SOLUTIONS MANUAL

BUSINESS DATA COMMUNICATIONS SEVENTH Edition

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Do Not Post on Web

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

ANSWERS TO QUESTIONS

1.1 (1) Networks make it easier to manage geographically dispersed operating locations. (2) They also help organizations deliver information to workers in a timely manner, including anytime-anywhere on a mobile device if necessary. (3) Networks improve communication and information management within and between business organizations. Good networks bring business partners closer together in ways that improve efficiency, customer service, agility, and innovation.

1.2 Communication traffic, both local (within a building or business campus) and long distance, has been growing at a high and steady rate for decades. Network traffic is no longer limited to voice and data and increasingly includes image and video. Increasing business emphasis on web services, remote access, online transactions, and social networking means that this trend is likely to continue.

   As businesses rely more and more on information technology, the range of services that business users desire to consume is expanding. For example, mobile broadband traffic growth is exploding as is the amount of data being pushed over mobile networks by business users' smart phones and tablets. In addition, over time, mobile users are increasingly demanding high quality services to support their high resolution camera phones, favorite video streams and high-end audio.

Four technology trends are particularly notable:
(1)   The trend toward faster and cheaper, both in computing and communications, continues.
(2)   Today's networks are more "intelligent" than ever.
(3)   The Internet, the Web, and associated applications have emerged as dominant features for both business and personal network landscapes.
(4)   While there has been a trend toward mobility for decades, the mobility explosion has occurred and has liberated workers from the confines of the physical enterprise.

1.3 Convergence refers to the merger of previously distinct telephony and information technologies and markets. The benefits include:
(1)   cost savings, through reduction in network management costs and through better use of existing resources;

(2) effectiveness, allowing companies to employ a more mobile workforce;

(3) transformation: converged IP networks can easily adapt to new functions and features as they become available through technological advancements without having to install new infrastructure.

1.4 A concept related to that of convergence is unified communications (UC). Whereas convergence focuses on the merger of fundamental voice, video, and data communications facilities and the resulting ability to support multimedia applications, UC focuses on the user perspective to the broad spectrum of business applications. Three major categories of benefits are typically realized by organizations that use UC:

(1) personal productivity gains, through effective use of presence information;

(2) workgroup performance gains, through real-time collaboration;

(3) enterprise-level process improvements: IP convergence enables UC to be integrated with enterprise-wide and departmental-level applications, business processes, and workflows.

1.5 Voice communications, data communications, image communications, and video communications are all found on networks.

1.6 Optical fiber transmission has become more common because of its high capacity and security characteristics.

1.7 Wireless transmission is becoming more common in business for much the same reason as it is for consumers: convenience and mobility.

1.8 Distributed data processing has become more common because of the widespread use of PCs, laptops, and mobile computing devices, the deployment of wireless LANs, and the push to support mobile workers.

1.9 Application software performs a specific function such as accounting while interconnection software ensures that all computers and terminals speak the same language and can be connected together.

1.10 There are several key distinctions between LANs and WANs.

(1) The geographic scope of the LAN is small, typically a single building or a cluster of buildings.

(2) It is usually the case that switches and communication equipment used to implement the LAN are owned by the same organization that owns the LAN-attached computing devices. For WANs, this is less often the case, with all or at least a significant

fraction of the WAN circuits and switching nodes are not owned by the business.

(3) The internal data rates of LANs are typically much greater than those of WANs. MANs are closer to LANs than WANs in terms of these distinctions.

ANSWERS TO PROBLEMS

1.1 Answers will vary. The grading rubric for the paper should ensure presence of acceptably accurate and complete definitions for each type of cloud services. The rubric should also include two or more examples of major providers for each cloud services category (e.g. for SaaS: SalesForce.com, NetSuite.com; for IaaS: Amazon EC2, OpSource, Rackspace; for PaaS: Amazon EC2, Google Apps, SAP).

1.2 Answers will vary. The grading rubric should ensure presence of acceptably accurate and complete URLs for at least three YouTube videos that focus on Unified Communications. It should also include sufficiently complete and compelling justification for the video selected as being best. It may include presence of rationale for why the other videos are not deemed to be the best.

1.3 Answers will vary. The grading rubric for the paper should ensure presence of acceptably complete descriptions of the business benefits derived by three or more organizations that have implemented UC. The rubric may include the presence of examples of benefits realized at personal, workgroup, and enterprise-wide levels.

1.4 Answers will vary. The grading rubric for the paper should ensure presence of acceptably complete descriptions of the business benefits derived by three or more organizations that have implemented IPTV and the business rationale underlying its implementation.

