ANSWER KEYS

CHAPTER 1

NETWORKING: HOW WE GOT HERE

Test Your Understanding

1. Note: These questions will require you to use your imagination.

a) How do you think Senator Obama may have used his BlackBerry for e-mail during the campaign? Try to come up with concrete examples.

President Obama most likely used his BlackBerry to get his e-mail on demand and of course to respond quickly. He probably used his BlackBerry e-mailing function for scheduling, as well as notifying others and receiving information that would be helpful to him on the campaign, or immediate issues that needed to be addressed, such as at an upcoming town meeting, where he needed the information fast. Of course, he most likely also used it for personal reasons such as to keep in touch with family that was not with him on the campaign as well as his supporters

b) What non-email applications may he have run on his smart phone? How would he have used each?

News as well as weather and maybe even a game application like Bejeweled could be one of the many applications on his phone. He could have used news to get up-to-date information and weather to see forecasts for the area he is in.

c) What did Senator Obama have to know to use his BlackBerry?

He basically had to know how to use a phone and the function of the applications, but not how cellular telephony works.

d) What did he have to understand about how cellular telephony worked?

He most likely had to only understand that if he put in a telephone number, it would connect him to that telephone number.

e) How do you think he controlled who could call him?

First, he kept his number secret. In addition, he most likely had a call blocker and caller ID like anyone else who uses a phone and tries to keep people from calling them.

f) What would have happened if his mobile phone number had been published on a website?

His phone would have become compromised and he would probably have had a flood of calls and text messages, making him unable to keep using his phone. He would have had to get a new secret number.

g) After Senator Obama became president, he was told he could not use his BlackBerry any more. Why do you think that was the case?

It was most likely for security concerns as the information he received would not necessarily be screened and if someone was able to hack into his BlackBerry, national secrets would be at risk if anything important was kept on his phone. Also, calls could be intercepted and decrypted with the BlackBerry's commercial-grade but not NSA-grade security.

h) How do you think he got around this problem?

The Secret Service gave him a phone created by the National Security Agency.

2. a) Give the book's definition of *network*.

A system that permits networked applications on different hosts to work together.

b) What is a networked application?

A networked application is an application that requires a network in order to work.

c) What are Web 2.0 applications?

They are web applications in which viewers create content.

d) What are social media applications?

These are applications that facilitate the creation and maintenance of group relationships.

e) What is a host?

Any device connected to a network.

f) Is your laptop PC or desktop PC a host?

Yes, if it is connected to a network.

g) Is a mobile smart phone a host?

Yes.

h) Why is the network core shown as a cloud?

To emphasize that the user does not have to look inside the cloud to see how it works.

i) Why may the user need to know more about his or her access link than about the network core?

If the user needs to take any action regarding the network, it is likely to be regarding the access link.

3. a) Where is processing done in terminal–host communication?

The processing is done on a large central host computer serving terminal users.

b) In client/server processing?

Processing is done on both the server and client, as the server program on a server host provides services to a client program on a client host. An example is the Internet, where the browser is run on a client host, and a webserver program is run on a server host.

c) In P2P applications?

Processing is done mostly on client hosts.

d) What is the client/server request–response cycle?

It is when the client sends a request message to the server and the server sends back a response message. An example is when a browser sends a request for a web page to a server, and the server sends the web page or an error message.

e) What is cloud computing?

Cloud computing is when servers for internal corporate applications are managed by an outside company. This means that corporations don't have to maintain their own servers and possibly may not have to maintain their own applications either.

4. a) Are network speeds usually measured in bits per second or bytes per second?

Bits per second.

b) How many bits per second (without a metric prefix) is 20 kbps? Use commas.

20,000 bps.

c) How many bits per second (without a metric prefix) is 7 Mbps? Use commas.

7,000,000 bps.

d) How many bits per second (without a metric prefix) is 320 kbps? Use commas.

320,000.

e) Is the metric prefix for kilo k or K?

k.

5. a) In telephony, what is a circuit?

A circuit gives reserved capacity when making a telephone call between you and the other party you are calling.

b) What two types of circuits can corporations use to link terminals with hosts?

A leased line circuit and a dial-up circuit.

c) Compare and contrast these two types of circuits.

You only pay for a dial-up circuit when you use it, while a leased line circuit is always on, and thus you're always paying for it, regardless of use. On the other hand, a dial-up circuit has very low speeds, and if you are using a dial-up circuit, you cannot use the phone for voice conversations when on the Internet. On the other hand, a leased line circuit has much higher speeds of megabits instead of kilobits.

d) What is good about reserved capacity?

