Chapter 9: Metropolitan and Wide Area Networks

Answers to End-of-Chapter Questions

1. Other than geographic differences, how do wide area networks differ from small local area networks?

2. What is a common carrier, local exchange carrier, and interexchange carrier?

3. Name three of the largest common carriers in North America.

4. Who regulates common carriers and how is it done?

5. What is the difference between the FCC/CRTC and a PUC?

6. Describe how direct dialing services work.

7. What is WATS service?

8. How do dedicated circuits differ from dial-up circuits?

9. Is a WAN that uses dedicated circuits easier or hard to design than one that uses dialed circuits? Explain.

10. Are voice grade circuits digital or analog?

11. How do wideband services differ from voice grade services?

12. Why is conditioning performed?

13. Can the telephone company condition dial-up circuits? Why or why not?

14. What are the most commonly used T carrier services? What data rates do they provide?

<table>
<thead>
<tr>
<th>T-Carrier Designation</th>
<th>DS Designation</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS-0</td>
<td>DS-0</td>
<td>64 Kbps</td>
</tr>
<tr>
<td>T-1</td>
<td>DS-1</td>
<td>1.544 Mbps</td>
</tr>
<tr>
<td>T-2</td>
<td>DS-2</td>
<td>6.312 Mbps</td>
</tr>
<tr>
<td>T-3</td>
<td>DS-3</td>
<td>33.375 Mbps</td>
</tr>
<tr>
<td>T-3</td>
<td>DS-4</td>
<td>274.176 Mbps</td>
</tr>
</tbody>
</table>

15. What are the two factors that distinguish T-1 circuits from voice grade circuits?

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17. Describe SONET. How does it differ from SDH?
18. What is DSL?
19. How does SDSL differ from ADSL?
20. What is a cable modem?
21. What distinguishes ISDN from other services?
22. How do basic rate interface and primary rate interface differ?
23. What is a 2B+D? Define it.
24. How does broadband ISDN differ from narrowband ISDN?
25. What are the problems with ISDN in North America today?
26. How do packet switching services differ from other wide area networks services?
27. How is a virtual circuit distinguished from other circuits?
28. Where does packetizing take place?
29. What does a packet contain?
30. How does a reliable packet service differ from an unreliable packet service?
31. How do datagram services differ from virtual circuit services?
32. How does a switched virtual circuit differ from a permanent virtual circuit?
33. How does frame relay differ from ATM?
34. How does ATM differ from frame relay?
35. How does SMDS differ from ATM?
36. Which likely to be the longer term winner, X.25, frame relay, ATM, or SMDS?
37. Explain the differences between CIR and MAR.
38. How can you improve WAN performance?
39. Describe five important factors in selecting WAN services?
40. What is a VAN?
41. How do VPN services differ from common carrier services?
**TRUE/FALSE**

The following are possible True/False questions for tests. The statement is given and the answer is provided in square brackets. The level of difficulty (easy, moderate, difficult) is also furnished.

1. In building Wide Area Networks, many organizations build their own long distance communication circuits.
   *Easy*

2. Four principal types of MAN and WAN services that can be leased from common carriers are: dialed circuits, dedicated circuits, switched circuits, and packet switched services.
   *Easy*

3. MANs usually span 3 to 30 miles and connect BNs and LANs.
   *Easy*

4. WANs connect BNs and MANs across distances greater than 30 miles.
   *Easy*

5. PTTs own, control, and sell all voice and data communication services in many countries outside North America.
   *Easy*

6. Today, a common carrier that provides local telephone services is typically called an interexchange carrier.
   *Easy*

7. Another way to refer to dialed services is by the term, plain old telephone service (POTS).
   *Easy*

8. Dial-up is also known as direct dialing.
   *Easy*

9. A private dedicated circuit is one which the user leases from a common carrier for 24-7 exclusive use.
   *Moderate*

10. Unlike dial-up lines, which are charged based on usage (time and distance), dedicated circuits are billed at a flat fee, contractually arranged, for unlimited usage.
    *Moderate*

11. Conditioning, or equalization, degrades data transmission qualities on dedicated voice grade channels.
    *Moderate*
12. Wideband analog services provide much greater bandwidth than regular voice grade circuits. 
*Easy*

13. Fractional T-1 is a leased digital service that offers portions of a T-1 circuit for a fraction of its full cost. 
*Easy*

14. Undersea cable connections cannot currently be installed with fiber. 
*Moderate*

15. A new version of SDSL, Very high rate Digital Subscriber Line, has been designed for use over local loops of 1000 feet or less, and provides the same transmission rates in both directions on the circuit, using traditional telephone lines. 
*Moderate*

