

EE3009 Data Communications and Networking

Quiz 1 (Solution)

Semester A, 2015/16

1. Physical, data link, network, transport, session, presentation, application. Network layer is responsible for routing.
2. TCP connection setup is based on the following three-way handshake:
 - a) First, a client initiates a connection by sending a SYN packet to a server. The sequence number is initialized.
 - b) Next, the server replies with a SYN-ACK message. The sequence number of the other direction is initialized.
 - c) Last, the client sends ACK message to complete the setup procedure. In this ACK packet, data can also be sent.
3. The statement is incorrect. Because there is propagation delay, a sender may fail to sense a transmission that has started.

4. $N = p \cdot q = (17) \cdot (5) = 85$

$$31^2 \bmod 85 = 26$$

$$31^4 \bmod 85 = 81$$

$$31^8 \bmod 85 = 16$$

$$31^{16} \bmod 85 = 1$$

$$31^{32} \bmod 85 = 1$$

$$c = 31^{61} \bmod 85 = (31^{32})(31^{16})(31^8)(31^4)(31) \bmod 85$$

$$= (1)(1)(16)(81)(31) \bmod 85 = 56$$

5.

- a) Throughput of node B = $0.4p$. It is maximized by $p = 1$.
- b) Total throughput = $0.6(1-p) + 0.4p = 0.6 - 0.2p$. It is maximized by $p = 0$.
- c) $0.6(1-p) = 0.4p$, which implies that $p = 0.6$.

6. Maximum size of each fragmented datagram in user bytes = 680

a) Number of fragments required $= \left\lceil \frac{4000 - 20}{680} \right\rceil = 6$

b) Each fragment except the last one is of size 700 bytes (incl. 20 bytes of IP header). The last fragment is of size 600 bytes (incl. 20 bytes of IP header).

c) Each fragment has identification number 411.

The segment offsets of the fragments are 0, 85, 170, 255, 340, and 425.

Each fragment except the last one has the More flag equal to 1. The last fragment has the More flag equal to 0.

7.

a) Size of a packet = 5000 bits.

Time to send a packet from A to B

$$= (5000 \text{ bits} / 20 \text{ Mbps} + 40 \mu\text{sec}) \times 3$$

$$= 0.87 \text{ msec.}$$

b) Total time required

= Time to send the entire file from A to the first router +
Time to send the last packet from the first router to B (i.e. 2 links) +
Time to send the last ACK from B to A

$$= (25000 \text{ bits} / 20 \text{ Mbps} + 40 \mu\text{sec}) \\ + 2 \times (5000 \text{ bits} / 20 \text{ Mbps} + 40 \mu\text{sec}) + 120 \mu\text{sec}$$

$$= 1.29 \text{ msec} + 0.58 \text{ msec} + 0.12 \text{ msec}$$

$$= 1.99 \text{ msec}$$

8. No, the sequence number of next segment is not necessarily m+1, because sequence number is used to count the number of bytes and so it depends on the number of data bytes in the previous segment.

9. The 8×8 Hadamard matrix can be constructed as follows:

$$H_1 = (0) \quad H_2 = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix} \quad H_4 = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \end{pmatrix} \quad H_8 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{pmatrix}$$

10. In a connection-oriented protocol, a procedure is needed to set up a connection first before data can be transmitted. In a connectionless protocol, such a procedure is not needed.

11.

- a) The tree algorithm involves the following steps:
 - i. After a collision, all nodes not involved keep silent.
 - ii. Each colliding node randomly joins one of two groups (called Left and Right groups).
 - iii. Left group transmits in the next slot while Right group waits. If collision occurs, Left group splits again. Right group waits until Left group collision is resolved.
 - iv. When Left group is done, Right group transmits. If collision occurs, Right group splits again. The procedure repeats until collision is resolved.
- b) At least 6 time slots are needed.

By symmetry, we only need to consider the three cases where Left group consists of two nodes, one node, or no node. If it is empty, then one more time slot is wasted, so we can ignore this case.

In the first case when Left group consists of two nodes, the best scenario is that a binary tree is formed, and the number of non-root node is 6. In the second case when Left group consists of one node, then Right group consists of three nodes. The Right group will split again with one sub-group consists of two nodes and the other sub-group consists of one node. The total number of non-root node is also 6. Therefore, at least 6 time slots are needed.

- c) The average throughput is $4/7$.