The good thing about reserved capacity is that no matter how many people are using the system, the data transmission speeds do not slow down.

e) What is bad about reserved capacity?

The negative thing about reserved capacity is that it is there, but you're not always using it, because data transmission is bursty, where there are bursts of traffic followed by no transmissions. Thus, you're basically wasting all of that unused reserved capacity when you read a web page after it has loaded.

f) What does it mean that data traffic is bursty?

It means that there are bursts of data transmissions followed by silences where there are no data transmissions. This is like when you load a web page and then go about browsing the page; during the browsing, there is no transmission.

g) Why is circuit switching very inefficient for bursty data traffic?

Circuits use reserved capacity, which means that when there is bursty data traffic, you are wasting all of the reserved capacity of the circuits.

6. a) How did analog telephone line signaling get its name?

It was called "analog" to reflect the fact that when voice loudness rises or falls, the electrical signal rises or falls analogously, and vice-versa.

b) Distinguish between analog and binary signaling.

Analog signals rise and fall smoothly, whereas binary transmission jumps abruptly between two states.

c) What is a state?

A state is a specific condition, such as a high or low voltage or on versus off.

d) How many states are there in binary signaling?

Two.

e) How many states are there in digital signaling?

A few (two or more, but not many).

f) Is all binary signaling digital signaling?

Yes, because two is a special case of few.

g) Is all digital signaling binary signaling?

No. Digital signaling can have more than two states.

h) Why does digital signaling give resistance to error?

Even if there is a change during propagation, if the change is not too great, the signal will be received correctly.

i) What does a modem do?

It converts outgoing binary computer signals into analog signals that can travel down the telephone system from the premises. It does the reverse for incoming signals.

j) Describe amplitude modulation briefly.

In amplitude modulation, a one is a loud sound, and a zero is a soft sound (or vice versa).

k) Why are clock cycles necessary in signaling?

The state is held constant during a clock cycle. At the end of a clock cycle, the state may remain the same or change.

If several ones or zeros in a row were sent, the state would not change. If there were no clock cycles, the receiver would not be able to know how many ones or zeros had been sent.

7. a) In packet switching, what does the source host do?

In packet switching, when the source host wants to send an application message to another host, it breaks the message into small segments and sends each in a separate message known as a packet.

b) About how long is a packet?

The average packet is about 100 bytes long.

c) Why is fragmentation done?

So that the parts of the original application message can fit into small packets.

d) Where is reassembly done?

On the destination host.

e) What is the benefit of multiplexing?

Multiple conversations can share the line capacity. This reduces the cost for each compared to having a reserved line.

f) Why is packet switching good for bursty data traffic?

Packet switching is good for bursty data traffic because it makes use of multiplexing. Thus bursty traffic only pays for the capacity it makes use of.

g) When a packet switch receives a packet, what decision does it make?

It makes a forwarding decision—deciding which port to send the packet back out.

h) Do packet switches know a packet's entire path through a network?

No. They only know what port to send the packet back out.

8. a) In Figure 1-11, how many physical links are there between the source host and the destination host along the indicated data link?

There are five physical links between the source and destination hosts.

b) How many data links are there between the source host and the destination host?

There is one data link, as it is the packet's entire path through the network.

c) If a packet passes through eight switches between the source and destination host, how many physical links would there be? (Careful!)

d) How many data links will there be?

There would be nine physical links and one data link.

9. a) On the ARPANET, explain the functions of IMPs.

IMPs were the packet switches of the ARPANET.

b) Explain the functions of NCPs.

They control each computer's communication with the network.

10. a) Why was the Network Working Group created?

Standards needed to be developed, and nobody was doing it.

b) What did it call its standards?

Requests for Comment (RFCs).

c) Why?

The group did not have a charter for developing standards, so the group, while designing the standards, decided not to call them standards.

11. a) How did Ray Tomlinson extend e-mail?

He extended e-mail from being a communication system among users of a single computer to being a communication system among users of many computers.

b) Why did he need the @ sign?

To separate the traditional username from the host name.

c) Why did Larry Roberts have to write a mail reading program?

Larry had to read all the email he received one by one, so he wrote an e-mail program to create a solution to his problem.

d) Why was ARPA initially concerned about e-mail?

ARPA thought that e-mail was very expensive and that publicity about e-mail on the ARPANET could be embarrassing.

12. What problem that Bob Kahn had led to the Internet?

He was funding several different types of networks and needed to have their users interconnected.

13. a) What device connects different networks into an internet?

Router.

b) What is the old name for this device?

Gateway.

