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.