

CHAPTER 2 BUSINESS INFORMATION

ANSWERS TO QUESTIONS

- 2.1 The terms can mean one thousand, one million, one billion or they can mean 2^{10} , 2^{20} , 2^{30} . The former meanings are common in a communications context, the latter in a computer storage context.
- 2.2 About 3400 Hz.
- 2.3 Compression.
- 2.4 The PBX is an on-premises telephone switching facility. With Centrex, the switching, even between extensions in the same office, is done at the telephone company's central office.
- 2.5 Printable characters are visible on the display screen or when a document is printed. Control characters are not displayed or printed but control some aspect of the formatting or communications of a document.
- 2.6 In vector graphics, an image is represented as a collection of straight and curved line segments. Simple objects, such as rectangles and ovals, and more complex objects are defined by the grouping of line segments. In raster graphics, an image is represented as a two-dimensional array of spots, called pixels, which may take on the values black or white, or may be gray scale.
- 2.7 Gray scale and RGB.
- 2.8 PDF and postscript.
- 2.9 Interlacing - odd and even scan lines are scanned separately. By separating the scans, the screen is refreshed twice as often (60 times per second vs. 30) and flicker is avoided.
- 2.10 The time it takes for a system to respond to a given input.
- 2.11 In order to increase productivity, system response times should be kept to 2 seconds or less. For the World Wide Web, site response time should be kept to 3 seconds or less to ensure user interest levels are kept high.

ANSWERS TO PROBLEMS

- 2.1 The required bandwidth for each CD-quality music channel is $44100 \text{ Hz} \times 2 \times 16 \text{ bits} = 1,411,200 \text{ bps}$. Assuming that no other traffic is carried on the same network, seven CD-quality music channels can be transmitted simultaneously.
- 2.2 a. $16 \text{ bits/smp} \times 44100 \text{ smp/sec} \times 1 \text{ sec/channel} \times 2 \text{ channels} = 1.41 \text{ MB}$
 $1.41 \text{ MB} \div 75 \text{ sectors} \div 8 \text{ bits/byte} = 2352 \text{ bytes/sector}$
b. $700 \text{ MB} \div 2352 \text{ bytes/sector} \div 75 \text{ sectors/second} \div 60 \text{ sec/min} = 69 \text{ minutes}$
c. $5 \text{ minutes} \times 60 \text{ sec/min} \times 75 \text{ sectors/second} \times 2352 \text{ bytes/sector} = 53 \text{ MB}$
Several types of media are available: high-density diskettes, zip disks, CD, USB drives, etc., although sector capacities may vary.
- 2.3 a. The required bandwidth for transmitting the 24 telephone channels is 1,536 Mbps.
b. For storing each of the 3-minute audio messages, 1,370 MB of data storage space are needed.
- 2.4 a. 5 bits ($2^5 = 32$)
b. 4 bits ($2^4 = 16$, this is one reason why hexadecimal is used)
c. 17 bits (The size of the set is $60 \times 60 \times 24 = 86,400$
 $2^{17} = 2 \times 65,536 = 131,072$)
d. 28 bits ($2^{10} \times 2^{10} \times 2^8 = 2^{28} = 1024 \times 1024 \times 256 = 268,435,456$)
e. 33 bits ($2^{10} \times 2^{10} \times 2^{10} \times 2^3 = 2^{32} \times 2 = 4.3 \times 10^9$)
Thus, for example, every person in the world can be individually identified with a string of 33 "1"s and "0"s.)
- 2.5 A 6-bit code allows only 64 unique characters to be defined. Several *shift lock codes* were defined in various versions of TTS (shift, supershift, unshift). These codes change the meaning of all codes that follow until a new shift lock code appears. Thus, with two shift locks, $3 \times (64 - 3) = 183$ different codes can be defined. The actual number is less, since some codes, such as space, are "don't-cares" with respect to shift locks.
- 2.6
- | | | | |
|----|--|----|--|
| a. | D = 0010001
d = 0010011
H = 0001001
h = 0001011 | b. | D = 00100011
d = 00100110
H = 00010011
h = 00010110 |
|----|--|----|--|
- All represented with the least significant bit first.
- 2.7 Carriage return, space, tabulation, form feed, line feed, separators.
- 2.8 Potential benefits include extended character sets, providing specialized symbol sets and internationalization via additional language support. Potential detriments include additional storage space, increase in system footprint and transmission bandwidth, as well as possible interfacing problems between distributed heterogeneous systems.

