walsh tables.

Chapter 14: Wireless LANs

* Ethernet is the most widely used local area network protocol.
* The IEEE 802.3 standard defines 1-persistent CSMA/CD as the access method for first-generation 10-Mbps Ethernet.
* The data link layer of Ethernet consists of the LLC sublayer and the MAC sublayer.
* The MAC sublayer is responsible for the operation of the CSMA/CD access method.
* Each station on an Ethernet network has a unique 48-bit address imprinted on its network interface card (NIC).
* The minimum frame length for 10-Mbps Ethernet is 64 bytes; the maximum is 1518 bytes.
* The physical layer of 10-Mbps Ethernet can be composed of four sublayers: the physical layer signaling (PLS) sublayer, the attachment unit interface (AUI) sublayer, the medium attachment unit (MAU) sublayer, and the medium-dependent interface (MDI) sublayer.
* The common baseband implementations of 10-Mbps Ethernet are 10Base5 (thick Ethernet), 10Base2 (thin Ethernet), 10Base-T (twisted-pair Ethernet), and 10Base-FL (fiber link Ethernet).
* The 10Base5 implementation of Ethernet uses thick coaxial cable. The 10Base2 implementation of Ethernet uses thin coaxial cable. The 10Base-T implementation of Ethernet uses twisted-pair cable that connects each station to a port in a hub. The 10Base-FL implementation of Ethernet uses fiber-optic cable.
* A bridge can raise the bandwidth and separate the collision domains on an Ethernet LAN.
* A switch allows each station on an Ethernet LAN to have the entire capacity of the network to itself.
* Full-duplex mode doubles the capacity of each domain and deletes the need for the CSMA/CD method.
* Fast Ethernet has a data rate of 100 Mbps.
* In Fast Ethernet, autonegotiation allows two devices to negotiate the mode or data rate of operation.
* The Fast Ethernet reconciliation sublayer is responsible for the passing of data in 4-bit format to the MII.
* The Fast Ethernet MII is an interface that can be used with both a 10- and a 100-Mbps interface.
* The Fast Ethernet PHY sublayer is responsible for encoding and decoding.
* The common Fast Ethernet implementations are 100Base-TX (two pairs of twisted-pair cable), 100Base-FX (two fiber-optic cables), and 100Base-T4 (four pairs of voice-grade, or higher, twisted-pair cable).
* Gigabit Ethernet has a data rate of 1000 Mbps.
* Gigabit Ethernet access methods include half-duplex using traditional CSMA/CD (not common) and full-duplex (most popular method).
* The Gigabit Ethernet reconciliation sublayer is responsible for sending 8-bit parallel data to the PHY sublayer via a GMII interface.
* The Gigabit Ethernet GMII defines how the reconciliation sublayer is to be connected to the PHY sublayer.
* The Gigabit Ethernet PHY sublayer is responsible for encoding and decoding.
* The common Gigabit Ethernet implementations are 1000Base-SX (two optical fibers and a shortwave laser source), 100Base-LX (two optical fibers and a long-wave laser source), and 100Base-T (four twisted pairs).

Quiz

1. IEEE has defined the specifications for a wireless LAN, called 802.11, which covers the physical and data link layers
2. In IEEE 802.11, a BSS is made of stationary or mobile wireless stations and an optional central base station, known as the access point (AP)