1.5 Answers will vary. The grading rubric for the paper should ensure presence of acceptably complete descriptions of Metro Ethernet and two or more MAN alternatives. The rubric may include the presence of both wireless and wired MAN alternatives.

1.6 Answers will vary. The rubric should include presence of two or more Web cam images including one for the student in the screenshots. It should also include at least one chat session window. It may require evidence of Skype or another well-known real time multimedia communication environment that combines voice, video, and chat.

CHAPTER 2 BUSINESS INFORMATION

ANSWERS TO QUESTIONS

2.1 A digital communication system uses a sequence of discrete, discontinuous values or symbols to represent information. Analog communication systems use a continuous signal to represent either continuous or discrete information sources; voltage may be used because it can take on a continuum of values to represent information.

2.2 Discrete information has a finite "alphabet." Examples include letters, numbers, icons, and binary data (which represent one of two states as "on or off," "yes or no," etc.). Continuous (analog) information sources include sounds, music, and video.

2.3 The audio signal's amplitude is sampled at a rate that is at least twice its maximum frequency. For voice of telephone quality, a sampling rate of 8000 samples per second is used. After sampling, the signal amplitudes are put in digital form, a process referred to as quantization. Eight bits per sample are usually used for telephone quality voice. The audio signal is considered "digitized" after each sample is converted to a fixed-length string of bits.

2.4 With **lossless compression**, receivers can reproduce an exact digital duplicate of the original data transmitted by the sender by expanding/decompressing the file that is received. When **lossy compression** is used, irreversible changes are made to original file that diminishes the quality of the original data when the receiver decompresses the file.

2.5 The **PBX** is an on-premises telephone switching facility. With a **hosted IP-PBX,** the switching, even between extensions in the same office, is done at the host's location. Another important difference is that voice over IP (VoIP) and other IP-based voice-oriented communication services is supported by an IP-PBX; an on-premises PBX may or may not support VoIP and IP-based voice communication services.

2.6 In the **International Reference Alphabet (IRA)** each character is represented by a unique 7-bit pattern; thus 128 different characters can be represented. **ACSII** is the IRA-based character set that is the most common format for English language text files. Text files, files saved with a .txt extension do not support formatting such as boldface, italics, or underline. **UTF-8 (the UCS [Universal Character Set] Transformation Format)-8** is an 8 bit code that is backward compatible with ASCII. Because it allows for variable-length encoding, which allows multiple bytes to be used to represent characters in an alphabet or character set, UTF-8 is capable of representing symbols and characters used in all the major languages spoken around the world. UTF-8 allows characters and symbols to be represented by one, two, three, or four bytes and is therefore capable of representing more than a million different characters or symbols. UTF-8 is the dominant character-encoding scheme on the World Wide Web. **Unicode** is another character-encoding scheme that is supported in numerous programming languages, including Java, Microsoft's .NET Framework, and XML. It is also supported by the operating systems used on most computing and communication devices. Unicode is a 16-bit code that is backward compatible with IRA/ASCII that, like UTF-8, allows for variable-length encoding.

2.7 Lossless compression algorithms are used for business data compression because it is critical for destination devices to receive exact duplicates of the characters and symbols transmitted by senders. These are also used for to compress business data for storage because exact duplicates of original business documents and data are needed to ensure compliance with regulatory requirements.

2.8 **Lempel-Ziv** encoding algorithms are the most widely used data compression schemes for both data storage and data communication over networks. For example, Lempel-Ziv algorithms are employed to "zip" files into compressed files/folders with .zip extensions that can be sent as attachments to e-mail message. **V.44** is an ISO standard for data compression that uses Lempel-Ziv encoding to compress a data stream being transmitted across a communication line.

2.9 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.

2.10 The most widely used format for compressing raster-scan images is referred to as **JPEG (Joint Photographic Experts Group)**. Both 8-bit grayscale and 24-bit color are supported and the JPEG standard is designed to be general purpose, meeting a variety of needs in such areas as desktop publishing, graphic arts, newspaper wire photo transmission, and medical imaging. JPEG is appropriate for high-quality images, including photographs and is widely used to encode photo images. Another format that is often seen on the Web is the **Graphics Interchange Format (GIF)**, an 8-bit color format that can display up to 256 colors; it is useful for non-photographic images with a fairly narrow range of color, such as company logos. **TIFF (.TIF)** files are widely used by commercial printers and publishers; it is a format of choice for storing/archiving important documents because it is excellent for high-resolution photographs and high-quality graphics, logos, line art, and documents when its lossless compression option is used. It supports 24-bit or 48-bit color and 8- or 16-bit grayscale. Relative to other image formats, .TIF files are very large; this essentially rules them out for use on Web pages because they can slow the download process. **PNG (Portable Network Graphics)** support the same color and grayscale ranges as TIFF. It uses lossless ZIP compression and like TIFF, it can be used to store or archive high-quality images of photographs, logos, graphics, documents, and master copies of data. PNG files on average are 25% smaller than TIF files.