14. a) Distinguish between *internet* with a lower-case i and *Internet* with an uppercase I.

The lowercase *internet* will refer to any internet and the internet layer, whereas the uppercase *Internet* will refer to the global Internet of today.

b) Why are many networking concepts duplicated in switched networks and internets?

Individual networks already existed. They had different technologies and addressing schemes. The only way to connect their users was to add a second level of networking, including messages, forwarding devices, and end-to-end paths.

c) What are the two levels of addresses?

Single network (data link) addresses.

IP addresses.

d) How long are IP addresses?

32 bits.

e) How are IP addresses usually expressed for humans?

In dotted decimal notation.

f) Distinguish between packets and frames.

Packets are messages at the internet layer.

Frames are messages at the data link layer.

g) A host transmits a packet that travels through 47 networks. How many packets will there be along the route?

One.

h) How many frames will there be along the route?

47.

i) Distinguish between switches and routers.

Switches are forwarding devices for frames at the data link layer.

Routers are forwarding devices for packets at the internet layer.

j) Distinguish between physical links, data links, and routers.

A physical link connects adjacent devices in a single network.

A data link is the path a frame takes through a single network.

A route is the path a frame takes through an internet.

k) Distinguish between what happens at the internet and transport layers.

The internet layer forwards a packet across routers from the source host to the destination host. The internet layer also governs packet organization.

The transport layer fragments and defragments application messages. It also checks for errors.

l) Why are application layer standards needed?

So that application programs can work together.

m) List the numbers and names of the five layers.

5. Application
4. Transport
3. Internet
2. Data Link
1. Physical

n) Are frames carried inside packets?

No. Packets are carried inside frames.

15. a) What are the roles of the Internet Protocol?

The Internet Protocol deals with addresses and functionality for routers to move packets across an internet.

b) What are the roles of the Transmission Control Protocol?

It places packets in order, corrects errors, and reduces the likelihood of congestion.

Also does fragmentation and defragmentation.

c) When would the User Datagram Protocol be used at the transport layer?

When an application cannot use error correction or does not need it.

16. What three networks were involved in the first test of the TCP/IP standards?

The ARPANET, PRNET, and SATNET.

17. a) In what sense is January 1, 1983, the birthday of the Internet?

On that day, NCP was ended and all hosts had to follow TCP/IP.

b) In what sense is it not?

Many hosts were already using TCP/IP.

18. When did Internet e-mail begin to interconnect with e-mail on other networks?

The Internet e-mail began to interconnect with e-mail on other networks during the 1970s.

19. a) What was the Acceptable Use Policy in place on the Internet before 1995?

The NSF ran the backbone. It forbade the use of commercial activities through the AUP.

b) Why did commercial activities on the Internet become acceptable in 1995?

They became acceptable because the NSF ended its support of the Internet.

c) What are the carriers that provide Internet service?

Internet service providers (ISPs).

d) Why do they need to be interconnected?

They need to be interconnected because the source and destination hosts may be on different ISPs.

e) At what locations do ISPs interconnect?

Network Access Points (NAPs).

f) Did e-commerce collapse after the dotcom failures of 2000 and 2001?

No. Although the bottom dropped out of dot-com stocks, e-commerce did not collapse. After one year of stagnant growth in the middle of a recession, e-commerce continued to grow very rapidly.

20. a) Distinguish between static and dynamic IP addresses.

A static IP address is one that does not change, whereas a dynamic IP address is one that is assigned by a DHCP for a client PC and does change.

b) What protocol provides a client PC with its dynamic IP address?

The Dynamic Host Configuration Protocol (DHCP).

c) What other configuration information does it provide?

Configuration information also includes the IP addresses of local Domain Name System servers, which we will see next.

It includes other information such as a subnet address mask, which we will see later in this book.

d) Why should PCs get their configuration information dynamically instead of manually?

Configuring each PC manually would be expensive, as would manual reconfiguration after every necessary change.

21. a) To send packets to a target host, what must the source host know?

The target host's IP address.

b) If the source host knows the host name of the target host, how can it get the target host's IP address?

It can ask a DNS host for the IP address associated with the host name.

22. Both DHCP servers and DNS servers send a host an IP address. These are the IP addresses of what hosts?

The DHCP server sends the requesting host an IP address that the requesting host will use as its IP address—not the IP address of the DHCP server.

The DNS server sends the requesting host the IP address of a target host (the host the requesting host wishes to communicate with)—not the IP address of the DNS server.

23. a) Distinguish between LANs and WANs.

A local area network exists within a company's site whereas a wide area network connects different sites within an organization or between them.

b) Why do you have more flexibility with LAN service than with WAN service? Why?