3. In IEEE 802.11, a BSS without an AP is called an ad hoc architecture
4. In IEEE 802.11, a BSS with an AP is sometimes referred to as an infrastructure network.
5. In IEEE 802.11, communication between two stations in two different BSSs usually occurs via two APs
6. In IEEE 802.11, a station with no transition mobility is either stationary (not moving) or moving only inside a BSS.
7. In IEEE 802.11, a station with BSS-transition mobility can move from one BSS to another, but the movement is confined inside one ESS.
8. In IEEE 802.11, a station with ESS-transition mobility can move from one ESS to another.
9. In IEEE 802.11, PCF is an optional access method that can be implemented in an infrastructure network (not in an ad hoc network).
10. In IEEE 802.11, when a frame is going from one station in a BSS to another without passing through the distribution system, the address flag is 00
11. In IEEE 802.11, when a frame is coming from an AP and going to a station, the address flag is 01
12. In IEEE 802.11, when a frame is going from a station to an AP, the address flag is 10.
13. In IEEE 802.11, when a frame is going from one AP to another AP in a wireless distribution system, the address flag is 11
14. The IEEE 802.11 standard for wireless LANs defines two services: BSS and ESS
15. In IEEE 802.11, the access method used in the DCF sublayer is CSMA/CA
16. In IEEE 802.11, the access method used in the PCF sublayer is polling
17. In IEEE 802.11, the NAV is a timer used for collision avoidance
18. In IEEE 802.11, the MAC layer frame has none of the above (four, five, six) fields
19. In IEEE 802.11, the addressing mechanism can include up to four addresses.
20. The original IEEE 802.11, uses FHSS or OFDM
21. The IEEE 802.11a, uses OFDM
22. The IEEE 802.11b, uses DSSS
23. The IEEE 802.11g, uses OFDM
24. The original IEEE 802.11, has a data rate of 1 Mbps.
25. IEEE 802.11a, has a data rate of 6Mbps.
26. IEEE 802.11b, has a data rate of 5.5Mbps.
27. IEEE 802.11g, has a data rate of 27Mbps.
28. The IEEE 802.11 wireless LANs use none of the above (four, five, six) types of frames.
29. Bluetooth is a wireless LAN technology that connects devices (called gadgets) in a small area.
30. A Bluetooth network is called a piconet
31. In Bluetooth, multiple piconets form a network called a scatternet.
32. A Bluetooth network consists of one primary device(s) and up to seven secondary devices.
33. The RTS and CTS frames in CSMA/CA can solve the hidden station problem. The RTS and CTS frames in CSMA/CA cannot solve the exposed station problem.
34. In Bluetooth, the current data rate is 11Mbps
35. In Bluetooth, the radio layer is roughly equivalent to the physical layer of the Internet model.
36. In Bluetooth, the baseband layer is roughly equivalent to the MAC sublayer in LANs.
37. In Bluetooth, the L2CAP sublayer, is roughly equivalent to the LLC sublayer in LANs.
38. The access method in Bluetooth is TDD-TDMA
39. In Bluetooth, the SCO link is used when avoiding latency (delay in data delivery) is more important than integrity (error-free delivery).
40. In Bluetooth, the ACL link is used when data integrity is more important than avoiding latency.
41. Bluetooth uses FHSS method in the physical layer to avoid interference from other devices or other networks.

Chapter 15: Connecting LANS, Backbone Networks, and Virtual LANs

* The IEEE 802.11 standard for wireless LANs defines two services: basic service set (BSS) and extended service set (ESS). An ESS consists of two or more BSSs; each BSS must have an access point (AP).
* The physical layer methods used by wireless LANs include frequency-hopping spread spectrum (FHSS), direct sequence spread spectrum (DSSS), orthogonal frequency-division multiplexing (OFDM), and high-rate direct sequence spread spectrum (HR-DSSS).
* FHSS is a signal generation method in which repeated sequences of carrier frequencies are used for protection against hackers.
* One bit is replaced by a chip code in DSSS.
* OFDM specifies that one source must use all the channels of the bandwidth.
* HR-DSSS is DSSS with an encoding method called complementary code keying (CCK).
* The wireless LAN access method is CSMA/CA.
* The network allocation vector (NAV) is a timer for collision avoidance.

