CHAPTER 14

PRACTICE SET

Questions

Q14-1. *Dial-up modems* use part of the bandwidth of the local loop to transfer data. The latest dial-up modems use the V-series standards such as V.32 and V.32bis (9600 bps), V.34bis (28,800 or 33,600 bps), V.90 (56 kbps for downloading and 33.6 kbps for uploading), and V.92. (56 kbps for downloading and 48 kbps for uploading.

Q14-2. A UNI defines a connection between the end users and an ATM switch; an NNI defines the connection between two ATM switches.

Q14-3. *A virtual tributary* is a partial payload that can be inserted into an STS-1 and combined with other partial payloads to fill out the frame. Instead of using all 86 payload columns of an STS-1 frame for data from one source, we can subdivide the SPE and call each component a VT.

Q14-4. The ANSI standard is called *SONET* and the ITU-T standard is called *SDH*. The standards are nearly identical.

Q14-5. The *traditional cable networks* use only coaxial cables to distribute video information to the customers. The *hybrid fiber-coaxial* (HFC) networks use a combination of fiber-optic and coaxial cable to do so.

Q14-6. *Pointers* are used to show the offset of the SPE in the frame or for justification. SONET uses two pointers to show the position of an SPE with respect to an STS. SONET use the third pointer for rate adjustment between SPE and STS.

Q14-7. *Signaling System Seven* (SS7) is the protocol used to provide signaling services in the telephone network. It is somehow similar to the five-layer Internet model.

Q14-8. A *regenerator* takes a received optical signal and regenerates it. The SONET regenerator also replaces some of the existing overhead information with new information.

Q14-9. SONET defines a hierarchy of electrical signaling levels called *synchronous transport signals* (STSs). SDH specifies a similar system called a *synchronous transport modules* (STMs).

Q14-10. An ATM virtual connection is defined by two numbers: a *virtual path identifier* (VPI) and a *virtual circuit identifier* (VCI).

Q14-11. *STSs* are the hierarchy of electrical signals defined by the SONET standards. *OCs* are the corresponding optical signals.

Q14-12. Telephone companies developed *digital subscriber line* (DSL) technology to provide higher-speed access to the Internet. DSL technology is a set of technologies, each differing in the first letter (ADSL, VDSL, HDSL, and SDSL). The set is often referred to as xDSL, where x can be replaced by A, V, H, or S. ADSL uses a device called *ADSL modem* at the customer site. It uses a device called a *digital subscriber line access multiplexer* (DSLAM) at the telephone company site.

Q14-13. The telephone network is made of three major components: *local loops*, *trunks*, and *switching offices*.

Q14-14. A *LATA* is a small or large metropolitan area that according to the divestiture of 1984 was under the control of a single telephone-service provider. The services offered by the common carriers inside a LATA are called intra-LATA services. The services between LATAs (inter-LATA services) are handled by interexchange carriers (IXCs). These carriers, sometimes called long-distance companies, provide communication services between two customers in different LATAs.

Q14-15.

a. The *Application Adaptation Layer* (AAL) allows existing networks to connect to ATM facilities by mapping packet data into fixed-sized ATM cells.

b. The *ATM layer* provides routing, traffic management, switching, and multiplexing services.

c. The *Physical layer* defines any transmission media that can be the carrier of the cells.

Q14-16.

a. The *path layer* is responsible for the movement of a signal from its source to its destination.

b. The *line layer* is responsible for the movement of a signal across a physical line.

c. The *section layer* is responsible for the movement of a signal across a physical section.

d. The *photonic layer* corresponds to the physical layer of the OSI model. It includes physical specifications for the optical fiber channel. SONET uses NRZ encoding with the presence of light representing 1 and the absence of light representing 0.

Q14-17. The *cable modem* (CM) is installed on the subscriber premises. The *cable modem transmission system* (CMTS) is installed inside the distribution hub by the cable company. It receives data from the Internet and passes them to the combiner, which sends them to the subscriber. The CMTS also receives data from the subscriber and passes them to the Internet.