LANs are on your premises, so you can use whatever technology you wish.

If you use a carrier, you can only have what they offer.

c) What are rights of way?

Permissions to lay wires through public areas.

d) What are carriers?

Carriers are companies given rights of way by the government to lay wires in public areas and offer services to customers.

e) What is the advantage of using carriers?

When using a carrier, you don't need a large staff to maintain and operate a WAN.

24. Why are typical WAN speeds slower than typical LAN speeds? Give a clear and complete argument.

WANs cost more per bit to transmit than LANs because they must carry the signal farther.

As unit price goes up, unit demand usually goes down.

Therefore companies learn to live with lower WAN speeds.

25. a) Are LANs single networks or internets?

They can be either single networks or internets.

b) Are WANs single networks or internets?

They can be either single networks or internets.

26. a) List the hardware elements in the small home network described in this section.

Wireless access router, broadband modem, client PCs, and a printer.

b) For wired connections, what transmission medium is used?

4-pair unshielded twisted pair (UTP) wiring. (Or just UTP.)

c) What is its connector standard?

RJ-45.

d) What is the standard for wireless PCs and printers to connect to a wireless access point?

802.11.

e) What are the five hardware functions in a wireless access router?

Router, Ethernet switch, wireless access point, DHCP server, and network address translation (NAT).

f) Why is the DHCP function necessary?

Each internal client PC or network-ready printer needs an IP address. The DHCP function provides these.

g) Why is NAT necessary?

There must be translation between internal IP addresses assigned by the wireless access router and the single external IP address provided by the ISP. Network address translation (NAT) provides the translation.

h) Which devices need to be configured? (List them.)

All devices, including the client PCs, the network printer, and the wireless access point.

END-OF-CHAPTER QUESTIONS

Thought Questions

1. a) In Figure 1-11, when Host X transmits a packet along the data link shown, how many physical links are there along the way along the data link shown?

   5.

   b) How many data links?

   1.

2. a) In Figure 1-15 when the client host sends a packet to the server host, how many data links will there be along the way? (Assume that the packet will take the minimum number of router hops.)

   3.

   b) How many routes?

   1.

   c) How many packets?

   1.

   d) How many frames?

   3.

3. a) In Figure 1-16, how many physical links, data links, and routes are there when Host A sends a packet to Host B?

   7, 3, 1.

   b) When Host E sends to Host C? (Assume that hops will be minimized across switches and routers.)

   8, 3, 1.

   c) When Host D sends to Host E? (Assume that hops will be minimized across switches and routers.)

   3, 1, 1.

4. A host sends out a light flash in each clock cycle to represent data. Light flashes can be off, red, green, or blue.

   a) Is this digital signaling?

   Yes. There are a few states (4).

   b) Is it binary signaling?

   No. Binary signaling only has two states.

5. There are nine routers between Host R and Host S. a) How many data links will there be along the way when Host R transmits a packet to Host S? (Hint: Draw a picture.)

   10.

   b) How many routes?

   1.

   c) How many frames?

   10.

6. Why does it make sense to make only the transport layer reliable? This is not a simple question.

First, error correction only has to be done on the source and destination hosts—not on each router along the way.

Second, it is directly beneath the application layer, so wherever errors occur, the application program gets clean data.

7. a) What does it mean that data transmission is bursty?

There are brief transmission bursts separated by long silences.

b) Why is burstiness bad in circuit switching?

In circuit switching, you pay for the reserved circuit capacity whether you use it or not. In burstiness, you are not using it most of the time.

8. What layer fragments application messages so that each fragment can fit inside an individual packet?

The transport layer.

Case Study

A friend of yours wishes to open a small business. She will sell microwave slow cookers. She wishes to operate out of her house in a nice residential area. She is thinking of using a wireless LAN to connect her four PCs. What problems is she likely to run into? Explain each as well as you can. Your explanation should be directed to her, not to your teacher.

Student answers will vary. The goal of this question is not to get specific answers but to help students think through the matter.

She will need to purchase cable modem service or DSL service with sufficient speed.

She will need to have a wireless access router.

She will have to configure the router and the individual PCs.

<She should turn on security.>

Hands-On Exercises

1. a) What is 11001010 in decimal?

202

b) Express the following IP address in binary: 128.171.17.13. (*Hint:* 128 is 10000000. Put spaces between each group of 8 bits.)

10000000 10101011 00010001 00001101

c) Convert the following address in binary to dotted decimal notation: 11110000 10101010 00001111 11100011. (Spaces are added between bytes to make reading easier.) (*Hint:* 11110000 is 240 in decimal.)