- 2.9** The file will be expanded by about 37%. Each 57 octets of the original file will result in an output string of 76 printable characters, plus 2 bytes (CR, LF) for indicating the line break.
- 2.10 a.** We allow one extra character per word for spaces and punctuation. Thus, the total number of characters is about $6.1 \times 44,000,000 = 268,400,000$ bytes, or 2.147 Gb.
- b.** Transmission time at 1.544 Mbps is $2,147/1.544 = 1391$ seconds or about 23 minutes. At 2.488 Gbps the transmission time is under a second.
- c.** The text (note we have not considered the pictures) would take less than one-half of a CD ($2.147/5 = 0.43$).
- 2.11 a.** The visual resolution of the resulting image is 2550×3300 .
- b.** In order to store the image as raw data, 8,415,000 bytes are needed.
- 2.12 a.** $2^{12} = 4096$ levels
- b.** $2048 \times 2048 \times 12 = 50,331,648$ bits
- c.** $(5 \times 50,331,648)/1,544,000 = 163$ seconds = 2 minutes 43 seconds
- d.** $(5 \times 50,331,648)/2 = 126$ Mbps
- e.** 4 times 126 Mbps = 503 Mbps.
- 2.13 a.** $700 \times 2^{20} = 700 \times 1,048,576 = 734,003,200$ bytes
 $= 5,872,025,600$ bits ≈ 5.872 Gb.
- b.** Data (text): $1000 \text{ pages} \times (9 \times 6) \text{ lines} \times (6.5 \times 10) \text{ char/line} \times 8 \text{ bits/char} = 28.1 \text{ Mb}$
 Images: $100 \times (1024 \times 768 \times 8) = 629.1 \text{ Mb}$
 Audio: $30 \text{ minutes} \times 60 \text{ seconds/minute} \times 16,000 \text{ samples/second} \times 6 \text{ bits/sample} = 172,800,000 = 172.8 \text{ Mb}$
 The total is 830 Mb, which corresponds to $5,872/830 \approx 7$ volumes per CD.
- c.** $830 \text{ Mb}/1.544 \text{ Mbps} = 537.6$ seconds ≈ 9 minutes
- d.** Data: $28.1/3 = 9.4 \text{ Mb}$
 Image: $629.1/10 = 62.9 \text{ Mb}$
 Audio: $172.8/2 = 86.4 \text{ Mb}$
 Total: 158.7 Mb or about 37 volumes on a CD.
 The transmission time would be $158.7/1.544 = 103$ seconds = 1 minute, 43 seconds.
- 2.14 a.** $25 \times 512 \times 512 \times 8 = 52.4 \text{ Mb}$
- b.** $30 \times 512 \times 512 \times 8 = 62.9 \text{ Mb}$
- c.** $25 \times 30 \times 512 \times 512 \times 8 = 1.6 \text{ Gb}$ for each study. A CD can hold $5/1.6 = 3.1$ studies.
- 2.15 a.** 1,440,000 bytes
- b.** 480,768 bytes are needed (480,000 bytes for the indices, plus 24 bits for each element in the color look-up table).
- c.** The compression ratio achieved by using CLUT encoding is almost 3 : 1.
- 2.16 a.** 18,432 Mbps
- b.** 264 MB

2.17 The old workstation won't display the video stream successfully, as it cannot decode and display a frame before the next one is due to be processed. The frame inter-arrival time is about 33 milliseconds ($1/30$ sec), while the time it takes the old workstation to decode and display each frame is about 56 milliseconds.

2.18 A sample solution is provided below, but any number are possible.

- a. 2 to 4 sec (+ \$1K)
- b. > 15 sec (+ \$0K)
- c. subsecond (+ \$2K)
- d. < 2 sec (+\$1.5K)
- e. decisecond (+\$2.5K)

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