* The MAC layer frame has nine fields. The addressing mechanism can include up to four addresses.
* Wireless LANs use management frames, control frames, and data frames.
* Bluetooth is a wireless LAN technology that connects devices (called gadgets) in a small area.
* A Bluetooth network is called a piconet. Multiple piconets form a network called a scatternet.
* The Bluetooth radio layer performs functions similar to those in the Internet model's physcial layer.
* The Bluetooth baseband layer performs functions similar to those in the Internet model's MAC sublayer.
* A Bluetooth network consists of one master device and up to seven slave devices.
* A Bluetooth frame consists of data as well as hopping and control mechanisms. A fram is one, three, or five slots in length with each slot equal to 625 μs.

Quiz

1. A repeater is a connecting device that operates in the physical layer of the Internet model
2. A repeater regenerates a signal, connects segments of a LAN, and has no filtering capability.
3. A bridge is a connecting device that operates in the physical and data link layers of the Internet model.
4. A transparent bridge can forward and filter frames and automatically build its forwarding table.
5. A bridge can use the spanning tree algorithm to create a loopless topology.
6. A backbone LAN allows several LANs to be connected.
7. A backbone is usually a bus or star
8. A virtual local area network (VLAN) is configured by software
9. Membership in a VLAN can be based on port numbers, MAC addresses, IP addresses (all of the above
10. VLANs can both reduce network traffic and provide an extra measure of security
11. A passive hub is just a connector
12. In a star-topology Ethernet LAN, a passive hub is just a point where the signals coming from different stations collide; it is the collision point.
13. A passive hub is part of the media; its location in the Internet model is below the physical layer.
14. A repeater is a device that operates only in the physical layer.
15. A repeater receives a signal and, before it becomes too weak or corrupted, regenerates the original bit pattern. It then sends the refreshed signal.
16. A repeater forwards every frame; it has no filtering capability.
17. An active hub is actually a multiport repeater. It is normally used to create connections between stations in a physical star topology.
18. A bridge operates in both the physical and the data link layer.
19. A bridge can check the MAC addresses contained in the frame.
20. A bridge has a table used in filtering decisions.
21. A transparent bridge is a device in which the stations are completely unaware of its existence.
22. IEEE 802.1d specification, defines three criteria for a transparent bridges.
23. A spanning tree is a graph in which there is no loop
24. In a bridged LAN, the spanning tree algorithm creates a topology in which each LAN can be reached from any other LAN through one path only.
25. A three-layer switch is a kind of router
26. A two-layer switch is a bridge
27. Some new two-layer switches, called cut-through switches, have been designed to forward the frame as soon as they check the MAC addresses in the header of the frame.
28. A router is a three-layer device that handles packets based on their logical addresses.
29. A router normally connects LANs and WANs in the Internet and has a table that is used for making decisions about the route.
30. A three-layer switch is a faster and more sophisticated router.
31. A gateway is normally a computer that operates in all five layers of the Internet model or seven layers of OSI model.
32. A gateway can be used as a connecting device between two internetworks that use different models.
33. In a star backbone, the backbone is just one switch.
34. A point-to-point link acts as a LAN in a remote backbone connected by remote bridges.
35. VLANs create broadcast domains.
36. In a(n) manual configuration, the administrator types the port numbers, the IP addresses, or other characteristics, using the VLAN software.
37. In a(n) automatic configuration, the stations are automatically connected or disconnected from a VLAN using criteria defined by the administrator.
38. In a(n) semiautomatic configuration, the initializing is done manually, with migrations done automatically.

Chapter 16: Wireless WANs: Cellular Telephone and Satellite Networks

* A repeater is a connecting device that operates in the physical layer of the Internet model. A repeater regenerates a signal, connects segments of a LAN, and has no filtering capability.
* A bridge is a connecting device that operates in the physical and data link layers of the Internet model.
* A transparent bridge can forward and filter frames and automatically build its forwarding table.
* A bridge can use the spanning tree algorithm to create a loopless topology.