240.170.15.227

2. a) What kind of connection do you have (telephone modem, cable modem, LAN, etc.)?

Student answers will vary.

b) What site did you use for your first test?

Student answers will vary.

c) What did you learn?

Student answers will vary.

d) What site did you use for your first test?

Student answers will vary.

e) What did you learn?

Student answers will vary.

3. Go to the command line. Clear the screen.

There is no answer to this part.

4. Use ipconfig/all or winipconfig. a) What is your computer's IP address?

Student answers will vary.

b) What is its Ethernet address?

Student answers will vary.

c) What is your default router (gateway)?

Student answers will vary.

d) What are the IP addresses of your DNS hosts?

Student answers will vary.

e) What is the IP address of your DHCP server?

Student answers will vary.

f) When you get a dynamic IP address, you are given a lease specifying how long you may use it. What is the starting time of your lease and the ending time?

Student answers will vary.

5. Ping a host whose name you know and that you use frequently. What is the latency? If this process does not work because the host is behind a firewall, try pinging other hosts until you succeed.

Student answers will vary.

6. Ping 127.0.0.1. Did it succeed?

Student answers will vary.

7. Do a tracert on a host whose name you know and that you use frequently. You can stop the tracert process by hitting Control-C.

a) What is the latency to the destination host?

Student answers will vary.

b) How many routers are there between you and the destination host? If this does not work because the host is behind a firewall, try reaching other hosts until you succeed.

Student answers will vary.

8. Distinguish between the information that ping provides and the data that tracert provides.

Ping determines if another host is reachable and provides latency to a destination host.

Tracert does this too: in addition, it identifies each router along the way and gives the latency to each router.

9. Find the IP address for Microsoft.com and Apple.com.

These vary over time. In addition, each has multiple webservers, so different students will get different answers.

10. a) Look up RFC 1149.

There is no answer to this part.

b) In layperson's terms, what does this RFC specify?

RFC1149 is the standard for the transmission of IP datagrams on Avian Carriers—in other words, using carrier pigeons to carry packets.

c) What are its sections? (This is a serious question. You should learn how RFCs are structured.)

Title

RFC Number, Date

Status of this Memo

Overview and Rational

Frame Format

Security Considerations

Author's Address

d) On what day was it created?

RFC1149 was created on April Fool's Day in 1990, and its latest edition was created nine years later on the same day (1 April 1999).

Perspective Questions

1. What was the most surprising thing you learned in this chapter?

Student answers will vary.

2. What was the most difficult part of this chapter for you?

Student answers will vary.

CHAPTER 2

NETWORK STANDARDS

Test Your Understanding

1. a) Give the definition of network standards that this chapter introduced.

   Network standards are rules of operation that govern the exchange of messages between two hardware or software processes. This includes message semantics, syntax, message order, reliability, and connection orientation.

   b) In this book, do *standards* and *protocols* mean the same thing?

   Yes.

2. a) What three things about message exchanges did we see in this section?

   Message order, semantics, and syntax.

   b) Give an example not involving networking in which the order in which you do things can make a big difference.

   Answers will vary.

   Example: Installing a printer on a computer (when to power it on, etc.).

   c) Distinguish between syntax and semantics.

   Syntax governs the organization of messages.

   Semantics defines the meaning of messages.

3. a) Describe the simple message ordering in HTTP.

   The client sends a request.

   The server sends a response.

   b) In HTTP, can the server transmit if it has not received a request message from the client?

   No.

   c) Describe the three-way handshake in TCP connection openings.

   The initiating host sends a SYN segment indicating that it wants a connection.

   The other host sends a SYN/ACK segment to acknowledge the SYN and to indicate that it is willing to open a connection.

   The initiating host sends an ACK segment to acknowledge the SYN/ACK. The connection is now open.

   d) What kind of message does the destination host send if it does not receive a segment during a TCP connection?

   None.

   e) What kind of message does the destination host send if it does it receive a segment that has an error during a TCP connection?

   None. (It simply drops the segment.)

   f) Under what conditions will a source host TCP process retransmit a segment?

   If it has not received an acknowledgement after a preset delay.

g) Describe the four-way handshake in TCP connection closes.

The side initiating the close sends a TCP FIN segment.

The other side transmits a TCP ACK segment to acknowledge the FIN segment.

Immediately or later, the other side sends a FIN.

The side that initiated the close sends back an ACK.

The connection is now closed.

h) After a side initiates the close of a connection by sending a FIN segment, will it send any more segments? Explain.

Yes. It will send ACK segments if the other side transmits segments.

