4.5 RECOMMENDED READINGS AND WEB SITES

[STAL04] provides a detailed description of the TCP/IP model and of the standards at each layer of the model. A very useful reference work on TCP/IP is [RODR02], which covers the spectrum of TCP/IP-related protocols in a technically concise but thorough fashion.


Recommended Web Sites:
- **Networking Links**: Excellent collection of links related to TCP/IP
- **IPv6**: Information about IPv6 and related topics

4.6 KEY TERMS, REVIEW QUESTIONS AND PROBLEMS

Key Terms

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<th>Application Layer</th>
<th>Internetworking</th>
<th>Service Access Point (SAP)</th>
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<td>Checksum</td>
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<td>Frame Check Sequence (FCS)</td>
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Review Questions

4.1 What is the major function of the network access layer?
4.2 What tasks are performed by the transport layer?
4.3 What is a protocol?
4.4 What is a protocol data unit (PDU)?
4.5 What is a protocol architecture?
4.6 What is TCP/IP?
4.7 What are some advantages to layering as seen in the TCP/IP architecture?
4.8 What is a router?
Problems

4.1 Using the layer models in Figure 4.9, describe the ordering and delivery of a pizza, indicating the interactions at each level.

4.2 a. The French and Chinese prime ministers need to come to an agreement by telephone, but neither speaks the other's language. Further, neither has on hand a translator that can translate to the language of the other. However, both prime ministers have English translators on their staffs. Draw a diagram similar to Figure 4.9 to depict the situation, and describe the interaction and each level.

   b. Now suppose that the Chinese prime minister's translator can translate only into Japanese and that the French prime minister has a German translator available. A translator between German and Japanese is available in Germany. Draw a new diagram that reflects this arrangement and describe the hypothetical phone conversation.

4.3 List the major disadvantages with the layered approach to protocols.

4.4 Two blue armies are each poised on opposite hills preparing to attack a single red army in the valley. The red army can defeat either of the blue armies separately but will fail to defeat both blue armies if they attack simultaneously. The blue armies communicate via an unreliable communications system (a foot soldier). The commander with one of the blue armies would like to attack at noon. His problem is this: If he sends a message to the other blue army, ordering the attack, he cannot be sure it will get through. He could ask for acknowledgment, but that might not get through. Is there a protocol that the two blue armies can use to avoid defeat?

4.5 A broadcast network is one in which a transmission from any one attached station is received by all other attached stations over a shared medium. Examples are a bus-topology local area network, such as Ethernet, and a wireless radio network. Discuss the need or lack of need for a network layer (OSI layer 3) in a broadcast network.

4.6 Among the principles used by ISO to define the OSI layers were
   - The number of layers should be small enough to avoid unwieldy design and implementation but large enough so that separate layers handle functions that are different in process or technology.
   - Layer boundaries should be chosen to minimize the number and size of interactions across boundaries.

   Based on these principles, design an architecture with eight layers and make a case for it. Design one with six layers and make a case for that.

4.7 In Figure 4.2, exactly one protocol data unit (PDU) in layer \( N \) is encapsulated in a PDU at layer \( (N - 1) \). It is also possible to break one \( N \)-level PDU into multiple \( (N - 1) \)-level PDUs (segmentation) or to group multiple \( N \)-level PDUs into one \( (N - 1) \)-level PDU (blocking).
a. In the case of segmentation, is it necessary that each \((N - 1)\)-level segment contain a copy of the \(N\)-level header?

b. In the case of blocking, is it necessary that each \(N\)-level PDU retain its own header, or can the data be consolidated into a single \(N\)-level PDU with a single \(N\)-level header?

4.8 A TCP segment consisting of 1500 bits of data and 160 bits of header is sent to the IP layer, which appends another 160 bits of header. This is then transmitted through two networks, each of which uses a 24-bit packet header. The destination network has a maximum packet size of 800 bits. How many bits, including headers, are delivered to the network layer protocol at the destination?

4.9 Why is UDP needed? Why can’t a user program directly access IP?

4.10 IP, TCP, and UDP all discard a packet that arrives with a checksum error and do not attempt to notify the source. Why?

4.11 Why does the TCP header have a header length field while the UDP header does not?

**APPENDIX 4A  INTERNET PROTOCOL**

Within the TCP/IP protocol suite, perhaps the most important protocol is the Internet Protocol (IP). The version that has been used for decades is known as IPv4. Recently, a new version, IPv6, has been standardized, although it is not yet widely deployed.

**IPv4**

Figure 4.10a shows the IPv4 header format, which is a minimum of 20 octets, or 160 bits. The fields are as follows:

- **Version (4 bits):** Indicates version number, to allow evolution of the protocol; the value is 4.

- **Internet Header Length (IHL) (4 bits):** Length of header in 32-bit words. The minimum value is five, for a minimum header length of 20 octets.

- **DS/ECN (8 bits):** Prior to the introduction of differentiated services, this field was referred to as the **Type of Service** field and specified reliability, precedence, delay, and throughput parameters. This interpretation has now been superseded. The first 6 bits of the TOS field are now referred to as the DS (differentiated services) field. The DS field supports a quality-of-service (QoS) capability for the Internet. The remaining 2 bits are reserved for an ECN (explicit congestion notification) field, which provides congestion control functionality for the Internet.

- **Total Length (16 bits):** Total IP packet length, in octets.

- **Identification (16 bits):** A sequence number that, together with the source address, destination address, and user protocol, is intended to identify a packet uniquely. Thus, the identifier should be unique for the packet’s source address, destination address, and user protocol for the time during which the packet will remain in the Internet.

- **Flags (3 bits):** Only two of the bits are currently defined. When a packet is fragmented, the More bit indicates whether this is the last fragment in the original packet.