Q14-18. In an UNI, the total length of VPI+VCI is 24 bits. This means that we can define 2^{24} virtual circuits in an UNI. In an NNI, the total length of VPI+VCI is 28 bits. This means that we can define 2^{28} virtual circuits in an NNI.

Q14-19. The larger data items can block the access of small data items to the multiplexers. This results in unusual delays for small items. This may cause the small data items to be assumed lost and resent.

Q14-20. To provide Internet access, the cable company has divided the available bandwidth of the coaxial cable into three bands: video, downstream data, and upstream data. The *downstream-only video band* occupies frequencies from 54 to 550 MHz. *The downstream data* occupies the upper band, from 550 to 750 MHz. The *upstream data* occupies the lower band, from 5 to 42 MHz.

Q14-21. A single clock handles the timing of transmission and equipment across the entire network.

Q14-22. *STS multiplexers/demultiplexers* mark the beginning points and endpoints of a SONET link. An STS multiplexer multiplexes signals from multiple electrical sources and creates the corresponding optical signal. An STS demultiplexer demultiplexes an optical signal into corresponding electric signals. *Add/drop multiplexers* allow insertion and extraction of signals in an STS. An add/drop multiplexer can add an electrical signals into a given path or can remove a desired signal from a path.

Q14-23. A transmission path (TP) is the physical connection between a user and a switch or between two switches. It is divided into several (VPs), which provide a connection or a set of connections between two switches. VPs in turn consist of several virtual circuits (VCs) that logically connect two points together.

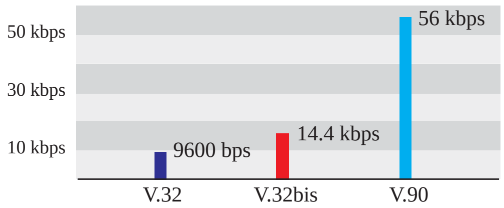
Q14-24. Telephone companies provide two types of services: *analog* and *digital*.

Q14-25. SONET defines four layers: *path*, *line*, *section*, and *photonic*.

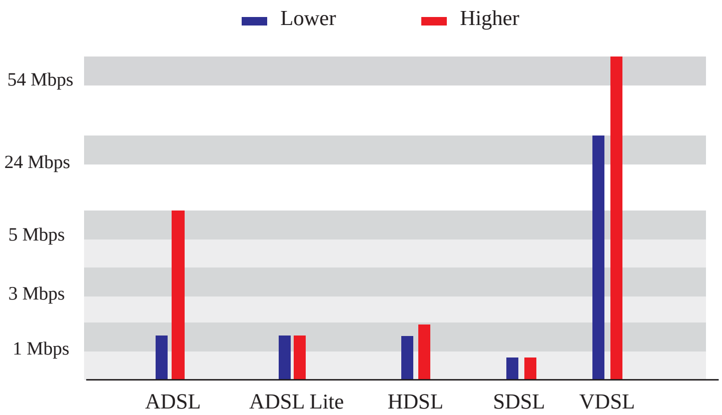
Q14-26. A transmission path (TP) is the physical connection between a user and a switch or between two switches. It is divided into several (VPs), which provide a connection or a set of connections between two switches. VPs in turn consist of several virtual circuits (VCs) that logically connect two points together.

Problems

P14-1. Although we did not discuss these rates in the book, the following information can be obtained from the Internet.



P14-2. Although we did not discuss these rates in the book, the following information can be obtained from the Internet.



P14-3. Each STS-n frame carries ($9 \times \boldsymbol{n} \times 86$) bytes of bytes. SONET sends 8000 frames in each second. We can then calculate the user data rate as follows:

$$\text{STS-3} \rightarrow 8000 \times (9 \times \mathbf{3} \times 86) \times 8 = 148.608 \text{ Mbps}$$
$$\text{STS-9} \rightarrow 8000 \times (9 \times \mathbf{9} \times 86) \times 8 = 445.824 \text{ Mbps}$$
$$\text{STS-12} \rightarrow 8000 \times (9 \times \mathbf{12} \times 86) \times 8 = 594.432 \text{ Mbps}$$

P14-4. The *setup phase* can be matched to the dialing process. After the callee responds, the *data transfer phase* (here voice transfer phase) starts. When any of the parties hangs up, the data transfer is terminated and the *teardown phase* starts. It takes a while before all resources are released.