* A backbone LAN allows several LANs to be connected.
* A backbone is usually a bus or a star.
* A virtual local area network (VLAN) is configured by software, not by physical wiring.
* Membership in a VLAN can be based on port numbers, MAC addresses, IP addresses, IP multicast addresses, or a combination of these features.
* VLANs are cost- and time-efficient, can reduce network traffic, and provide an extra measure of security.

Quiz

1. AMPS is a first-generation cellular phone system.
2. D-AMPS is a second-generation cellular phone system.
3. D-AMPS is a digital version of AMPS.
4. GSM is a second-generation cellular phone system used in Europe.
5. IS-95 is a second-generation cellular phone system based on CDMA and DSSS.
6. The third-generation cellular phone system will provide universal personal communication.
7. In a hard handoff, a mobile station only communicates with one base station.
8. In a soft handoff, a mobile station can communicate with two base stations at the same time.
9. AMPS is an analog cellular phone system using FDMA.
10. AMPS operates in the ISM 800-MHz band.
11. In AMPS, each band is divided into none of the above (800, 900, 1000) channels.
12. AMPS has a frequency reuse factor of 7
13. AMPS uses FDMA to divide each 25-MHz band into channels.
14. D-AMPS uses both FDMA and TDMA to divide each 25-MHz band into channels.
15. GSM allows a reuse factor of 3
16. GSM is a digital cellular phone system using both FDMA and TDMA
17. IS-95 is based on FDMA, CDMA and DSSS (all of the above)
18. IS-95 uses the ISM either 800-MHz or 1900-MHz band
19. IS-95 uses the GPS satellite system for synchronization
20. In an IS-95 system, the frequency-reuse factor is normally 1
21. In the third generation of cellular phones, IMT-DS uses W-CDMA.
22. In the third generation of cellular phones, IMT-MC uses CDMA2000.
23. In the third generation of cellular phones, IMT-TC uses a combination of W-CDMA and TDMA.
24. In the third generation of cellular phones, IMT-SC uses TDMA.
25. The period of a satellite, the time required for a satellite to make a complete trip around the Earth, is determined by Kepler's law.
26. The signal from a satellite is normally aimed at a specific area called the footprint
27. There is (are) one orbit(s) for a GEO satellite.

Chapter 17: SONET/SDH

* Cellular telephony provides communication between two devices. One or both may be mobile.
* A cellular service area is divided into cells.
* Advanced Mobile Phone System (AMPS) is a first-generation cellular phone system.
* Digital AMPS (D-AMPS) is a second-generation cellular phone system that is a digital version of AMPS.
* Global System for Mobile Communication (GSM) is a second-generation cellular phone system used in Europe.
* Interim Standard 95 (IS-95) is a second-generation cellular phone system based on CDMA and DSSS.
* The third-generation cellular phone system will provide universal personal communication.
* A satellite network uses satellites to provide communication between any points on earth.
* A geosynchronous Earth orbit (GEO) is at the equatorial plane and revolves in phase with the earth.
* Global Positioning System (GPS) satellites are medium-Earth-orbit (MEO) satellites that provide time and location information for vehicles and ships.
* Iridium satellites are low-Earth-orbit (LEO) satellites that provide direct universal voice and data communications for handheld terminals.
* Teledesic satellites are low-Earth-orbit satellites that will provide universal broadband Internet access.

Chapter 21: Network Layer: Address Mapping, Error Reporting, and Multicasting

* A metric is the cost assigned for passage of a packet through a network.
* A router consults its routing table to determine the best path for a packet.
* An autonomous system (AS) is a group of networks and routers under the authority of a single administration.
* RIP and OSPF are popular interior routing protocols used to update routing tables in an AIS.
* RIP is based on distance vector routing, in which each router shares, at regular intervals, its knowledge about the entire AS with its neighbor.
* A RIP routing table entry consists of a destination network address, the hop count to that destination, and the IP address of the next router.