4. a) What are the three general parts of messages?

The three general parts of messages are the header, the data field, and the trailer.

b) What does the data field contain?

The data field contains the content being delivered by the message.

c) What is the definition of a header?

The header is everything that comes before the data field.

d) Is there always a data field in a message?

No, there is not always a data field in a message.

e) What is the definition of a trailer?

The trailer is everything that comes after the data field.

f) Are trailers common?

No, trailers are not common.

g) Distinguish between headers and header fields.

The header is everything that comes before the data field. A header field is a subdivision of the header.

h) Distinguish between octets and bytes.

The two terms mean the same thing.

5. a) Why is Ethernet transmission called synchronous transmission?

It is called synchronous transmission because the senders' and receivers' clocks must be precisely synchronized for the receiver to read the message.

b) How long are Ethernet MAC addresses?

48 bits long.

c) What devices read Ethernet destination MAC addresses?

Switches. (Also the destination host, to see if the frame is addressed to it.)

d) In what field is the IP address stored?

The data field.

e) If the receiver detects an error on the basis of the value in the Frame Check Sequence field, what does it do?

It discards the frame. There is no retransmission.

f) Ethernet does error detection but not error correction. Is Ethernet a reliable protocol? Explain.

No. To be a reliable protocol, a protocol must correct errors, not simply detect them.

6. a) How many octets long is an IP header if there are no options? (Look at Figure 2-10.)

If there are no options, the IP header will be 20 octets.

b) List the first bit number on each header row in Figure 2-10, not including options. Remember that the first bit in Row 1 is Bit 0.

0, 32, 64, 96, and 128.

c) What is the bit number of the first bit in the destination address field? (Remember that the first bit in binary counting is Bit 0.)

128. <The first bit on each line is 0, 32, 64, 96, and 128.>

d) How long are IP addresses?

IP addresses are 32 bits long.

e) You have two addresses: B7-23-DD-6F-C8-AB and 217.42.18.248. Specify what kind of address each address is.

B7-23-DD-6F-C8-AB is an Ethernet address.

217.42.18.248 is an IP address.

f) What device in an internet besides the destination host reads the destination IP address?

Each router along the way reads the destination IP address.

g) What is this device's purpose in doing so?

The router reads the IP address in order to learn how to forward the IP packet to the next router or to the destination host itself.

h) Is IP reliable or unreliable?

IP is unreliable.

7. a) Why is TCP complex?

The Transmission Control Protocol (TCP) is complex because it is meant to handle complex internetworking management tasks that the simply designed IP cannot handle.

b) Why is it important for networking professionals to understand TCP?

It is important for networking professionals to understand TCP because they will have to use TCP to deal with more complex internetworking management tasks.

c) What are TCP messages called?

TCP messages are called TCP segments.

8. a) Why are sequence numbers good?

Sequence numbers are good because they allow the receiving transport process to put arriving TCP segments in order if IP delivers them out of order.

b) What are 1-bit fields called?

Flag fields.

c) If someone says that a flag field is set, what does this mean?

If someone says that a one-bit flag is set, this means that it is given the value 1.

d) If the ACK bit is set, what other field must have a value?

If the ACK bit is set, the acknowledgement number field value must be filled in, to indicate which TCP segment is being acknowledged.

e) What is the purpose of the acknowledgement number field?

To indicate which segment that was sent earlier the segment containing the acknowledgement number field is acknowledging.

9. a) What are the four fields in a UDP header?

The four fields in a UDP header are the two port number fields, the length field, and the header checksum field.

b) Describe the third.

The length field gives the length of the UDP datagram.

c) Describe the fourth.

The header checksum field allows the receiver to check for errors. If an error is found, the UDP datagram is discarded.

d) Is UDP reliable? Explain.

No. It does error detection but not error correction.

10. a) What message types have port numbers?

TCP segments and UDP datagrams.

b) What are a server's port numbers associated with?

Application programs.

c) What kind of port numbers do well-known applications usually get?

Well-known port numbers.

d) What is the well-known port number for HTTP?

80.

e) What is the well-known port number for SMTP e-mail applications?

25.

f) What are the well-known port numbers for FTP file transfer applications?

20 and 21.

11. a) Is the application layer standard always HTTP?

No, the application layer standard is not always HTTP.

b) Which layer has the most standards?

The application layer.

c) At which layer would you find standards for voice over IP? (The answer is not explicitly in this section.)

Voice over IP is an application, so one would expect to find standards for VoIP at the application layer.

d) Are all application layer standards simple like HTTP?