16. The earliest type of ISDN is called Broadband ISDN. 
*Easy*

17. A packet switched service enables multiple connections to exist simultaneously between computers, unlike dialed circuit, dedicated circuit, and circuit switched services. 
*Easy*

18. Packet switching is popular because most data communications are continuous in nature. 
*Moderate*

19. A maximum allowable rate is the data rate that a circuit must guarantee to transmit over a frame relay connection. 
*Moderate*

20.Switched Multimegabit Data Service is called a reliable packet service. 
*Moderate*

21. WAN selection decisions should be driven by hardware costs, versus common carrier services. 
*Moderate*
MULTIPLE CHOICE

The following are possible multiple choice questions for tests. The question is posed and the answer is provided under the choices. The level of difficulty (easy, moderate, difficult) is also furnished.

1. __________ are companies that build a data and telecommunications infrastructure from which other companies can lease services for WANs and MANs.
   a. Standards organizations
   b. Common carriers
   c. Router manufacturers
   d. PTTs
   e. PUCs

2. Each state or Canadian province has its own __________ to regulate communications within its borders.
   a. Federal Communications Commission
   b. Public utilities commission
   c. Common carriers
   d. IEEE
   e. PTTs

3. The ______________ is a government agency that regulates interstate and international communications to and from the United States.
   a. Federal Communications Commission
   b. Security and Exchange Commission
   c. Internet Command and Control Committee
   d. InterNIC
   e. Telephone, Telegraph, and Computer Commission

4. Which of the following is not one of the large common carriers operating in North America today?
   a. Sprint
   b. MCI
   c. AT&T
   d. RBOC
   e. GTE

5. ________ is a type of WAN connection that uses the normal voice telephone network.
   a. SONET
   b. T-Carrier services
   c. Digital Subscriber Line
   d. X.25
   e. Dialed circuit services
6. When a person uses a modem to make a regular dialed telephone call from one point to another through the telephone network, the data travels over a:
   a. dialed circuit
   b. dedicated circuit
   c. switched circuit
   d. ISDN circuit
   e. T-1 carrier circuit

7. A ___________ is a point-to-point circuit that connects two offices.
   a. dialed circuit
   b. dedicated circuit
   c. switched circuit
   d. dial-up circuit
   e. none of the above

8. Special rate services that allow dialed circuit calls for both voice communications and data transmission to be purchased in large quantities are known as __________
   a. SONET
   b. WATS
   c. X.25
   d. DSL
   e. RBOC

9. WATS service is limited to __________ only.
   a. outward dialing
   b. inward dialing
   c. one direction
   d. all of the above
   e. none of the above

10. WATS charges are based on:
    a. geographical bands
    b. strictly mileage
    c. whether the call is inter LATA or intraLATA
    d. fixed rates across all calls
    e. whether the call is interRBOC or intraRBOC

11. Which of the following is not a problem with dialed circuits?
    a. Dialed circuits may vary in quality.
    b. It is hard to predict if a given connection will be clear or noisy.
    c. Use of these circuits is very simple.
    d. Data transmission rates on dialed circuits are usually low.
    e. Currently, transmission rates for dialed circuits have a practical upper limit that ranges from 28.8 Kbps to 56 Kbps.
12. ___________ is the switching office to which the local telephone company terminates subscribers’ circuits for long distance dial-up or leased line communications.
   a. Point of presence
   b. Circuit end points
   c. Local loop
   d. Central exchange
   e. Destination office

13. Voice grade dedicated circuits are ________ circuits.
   a. digital
   b. analog
   c. binary
   d. ternary
   e. none of the above

14. _____ are dedicated digital circuits that are the most commonly used form of dedicated circuit services in North America today.
   a. SONET
   b. ATM
   c. T-carrier services
   d. Wideband analog services
   e. ISDN

15. A ___________ is/are devices which permit a user to connect to a digital T-carrier service.
   a. CSU/DSU
   b. modem
   c. codec
   d. NIC
   e. ATM

16. The data rate for a T-1 circuit in North America is:
   a. 1.544 Mbps
   b. 6.312 Mbps
   c. 44.376 Mbps
   d. 274.176 Mbps
   e. 1.544 Gbps

17. SONET:
   a. refers to Sprint Overall Network
   b. is a standard for optical transmission that currently operates at Terabit per second speeds
   c. is very similar to the ITU-T standard, synchronous digital hierarchy
   d. does not need a CSU/DSU for connection from a user’s network
   e. is not currently available, even in large cities
18. ________ is one way that data rates over traditional telephone lines can be increased dramatically.
   a. SONET
   b. T-carrier services
   c. CSU/DSU
   d. ATM
   e. DSL

19. Which of the following is not true with respect to Symmetric Digital Subscriber Line?
   a. It provides the same transmission rates in both directions on the circuit.
   b. The shorter the distance from the carrier’s end office to the customer premises equipment (CPE), the higher the speed that is possible.
   c. The longer the distance from the carrier’s end office to the customer premises equipment (CPE), the lower the speed that is possible.
   d. The shorter the distance from the carrier’s end office to the customer premises equipment (CPE), the lower the speed that is possible.
   e. The minimum data rate is currently 128 Kbps.

