School of Computing and Information Systems
COMP30023: Computer Systems

Workshop Week 11 and 12

Tutorial / Theory

(A) Network Layer IP

1. Assuming that all routers and hosts are working properly and that all software in both is free of all errors, is there any chance, however small, that a packet will be delivered to the wrong destination?

2. The IP packet header includes a time-to-live field that is decremented by each router along the path. Why is the time-to-live field necessary?

3. Consider sending a 1500-byte datagram into a link that has an *Maximum Transmission* Unit of 500 bytes. Suppose the original datagram is stamped with the identification number 1. Assume that IPv4 is used. Hint: The IPv4 header is 20 bytes long.

   i. Where does fragmentation happen? Where are the fragments reassembled?

   ii. How many fragments are generated?

   iii. In addition to the identification number, what are the fields in the generated IP datagram(s) that are related to fragmentation?

   iv. What are the values of the fragmentation-related fields in the generated IP datagram(s)?

4. What changes if IPv6 were used?
   Suppose that instead of using 16 bits for the network part of a class B address originally, 20 bits had been used. How many class B networks would there have been?

5. A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts that it can handle?

6. Suppose an ISP owns the block of addresses of the form 101.101.128.0/17. Suppose it wants to create four subnets from this block, each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?

(B) Socket Programming

1. Is the following statement true or false?

   With UDP sockets, a server can easily determine the IP address of the client, from the data returned via a socket read.

   Briefly explain your answer.

   Answer the same question (true or false?) for TCP sockets.

2. What is the purpose of the connection-oriented welcoming socket, which the server uses to perform an `accept()`? Once the `accept()` is done, does the server use the welcoming socket to communicate back to the client? Explain your answer.

(C) Transport Layer

1. Indicate whether TCP or UDP (or both or neither) provide the following services to applications:

   (a) Reliable data transfer between processes.

   (b) Minimum data transmission rate between processes.

   (c) Congestion-controlled data transfer between processes.

   (d) A guarantee that data will be delivered within a specified amount of time.

   (e) Preserve application-level message boundaries. That is, when a sender sends a group of bytes into a socket via a single send operation, that group of bytes will be delivered as a group in a single receive operation at the receiving application.

   (f) Guaranteed in-order delivery of data to the receiver.

2. Suppose you use UDP to do a transaction from a remote client to a server. UDP provides no reliability, but you want your transaction request to be sent reliably. How could you do is?

3. Why does UDP exist? Would it not have been enough to just let the user processes send raw IP packets?

4. Both UDP and TCP use port numbers to identify the destination entity when delivering a message. Given two reasons for why these protocols invented a new abstract ID (port numbers), instead of using process IDs, which already existed when these protocols were designed?

5. TCP provides reliable end-to-end data transmission over an unreliable network layer. What do the terms *reliable* and *unreliable* mean in this context?

   In your answer, you should clearly differentiate between the functionality provided in each of the corresponding layers in the protocol hierarchy.

(D) Transport Layer

1. What is meant by a *handshaking protocol*? Use an example to illustrate your answer.

2. Review the fields in the TCP, UDP, and IP headers. Briefly describe the role of the "important fields" from each of the headers. (I know "important fields" is ambiguous .... but my objective is to get you to think about the Wireshark tasks from the lab).

3. **A multiple choice question:**

   Host A sends a TCP segment (Seq = 43, ACK = 103), to which host B replies with a TCP segment (Seq = 103, ACK = 57). The payload of the first TCP segment is

   (a) 14 bytes long
   (b) 43 bytes long
   (c) 46 bytes long
   (d) 57 bytes long
   (e) 60 bytes long

4. Datagram fragmentation and reassembly are handled by IP and are invisible to TCP. Does this mean the TCP does not have to worry about data arriving in the wrong order? Justify your answer.

5. The maximum payload of a TCP segment is $65,495$ bytes. Why was such a strange number chosen?

6. TCP and UDP provide two very different service models. Suppose that an application wants all of the functionality provided by UDP but only some of the functionality provided by TCP (e.g., the application wants reliable message transfer and flow control, but not congestion control). How would an application get this different service in todays Internet?

7. Explain the concepts of slow start, fast retransmit and fast recovery in TCP and their effects on TCP performance.

(E) Network Layer

1. The IP packet header includes a time-to-live field that is decremented by each router along the path. Why is the time-to-live field necessary?

2. A router has the following entries in its routing table:

Address/mask	Next hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
192.53.40.0/23	Router 1
default	Router 2

   For each of the following IP addresses, what does the router do if a packet with that address arrives? a) 135.46.63.10, b) 135.46.57.14, c) 135.46.52.2, d) 192.53.40.7, e) 192.53.56.7

3. List one motivation for a host to send an IP packet with the wrong source IP address. List two ways that this can adversely affect the legitimate owner of that IP address.

(F) Application Layer

1. Does a DNS server for a domain have to be on the same network as the hosts whose names it resolves?
2. DNS uses UDP instead of TCP. If a DNS packet is lost, there is no automatic recovery. Does this cause a problem, and if so, how is it resolved?
3. Describe the basic operation of a Web server using high-level pseudocode. It is sufficient to show this basic operation for only the case of HTTP GET.
4. The standard HTTP URL assumes that the Web server is listening on port 80. However, it is possible for a Web server to listen on some other port. Devise a reasonable syntax for a URL accessing a file on a nonstandard port.
5. Many Web browsers open several TCP connections in parallel when downloading multiple embed-ded images. How does this affect the other TCP traffic sharing the same congested link?
6. Web caches are often justified on the ground that they speed up web browsing and reduce band-width costs, but sometimes they do not work well. Provide reasons why a bad web cache might not be a good investment for an organization.