No. Many applications are more complex.

e) In HTTP response headers, what is the syntax of most lines (which are header fields)?

They consist of a keyword, a colon, and the value for the keyword.

f) In HTTP request and response message headers, how is the end of a field indicated?

With a carriage return/line feed, which starts a new line.

g) Do HTTP request messages have headers, data fields and trailers?

No, they just have headers. They do not have data fields or trailers.

h) Do HTTP response messages that deliver files have headers, data fields and trailers?

No, they just have headers and data fields.

They do not have trailers.

12. a) What is encoding?

Converting application message content into bits.

b) At what layer is encoding done?

The application layer.

13. a) Explain how many bytes will it take to transmit "Hello World!" without the quotation marks. (The correct total is 12.)

Component	Length
Hello	5
Space	1
World	5
!	1
Total	12

b) If you go to a search engine, you can easily find converters to represent characters in ASCII. What are the 7-bit ASCII codes for "Hello!" without the quotation marks? (Hint: H is 1001000.)

H	1001000
e	1100101
l	1101100
l	1101100
o	1101111
!	0100001

14. a) Does binary counting usually begin at 0 or 1?

0.

b) Give the binary representations for 13, 14, 15, 16, and 17 by adding one to successive numbers (12 is 1100).

13: 1101

14: 1110

15: 1111

16: 10000

17: 10001

15. a) If a field is *N* bits long, how many alternatives can it represent?

2^N

b) How many alternatives can you represent with a 4-bit field?

$2^4 = 16$

c) For each bit you add to an alternatives field, how many additional alternatives can you represent?

Twice as many.

d) How many alternatives can you represent with a 10-bit field? (With 8 bits, you can represent 256 alternatives.)

$2^8 = 256$ and $2^9=512$, so $2^{10}=1{,}024$.

e) If you need to represent 128 alternatives in a field, how many bits long must the field be?

7 ($2^7=128$)

f) If you need to represent 18 alternatives in a field, how many bits long must the field be?

4 bits can only encode 16 alternatives, so 4 bits is not enough.

5 bits can represent 32 alternatives; this is sufficient.

g) Come up with three examples of things that can be encoded with 3 bits.

With three bits, there can be 8 possibilities. Student answers will vary. Examples include: Points on a six-sided star, 5 to 8 priority levels, the names of the 7 continents, and the days of the week.

16. a) What is encapsulation?

Encapsulation is placing a message in the data field of another message.

b) Why is encapsulation necessary for there to be communication between processes operating at the same layer but on different hosts, routers, or switches?

The fact that two processes other than physical layer processes cannot communicate directly requires the use of encapsulation.

c) After the internet layer process in Figure 2-17 receives the TCP segment from the transport layer process, what two things does it do?

The internet layer process encapsulates the TCP segment in the data field of an IP packet and passes the IP packet down to the data link layer process.

d) After the data link layer process in Figure 2-17 receives the IP packet from the internet layer process, what two things does it do?

The data link layer process encapsulates the IP packet in the data field of a frame and passes the IP packet down to the physical layer process.

e) After the physical layer process receives a frame from the data link layer process, what does the physical layer process do?

It does not do encapsulation. It turns the bits of the frame into signals.

f) If encapsulation occurs on the source host, what analogous process will occur on the destination host? (The answer is not in the text.)

Decapsulation.

17. a) What does a network standards architecture do?

Network standards architectures break the standards functionality needed for communication into layers and define the functions of each layer.

b) In what order are standards and standards architectures developed?

The standards architecture is developed first. Then individual standards are developed that fit the architecture.

c) What are the two dominant network standards architectures?

The two dominant network standards architectures are OSI and TCP/IP.

d) What is the dominant network standards architecture in most real firms today?

The hybrid TCP/IP–OSI architecture.

e) Are the two network standards architectures competitors?

No. Although OSI and TCP/IP sometimes are viewed as competitors, they actually work together in most corporate networks.

18. a) What standards agencies are responsible for the OSI standards architecture? Just give the acronyms.

The standards agencies responsible for the OSI standards architecture are the International Organization for Standardization (ISO) and the International Telecommunications Union–Telecommunications Standards Sector (ITU-T).

b) At which layers do OSI standards dominate usage?

OSI is dominant at the physical and data link layers.

c) Name and describe the functions of OSI Layer 5.

OSI Layer 5 is the OSI session layer. It initiates and maintains a connection between application programs on different computers. It is especially good for database applications. If communication fails during a transaction, the entire transaction does not have to be done over—only the work since the last rollback point.

d) Name and describe the intended use of OSI Layer 6.