* OSPF divides an AS into areas, defined as collections of networks, hosts, and routers.
* OSPF is based on link state routing, in which each router sends the state of its neighborhood to every other router in the area. A packet is sent only if there is a change in the neighborhood.
* OSPF defines four types of links (networks): point-to-point, transient, stub, and virtual.
* Five types of link state advertisments (LSAs) disperse information in OSPF: router link, network link, summary link to network, summary link to AS boundary router, and external link.
* A router compiles all the information from the LSAs it receives into a link state database. This database is common to all routers in an area.
* An LSA is a mutifield entry in a link state update packet.
* BGP is an interautonomous system routing protocol used to upadate routing tables.
* BGP is based on a routing method called path vector routing. In this method, the ASs through which a packet must pass are explicitly listed.
* There are four types of BGP messages: open, update, keep-alive, and notification.
* The Internet Group Management Protocol (IGMP) helps multicast routers create and update a list of loyal members related to a router interface.
* The three IGMP message types are the query message, the membership report, and the leave report.
* A host or router can have membership in a group.
* A host maintains a list of processes that have membership in a group.
* A router maintains a list of groupids that shows group membership for each interface.
* Multicasting applications include distributed databases, information dissemination, teleconferencing, and distance learning.
* For efficient multicasting we use a shortest-path spanning tree to represent the communication path.
* In a source-based tree approach to multicast routing, the source--group combinations determines the tree.
* In a group-based tree approach to multicast routing, the group determines the tree.
* DVRMP is a multicast routing protocol that uses the distance routing protocol to create a source-based tree.
* In reverse path forwarding (RPF), the router forwards only the packets that have traveled the shortest path from the source to the router.
* Reverse path broadcasting (RPB) creates a shortest-path broadcast tree from the source to each destination. It guarantees that each destination receives one and only one copy of the packet.
* Reverse path multicasting (RPM) adds pruning and grafting to RPB to create a multicast shortest-path tree that supports dynamic membership changes.
* MOSPF is a multicast protocol that uses multicast link state routing to create a source-based least-cost tree.
* The Core-Based Tree (CBT) protocol is a multicast routing protocol that uses a core as the root of the tree.
* PIM-DM is a source-based routing protocol that uses RPF and pruning and grafting strategies to handle multicasting.
* PIM-SM is a group-shared routing protocol that is similar to CBT and u ses a rendzvous point as the source of the tree.
* For multicasting between two noncontiguous multicast routers, we make a multicast backbone (MBONE) to enable tunneling.

Chapter 22: Network Layer: Delivery, Forwarding, and Routing
* UDP and TCP are transport-layer protocols that create a process-to-process communication.
* UDP is an unreliable and connectionless protocol that requires little overhead and offers fast delivery.
* In the client-server paradigm, an application program on the local host, called the client, needs services from an application program on the remote host, called a server.
* Each application program has a unique port number that distinguishes it from other programs running at the same time on the same machine.
* The client program is assigned a random port number called the ephemeral port number.
* The server program is assigned a universal port number called a well-known port number.
* The combination of the IP address and the port number, called the socket address, uniquely defines a process and a host.
* The UDP packet is called a user datagram.
* UDP has no flow control mechanism.
* Transmission Control Protocol (TCP) is a connection-oriented, reliable, stream transport-layer protocol in the Internet model.
* The unit of data transfer between two devices using TCP software is called a segment; it has 20 to 60 bytes of header, followed by data from the application program.
* TCP uses a sliding window mechanism for flow control.
* Error detection is handled in TCP by the checksum, acknowledgment, and time-out.
* Corrupted and lost segments are retransmitted, and duplicate segments are discarded.
* TCP uses four timers—retransmission, persistence, keep-alive, and time-waited—in its operation.
* Connection establishment requires three steps; connection termination normally requires four steps.
* TCP software is implemented as a finite state machine.
* The TCP window size is determined by the receiver.