20. ________ uses traditional telephone lines, and provides different transmission rates to and from the carrier’s end office to the customer premises equipment.
   a. SDSL
   b. CSU/DSU
   c. SONET
   d. T-carrier services
   e. ADSL

21. A ____________ is a digital service offered by cable television companies, and is considered to be a potential competitor to DSL.
   a. SONET
   b. T-carrier service
   c. CSU/DSU
   d. cable modem
   e. ADSL

22. A ____________ is one in which the organization establishes network connection points at a variety of locations and uses the carrier’s network to make temporary connections between the locations as needed.
   a. dialed circuit
   b. dedicated circuit
   c. switched circuit
   d. dial-up circuit
   e. Fractional T-1 network
23. Which of the following is not a benefit of circuit switched services?
   a. You don’t have to specify all the interconnecting services you need for your WAN when you buy the service.
   b. You don’t have to set up dedicated circuits between each end point from and to which you wish to transmit data and/or voice.
   c. You have the flexibility to send data through a temporary circuit between two connection that will be disconnected as soon as the digital transmission is completed.
   d. All circuits are less susceptible to noise because they are digital.
   e. The data transmission rates tend to be lower than dial-up or dedicated circuits.

24. If you have a high volume of message traffic between the two points, ________ service is recommended, but if you don’t, __________ service may be more cost effective.
   a. dedicated, switched
   b. switched, dedicated
   c. inward, outward
   d. outward, inward
   e. dial-up, dedicated

25. ISDN:
   a. refers to Interexchange Symmetric Data Network
   b. can only send data over its circuits
   c. has been widely adopted in all parts of North America for more than 15 years
   d. requires that there is an “ISDN modem” in all computers connected to an ISDN terminator
   e. has had no standardization issues between equipment vendors and common carriers

26. Acceptance of ISDN in North America has been:
   a. slow
   b. moderate
   c. fast
   d. fast initially, but slower lately
   e. non existent, since it is not offered in North America

27. Basic rate interface:
   a. provides a communications circuit with 23 64 Kbps B channels, plus one D channel
   b. is typically offered only to commercial customers
   c. has almost the same capacity as a T-1 circuit
   d. provides a communications circuit with 2 64 Kbps B channels, plus one 16 Kbps D channel
   e. is comprised of analog circuits only
28. Broadband ISDN offers __________ , and that feature/service is not available with Narrowband ISDN.
   a. asymmetrical service
   b. circuit-switched services
   c. the ability to accept BRI and PRI transmissions
   d. digital service
   e. the ability to combine voice, video, and data over the same circuit

29. A __________ is a user’s connection into a packet switched service.
   a. packet assembly/disassembly device
   b. packet analog/digital device
   c. packet asynchronous/discrete device
   d. packet asymmetric/data transmission device
   e. packet analyzer/decoder device

30. A ______ is a connectionless method of sending data packets on a packet switched service.
   a. virtual circuit
   b. datagram
   c. histogram
   d. bursty packet
   e. frame

31. A ______ is a connection-oriented approach to sending packets on a packet switched service.
   a. virtual circuit
   b. datagram
   c. histogram
   d. bursty packet
   e. frame

32. Which of the following is not true about X.25?
   a. It is a type of circuit switched service.
   b. It is the oldest type of packet switched service.
   c. It offers datagram, switched virtual circuit, and permanent virtual circuit services.
   d. It uses the LAPB data link layer protocol.
   e. It is not used widely in North America, except by multinational companies.

33. __________ is a newer type of packet switching technology.
   a. SONET
   b. ISDN
   c. ADSL
   d. Frame relay
   e. X.25

34. Which of the following is not a difference between frame relay and X.25?
a. Frame relay networks do not perform error control at each node, or computer, in the network.
b. Frame relay operates only at the data link layer.
c. Frame relay defines two connection data rates that are negotiated per connection and for each virtual circuit as it is established.
d. Frame relay use devices for connection to user facilities/equipment that are similar to PADs.
e. Frame relay uses variable length packets, or frames.