OSI Layer 6 is the OSI presentation layer. It is designed to handle data formatting differences between two computers, as well as compression and encryption.

e) How is the OSI presentation layer actually used?

The OSI presentation layer is actually used as a category for data file formats.

f) Beginning with the physical layer (Layer 1), give the name and number of the OSI layers.

1. Physical
2. Data link
3. Network
4. Transport
5. Session
6. Presentation
7. Application

19. a) Which of the following is an architecture: TCP/IP, TCP, or IP?

TCP/IP is an architecture.

b) Which of the following are standards: TCP/IP, TCP, or IP?

TCP and IP are standards.

c) What is the standards agency for TCP/IP?

The standards agency for TCP/IP is the Internet Engineering Task Force (IETF).

d) Why have this agency's standards been so successful?

IETF TCP/IP standards have been successful because they tend to be simple standards that can be implemented quickly and inexpensively. (Not primarily because of the use of these standards on the Internet.)

e) What are most of this agency's documents called?

Most of this agency's documents are called requests for comment (RFCs).

f) At which layers is TCP/IP dominant?

TCP/IP is dominant at the internet and transport layers.

g) How dominant is TCP/IP today at these layers compared with OSI's dominance at the physical and data link layers?

TCP's dominance at these layers is not as universal as OSI's dominance at the physical and data link layers.

20. a) Is any standards architecture dominant at the application layer?

No standards architecture is dominant at the application layer, although IETF protocols are widely used.

b) Do almost all applications, regardless of what standards architecture they come from, run over TCP/IP standards at the internet and transport layers?

Yes.

21. a) What layers of the hybrid TCP/IP–OSI standards architecture use OSI standards?

The physical and data link layers of the hybrid TCP/IP–OSI standards architecture use OSI standards.

b) What layers use TCP/IP standards?

The internet and transport layers primarily use TCP/IP standards.

c) Do wireless LAN standards come from OSI or TCP/IP? Explain. (The answer is not explicitly in this section.)

Wireless LAN standards come from OSI because wireless LANs are single networks.

d) Do switched WAN standards come from OSI or TCP/IP? Explain. (Again, the answer is not explicitly in this section.)

Switched WAN standards come from OSI because WANs are single switched networks even if they are very large.

22. a) Under what circumstances might you encounter IPX/SPX standards?

You might encounter IPX/SPX standards if Novell NetWare servers are being used.

b) SNA standards?

You might encounter SNA standards if IBM mainframe computers were communicating over the network.

c) AppleTalk standards?

You might encounter AppleTalk standards if Apple Macintoshes were communicating over the network.

End-of-Chapter Questions

Thought Questions

1. How do you think TCP would handle the problem if an acknowledgement were lost, so that the sender retransmitted the unacknowledged TCP segment, therefore causing the receiving transport process to receive the same segment twice?

   Both segments would have the same sequence number. The receiving transport process would realize this and drop the duplicate.

2. a) In Figure 2-12, what will be the value in the destination port number field if a packet arrives for the e-mail application?

   25.

   b) When the HTTP program sends an HTTP response message to a client PC, in what field of what message will it place the value 80?

   It will place the value 80 in the source port number field of the TCP segment contained in the transmitted packet.

3. Binary for 47 is 101111. Give the binary for 48, 49, and 50.

   48: 110000

   49: 110001

   50: 110010

4. You need to represent 1,026 different city names. How many bits will this take if you give each city a different binary number?

   10 bits can represent 1,024 cities.

   11 bits can represent 2,048 cities.

   10 bits is not enough. We must use 11 bits.

Brain Teaser Questions

If you can get these, that's impressive; but it's not expected.

1. How can you make a connectionless protocol reliable? (Try to answer this one, but you may not be able to do so.)

   You do not have sequence and acknowledgement numbers.

   So you have to send one message, then stop and wait for an acknowledgement before sending the next messages.

   This is very slow compared with being able to send many messages before getting acknowledgements, as TCP can do.

2. Spacecraft exploring the outer planets need reliable data transmission. However, the acknowledgements would take hours to arrive. This makes an ACK-based reliability approach unattractive. Can you think of another way to provide reliable data transmission to spacecraft? (Try to answer this one, but you may not be able to do so.)

   Spacecraft transmission uses forward error correction, in which messages are sent with redundant bits. There is enough redundancy in messages to allow the receiver to correct most errors during transmission.

<FEC also is used in wireless LAN transmission because of the high error rates in wireless transmission.>

Perspective Questions

1. What was the most surprising thing you learned in this chapter?

   Student answers will vary.

2. What was the most difficult material for you in this chapter?

   Student answers will vary.