2.11 PDF and Postscript are popular document formats for documents that include text and images. The **Portable Document Format (PDF)** is widely used on the Web, and PDF readers are available for virtually all operating systems. **Postscript** is a page-description language that is built into many desktop printers and virtually all high-end printing systems.

2.12 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.

2.13 **CRT** monitors are inherently analog devices that use an electron gun to "paint" pictures on the screen. The gun emits an electron beam that scans across the surface of the screen from left to right and top to bottom. For black-and-white television, the amount of illumination produced (on a scale from black to white) at any point is proportional to the intensity of the beam as it passes that point. Thus at any instant in time the beam takes on an analog value of intensity to produce the desired brightness at that point on the screen. Further, as the beam scans, the analog value changes. Thus the video image can be thought of as a time-varying analog signal. **Liquid crystal display (LCD)**

televisions and computer monitors, are better known as flat panel or flat screen monitors, are inherently digital devices. These screens use thin sandwiches of glass containing a liquid-crystal material to display images. Electric current causes the molecules of the liquid-crystal material to change their alignment to either block or transmit light and create images. Each pixel in LCD displays is composed of red, green, and blue subpixels. Because LCDs are digital devices, they fit well with digital video sources and transmission by helping to ensure that captured and transmitted images are received with no signal loss or corruption.

2.14 Digital video refers to the capture, manipulation and storage of video in digital formats. If an analog video camera signal is digitized and then transmitted or stored in a digital format, it may be considered digital video. However, the term is more typically applied to video content that is initially captured with a digital video device. Digital video cameras capture moving images digitally. In essence, this is done by taking a series of digital photographs, at a rate of at least 30 frames per second. Digital video cameras use either interlacing or progressive scan, in which all the lines of each frame are drawn in sequence. Progressive scan is used for computer monitors and most HDTV (high-definition television) schemes.

2.15 **Discrete cosine transform (DCT)** is the video compression algorithm that underlies JPEG, MPEG, and H.263 video file formats. It samples an image at regular intervals, analyzes the image's frequency components, and discards the frequencies that do not affect how the human eye would perceive the image.

2.16 The **MPEG (Motion Pictures Expert Group)** is an ISO/IEC working group that develops standards for digital audio and video formats. Several MPEG standards are widely used including: **MPEG-1** (for moving pictures and audio), **MPEG-2** (for digital television set top boxes and DVD compression), **MPEG-4** (for multimedia and Web compression).

2.17 **H.263** is an ITU standard for two-way video communication (video conferencing). It is one of the most important VTC standards and is widely supported in unified communications systems.

2.18 The time is takes for a system to respond to a given input.

2.19 Research suggests that workers are often more productive when response times are short. In general, 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 3 seconds or less to ensure user interest levels are kept high.

2.20 It used to be widely accepted that a response time of 2 seconds or less, was acceptable for most interactive applications because the person was thinking about the next task. However, it now appears that productivity increases as rapid response times are achieved. Normally, the response time for a business application should be as fast as possible. However, it is also important to ensure that the system does not react so fast that the user cannot keep up. For example, if the response to a user action is not displayed long enough for the user to read or react to, potential productivity gains from rapid response times cannot be realized. Today, if the application reacts in a tenth of a second (0.1 s) or less, the user perceives the system as reacting instantaneously. Users notice a delay of 1.0 second, but it is not enough to interrupt their flow of thought. Hence, response times between 0.1 and 1.0 second are good for interactive applications.

2.21 Determinants include: computer processing power in clients and servers, competing requirements, network traffic volumes, presence/absence of QoS mechanisms.

2.22 **Quality of Experience (QoE)** is a subjective measure of the user's perception of the overall value of the network application or service. QoE can be affected by the extent to which QoS is used to improve the performance and user engagement with the application or service. There are many network elements that can degrade the quality of the service as it is experienced by the end user including encoding processes, WAN infrastructure components, the business LAN or home network, and the user's computing device. Network elements that facilitate flexibility, security, cost, mobility, and personalization may contribute positively to QoE for users of a particular network application or service.

2.23 Throughput has numerous meanings within the business context including the productivity of a machine, process, system, or procedure over a given time period. In business networks, throughput is the average rate of message delivery over a communication channel or the network as a whole. It can be thought of as the total bandwidth capacity of a communications channel or network and can be measured in various ways including bits per second, bytes per second, or packets per second. Throughput can be affected by numerous factors including communication media, media access control protocols, switch and router capabilities, security mechanisms, network congestion, the configuration of end devices, and appropriate use of QoS mechanisms.