35. _______ is a recently developed set of standards for frame relay.
   a. Synchronous Optical Network Standards
   b. Network-to-Network Interface
   c. Asymmetric Digital Subscriber Line Standards
   d. Open Systems Interconnection Model
   e. IEEE 802.3

36. _________ is one of the newest forms of packet switching technologies.
   a. Asynchronous Transfer Mode
   b. Asymmetric Technical Mode
   c. Synchronous Optical Network Mode
   d. Asymmetric Digital Subscriber Line Mode
   e. X.25 Mode

37. Which of the following is not a difference between ATM and frame relay?
   a. ATM uses fixed length packets or cells.
   b. ATM can be multiplexed into much faster ATM circuits.
   c. ATM is scaleable.
   d. ATM is more suited for voice transmission because it uses small, 53-byte packets or cells.
   e. ATM has no error control at the intermediate computers or nodes.

38. Which of the following is true about the ATM packets, or cells?
   a. They are variable in length.
   b. They are comprised of 53 bytes: 5 bytes of overhead, and 48 bytes of user data.
   c. They are comprised of 53 bytes: 5 bytes of user data, and 48 bytes of overhead.
   d. They are comprised of 53 bits: 5 bits of overhead, and 48 bits of user data.
   e. They are comprised of 128 bytes.

39. During packet transmission along a SMDS network service, the user’s data link layer address is mapped to:
   a. the application layer address
   b. a special switched multimegabit data service address
   c. the network layer address
   d. the physical layer address
   e. the cell address
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40. SMDS:
   a. refers to Subscriber Mainframe Digital Subscriber
   b. performs error checking, unlike frame relay and ATM
   c. provides both datagram and virtual circuit services
   d. is not yet a widely accepted standard
   e. is a reliable packet service

41. __________ is a term that refers to the speed in converting input packets to output packets.
   a. Transfer mode
   b. Burstiness
   c. Cell relay
   d. Frame relay
   e. Latency

42. The performance of MANs and WANs can be improved by:
   a. upgrading the circuits between the computers
   b. changing the demand placed on the network
   c. downgrading the circuits between the computers
   d. a and b
   e. b and c

43. Dynamic routing:
   a. should be used in 80 to 90 percent of total networks’ capacity
   b. imposes an overhead cost by increasing network traffic
   c. decreases performance in networks which have many possible routes
   d. decreases performance in networks with “bursty” traffic
   e. is another term for static routing in WANs

44. Which of the following is not a way to reduce network demand?
   a. shifting network usage from peak to lower demand times
   b. shifting network usage from high cost times to lower cost times
   c. using data compression techniques for all data in the network
   d. requiring a network impact statement for all application software developed by the organization
   e. moving data further from the applications and people who use them

45. Which of the following is not a key issue to be considered when selecting a WAN service?
   a. flexibility
   b. capacity
   c. control
   d. prestige value of using a particular common carrier
   e. reliability
46. ________ provide additional services over and above those provided by common carriers.
   a. SONETs
   b. Value added networks
   c. Vendor supported networks
   d. Interexchange carrier networks
   e. Local carrier networks

47. A _______________ is particular type of network that uses circuits that run over the Internet
    but that appears to the user to be a private network.
    a. software defined network
    b. local carrier network
    c. integrated service digital network
    d. virtual private network
    e. SONET network

**Short Answer Questions**

1. Under what circumstances would you recommend using dedicated circuit services rather than
   packet switched services?

2. Under what circumstances would you recommend using packet switched services rather than
   circuit switched services?

3. How does a T1 circuit differ from an SMDS circuit in terms of speed and the type of
   MAN/WAN circuit (i.e., dialed, dedicated, circuit switched, packet switched)?

4. How does a T1 circuit differ from a SONET OC-3 circuit in terms of speed and the type of
   MAN/WAN circuit (i.e., dialed, dedicated, circuit switched, packet switched)?

5. Describe two ways in which X.25 differs from frame relay.

6. Describe one way in which ATM differs from frame relay and one way in which they are the
   same.

7. What is a VPN (Virtual Private Network)?

8. Suppose you are having response time problems in a WAN using dedicated circuits. What
   would you do?

9. Suppose you are having response time problems in a WAN using packet switched services. What
   would you do?

10. Thought question: What are the implications of ADSL for the future of small local Internet
    service providers?
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11. Thought question: What are the implications of ADSL for the future of modems?

12. Thought question: What do you think the future holds for narrowband and broadband ISDN?

13. Thought question: Explain the two most important issues in selecting WAN services and justify why they are the most important.

Next Day Air Service Case Study

1. With your knowledge of NDAS's network, what service would you recommend for the future to connect the remote offices to the hubs at Atlanta and New Orleans and the hubs to the corporate office in Tampa? Will the current facilities be adequate?

2. President Coone has just informed you that NDAS is considering placing several new offices in Chicago and Los Angeles. Each office would have its own LAN. What factors would determine the use of a metropolitan area network (MAN) to connect NDAS offices in a single city together?