P14-5. Telephone networks were designed to carry voice, which was not packetized. A *circuit-switched* network, which dedicates resources for the whole duration of the conversation, is more suitable for this type of communication.

P14-6. The DSL technology is based on *star* topology with the hub at the telephone office. The local loop connects each customer to the end office. This means that there is no sharing; the allocated bandwidth for each customer is not shared with neighbors. The data rate does not depend on how many people in the area are transferring data at the same time.

P14-7. We can calculate the time based on the assumption of 10 Mbps data rate:

$$\text{Time} = (1{,}000{,}000 \times 8) / 10{,}000{,}000 \approx 0.8 \text{ seconds}$$

P14-8. The user data rate of STS-1 is ($8000 \times 9 \times 86 \times 8$) = 49.536 Mbps. To carry a load with a data rate 49.526, we need 10 kbps worth of dummy data. This means that we need 10000 / 8 = 750 bytes of dummy data in 8000 frames. In other words, 750 out of every 8000 frames need to allow the next byte after H3 to be empty (dummy). For example, we can have sequences of 32 frames in which the first three frames are under-loaded and the next 29 are normal.

P14-9. We can calculate the time based on the assumption of 56 Kbps data rate:

$$\text{Time} = (1{,}000{,}000 \times 8) / 56{,}000 \approx 143 \text{ seconds}$$

P14-10. The delay can be attributed to the fact that some telephone companies use satellite networks for overseas communication. In these case, the signals need to travel several thousands miles (earth station to satellite and satellite to earth station).

P14-11. The user data rate of STS-1 is ($8000 \times 9 \times 86 \times 8$) = 49.536 Mbps. To carry a load with a data rate 49.540, we need another 4 kbps. This means that we need to insert 4000 / 8 = 500 bytes into every 8000 frames. In other words, 500 out of every 8000 frames need to allow the H3 byte to carry data. For example, we can have sequences of 16 frames in which the first frame is an overloaded frame and then 15 frames are normal.

P14-12. We can calculate the time based on the assumption of 1.5 Mbps data rate:

$$\text{Time} = (1{,}000{,}000 \times 8) / 1{,}500{,}000 \approx 5.3 \text{ seconds}$$

P14-13. In a telephone network, the *telephone numbers* of the caller and callee are serving as source and destination addresses. These are used only during the setup (dialing) and teardown (hanging up) phases.

P14-14. To create one STS-36 from four STS-9s, we first need to demultiplex each STS-9 into nine STS-1s. We can then multiplex thirty-six STS-1s into one STS-36. However, there is no extra overhead involved in the process of demultiplexing or multiplexing. Demultiplexing is done byte by byte; multiplexing is also done byte by byte.

P14-15. The *cable modem* technology is based on the *bus* (or rather tree) topology. The cable is distributed in the area and customers have to share the available bandwidth. This means if all neighbors try to transfer data, the effective data rate will be decreased.

P14-16. The DSL technology is based on *star* topology with the hub at the telephone office. The local loop connects each customer to the end office. This means that there is no sharing; the allocated bandwidth for each customer is not shared with neighbors. The data rate does not depend on how many people in the area are transferring data at the same time.

P14-17.

a. The minimum number of cells is 1. This happens when the data size £ 36 bytes. Padding is added to make it exactly 36 bytes. Then 8 bytes of header creates a data unit of 44 bytes at the SAR layer.

b. The maximum number of cells can be determined from the maximum number of data units at the CS sublayer. If we assume no padding, the maximum size of the packet is 65535 + 8 = 65543. This needs 65543 / 44 ≈ 1489.61. The maximum number of cells is 1490. This happens when the data size is between 65,509 and 65,535 (inclusive) bytes. We need to add between 17 to 43 (inclusive) bytes of padding to make the size 65552 bytes. The 8 byte overhead at the CS layer makes the total size 65560 which means 1490 data units of size 44.