Chapter 23: Process-to-Process Delivery: UDP, TCP and SCTP

* The average data rate, peak data rate, maximum burst size, and effective band-width are qualitative values that describe a data flow.
* A data flow can have a constant bit rate, a variable bit rate, or traffic that is bursty.
* Congestion control refers to the mechanisms and techniques to control congestion and keep the load below capacity.
* Delay and throughput measure the performance of a network.
* Open-loop congestion control prevents congestion; closed-loop congestion control removes congestion.
* TCP avoids congestion through the use of two strategies: the combination of slow start and additive increase, and multiplicative decrease.
* Frame relay avoids congestion through the use of two strategies: backward explicit congestion notification (BECN) and the forward explicit congestion notification (FECN).
* A flow can be characterized by its reliability, delay, jitter, and bandwidth.
* Scheduling, traffic shaping, resource reservation, and admission control are techniques to improve quality of service (QoS).
* FIFO queuing, priority queuing, and weighted fair queuing are scheduling techniques.
* Leaky bucket and token bucket are traffic shaping techniques.
* Integrated Services is a flow-based QoS model designed for IP.
* The Resource Reservation Protocol (RSVP) is a signaling protocol that helps IP create a flow and makes a resource reservation.
* Differential Services is a class-based QoS model designed for IP.
* Access rate, committed burst size, committed information rate, and excess burst size are attributes to control traffic in Frame Relay.
* Quality of service in ATM is based on service classes, user-related attributes, and network-related attributes.

Chapter 24: Congestion Control and Quality of Service

* In the client-server model, the client runs a program to request a service and the server runs a program to provide the service. These two programs communicate with each other.
* One server program can provide services for many client programs.
* Clients can be run either iteratively (one at a time) or concurrently (many at a time).
* Servers can handle clients either iteratively (one at a time) or concurrently (many at a time).
* A connectionless iterative server uses UDP as its transport layer protocol and can serve one client at a time.
* A connection-oriented concurrent server uses TCP as its transport layer protocol and can serve many clients at the same time.
* When the operating system executes a program, an instance of the program, called a process, is created.
* If two application programs, one running on a local system and the other running on the remote system, need to communicate with each other, a network program is required.
* The socket interface is a set of declarations, definitions, and procedures for writing client-server programs.
* The communication structure needed for socket programming is called a socket.
* A stream socket is used with a connection-oriented protocol such as TCP.
* A datagram socket is used with a connectionless protocol such as UDP.
* A raw socket is sued by protocols such as ICMP or OSPF that directly use the services of IP.

Quiz

1. In congestion control we try to avoid traffic congestion.
2. In quality of service, we try to create an appropriate environment for the traffic.
3. Traffic descriptors are qualitative values that represent a data flow.
4. The peak data rate defines the maximum data rate of the traffic.
5. The maximum burst size normally refers to the maximum length of time the traffic is generated at the peak rate.
6. The effective bandwidth is a function of three values: average data rate, peak data rate, and maximum burst size.
7. A constant bit rate traffic model has a data rate that does not change.
8. In the variable bit rate traffic model, the rate of the data flow changes in time, with the changes smooth instead of sudden and sharp.
9. In the bursty traffic model, the data rate changes suddenly in a very short time.
10. Congestion happens in any system that involves waiting.
11. Congestion in a network or internetwork occurs because routers and switches have queues.
12. In a network, when the load is much less than the capacity of the network, the delay is at a minimum.
13. In a network, when the load reaches the network capacity, the delay increases sharply.
14. In a network, when the load is below the capacity of the network, the throughput increases proportionally with the load.
15. In a network, after the load reaches the capacity, throughput declines sharply.
16. In open-loop congestion control, policies are applied to prevent congestion before it happens.