2.24 Growing reliance on converged networks to carry all categories of business applications (voice, data, image, and video) has made throughput an increasingly important factor in enterprise network design. Investment in network infrastructure and business software upgrades is often driven by the need for greater throughput, improved QoS, and perceived QoS (or QoE). Increased throughput can contribute to improved response times and enhanced worker productivity.

ANSWERS TO PROBLEMS

2.1 Answers will vary. The grading rubric should include presence of descriptions of IVR benefits realized by three or more businesses and the reasons why IVR was implemented. It should also include a general description of IVR use by businesses.

2.2 Answers will vary. The grading rubric should include identification of multiple IP-PBX capabilities and the business benefits of these capabilities. The rubric should also include presence of multiple new/future IP-PBX capabilities.

2.3 **a.** The required data rate for each channel is 8 (bits per sample) × 8000 (samples per second) = 64,000 bps.
b. The required data rate for transmitting the 24 telephone channels is 24 × 64,000 bps = 1.536 Mbps.
c. For storing each of the 3-minute audio messages, the data storage space needed is 180 s × 8000 smp/s × 1 byte/sample = 1,440,000 bytes = 1.37 MB

2.4 **a.** 5 bits ($2^5 = 32$)
b. 4 bits [$2^4 = 16$]
c. 8 bits [$2^8 = 256$]
d. 14 bits [$2^7 \times 2^7 = 2^{14} = 128 \times 128 = 16,384$]
e. 32 bits [$2^8 \times 2^8 \times 2^8 \times 2^8 = 2^{32} = 4,294,967,296 = 4.3 \times 10^9$].

2.5 B: 1000010
C: 1000011
D: 1000100
7: 0110111
e: 1100101

with odd parity:

B: 10000101
C: 10000110
D: 10001001
7: 01101110
e: 11001011

2.6 **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 51.84 Mbps, the transmission time is $2{,}147/51.84 = 41.42$ seconds; at 40 Gbps, the transmission time is $2.147/40 = .053$ seconds.

2.7 **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.

2.8 **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 sec.]
  d. $[5 \times 50{,}331{,}648)/2 = 126$ Mbps]
  e. $4 \times 126 = 503$ Mbps.

2.9 **a.** $25 \times 512 \times 512 \times 8 = 52.4$ Mb
  b. $30 \times 512 \times 512 \times 8 = 62.9$ Mb
  c. $25 \times 30 \times 512 \times 512 \times 8 = 1.6$ Gb for each study

2.10 **a.** $(800 \times 600 \times 24)/8 = 1{,}440{,}000$ 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.

2.11 **a.** $320 \times 240 \times 8 \times 30 = 18{,}432$ Mbps
  b. 264 MB

2.12 Answers will vary. The rubric should include presence of examples of business use of TVoIP and characteristics of necessary network infrastructure to support TVoIP. The rubric should include descriptions of how three or more specific business examples of TVoIP usage.

CHAPTER 3 DISTRIBUTED DATA PROCESSING

ANSWERS TO QUESTIONS

3.1 "Big data" refers to everything that enables an organization to create, manipulate, and manage very large data sets and the facilities in which these are stored. Data being captured and stored includes documents, e-mail messages, voice- mail messages, text messages, and social media data. Other data sources being captured, transmitted, and stored include Web logs, Internet documents, Internet search indexing, call detail records, scientific research data and results, military surveillance, medical records, video archives, and e-commerce transactions.

3.2 Continuing declines in storage costs, the maturation of data mining and business intelligence (BI) tools, and government regulations and court cases have caused organizations to stockpile large masses of structured and unstructured data. Data sets continue to grow with more and more being gathered by remote sensors, mobile devices, cameras, microphones, radio frequency identification (RFID) readers, and similar technologies.

3.3 A data center is a facility that houses computer systems and their associated components including storage and telecommunication systems. A data center can occupy a single room in a building, one or more floors, or an entire building. Much of the equipment inside a data center consists of servers mounted in rack cabinets that are placed in rows that form corridors (aisles) that enable people access to both the front and the rear of each cabinet. Because mainframe computers and storage devices can be comparable in size to the rack cabinets, they are placed alongside the racks. To ensure proper performance of the servers and computing equipment, air -conditioning is used to control temperature and humidity in the data center.

3.4 In a centralized architecture, the data processing for an application does not take place on the user's computing device. Instead, users transmit data to the centralized data processing facility where it is processed by applications running on the computers that are located there.