17. In closed-loop congestion control, mechanisms are used to alleviate congestion after it happens.
18. The technique of backpressure refers to a congestion control mechanism in which a congested node stops receiving data from the immediate upstream node or nodes.
19. A choke packet is a packet sent by a node to the source to inform it of congestion.
20. In implicit signaling, there is no communication between the congested node or nodes and the source. The source guesses that there is a congestion somewhere in the network from other symptoms.
21. In the explicit signaling method, the signal is included in the packets that carry data.
22. In the slow-start algorithm of TCP, the size of the congestion window increases exponentially until it reaches a threshold.
23. In the congestion avoidance algorithm of TCP, the size of the congestion window increases additively until congestion is detected.
24. In the congestion detection algorithm of TCP, the size of the threshold is dropped to one-half, a multiplicative decrease.
25. In Frame Relay, the BECN bit warns the sender of congestion in the network.
26. In Frame Relay, the FECN bit is used to warn the receiver of congestion in the network.
27. Traditionally, four types of characteristics are attributed to a flow.
28. Reliability is a characteristic that a flow needs. Lack of it means losing a packet or acknowledgment, which entails retransmission.
29. Delay is a flow characteristic that applications can tolerate in different degrees.
30. Jitter is the variation in delay for packets belonging to the same flow.
31. In FIFO, queuing packets wait in a buffer (queue) until the node (router or switch) is ready to process them.
32. In priority queuing, packets are first assigned to a priority class. Each class has its own queue.
33. In weighted fair queuing, the packets are assigned to different classes and admitted to different queues. The queues, however, are weighted based on the priority of the queues; higher priority means a higher weight. The system processes packets in each queue in a round-robin fashion with the number of packets selected from each queue based on the corresponding weight.
34. In the leaky bucket algorithm, bursty chunks are stored in the bucket and sent out at an average rate.
35. The token bucket algorithm allows idle hosts to accumulate credit for the future in the form of tokens.
36. In integrated services, when a source makes a reservation, it needs to define a flow specification.
37. Differentiate Services is a class-based QoS model designed for IP.
38. In Frame Relay, the user can never exceed the access rate.
39. In Frame Relay, a committed burst size is the maximum number of bits in a predefined time that the network is committed to transfer without discarding any frame or setting the DE bit.
40. In Frame Relay, the committed information rate defines an average rate in bits per second.
41. In Frame Relay, the excess burst size is the maximum number of bits in excess of Bc that a user can send during a predefined time.
42. In ATM, the CBR class is designed for customers who need real-time audio or video services. The service is similar to that provided by a dedicated line such as a T line.
43. In ATM, the VBR class is divided into two subclasses: real-time (VBR-RT) and non-real-time (VBR-NRT). VBR-RT is designed for those users who need real-time services (such as voice and video transmission) and use compression techniques to create a variable bit rate. VBR-NRT is designed for those users who do not need real-time services but use compression techniques to create a variable bit rate.
44. In ATM, the ABR class delivers cells at a minimum rate. If more network capacity is available, this minimum rate can be exceeded.
45. In ATM, the UBR class is a best-effort delivery service that does not guarantee anything.

CH21:

1. The linking of one Bluetooth device that serves as a master controller to up to seven other Bluetooth slave devices form what is called a piconet
2. The commercial name for a PAN network technology similar to Bluetooth that is a short-range technology with networking capability is Zigbee
3. Although MANs are primarily fiber-optic networks, a wireless contender for metropolitan-area networking is known as WiMAX
4. A wireless PAN will not link to which of the following? PC in an adjacent room (will link nearby laptop, PC across a room, nearby PDA
5. What is the typical distance for IR data communication links between computers, computers and printers, or ad hoc PANs? Up to 1m
6. The device that consists of a cable attached to the interface in a PC which can be positioned to provide a clear view of the device to which it will communicate is a transceiver dongle
7. The most widely used IR data communication system was developed by HP and has since become an international standard is referred to as IrDA
8. What is the wireless technique that uses thin, inexpensive tags or labels that contain passive radio circuits which can be queried by a remote wireless interrogation unit? RFID
9. In the block diagram illustrated above, the unique ID code is stored in the EEPROM
10. Which of the following is not an advantage of ultrawideband wireless? Long range capabilities