City University of Hong Kong
Department of Electronic Engineering

EE3009 Data Communications & Networking

Solution to Test 1

1. Standards are important for protocols so that people can create networking systems and products that interoperate.

2. The delay components are processing delay, transmission delays, propagation delays and queueing delays. Only queueing delay is variable as it depends on the traffic load in the route.

3. A circuit-switched network can guarantee the end-to-end bandwidth for the duration of a call. Most packet-switched networks today (including the Internet) cannot make any end-to-end guarantees for bandwidth.

4. 50 Mbps/10 Mbps = 5.

5. a. $\binom{8}{2}(0.4)^2(0.6)^6 = 0.2090$

   When two users are transmitting, required bandwidth is 20 Mbps. So, 2/5 of link capacity is used.

   b. $\binom{8}{6}(0.4)^6(0.6)^2 + \binom{8}{7}(0.4)^7(0.6) + \binom{8}{8}(0.4)^8 = 0.04980$

6. a. institutional users b. residential users c. residential users

7. Yes, both segments will be directed to the same socket. For each received segment, at the socket interface, the operating system will provide the process with the IP addresses to determine the origins of the individual segments.

8. Yes. The mechanisms for reliable data transfer can be implemented in the application layer protocol.

9. TCP. For file transfer, it is important to ensure file integrity at the receiver. Since TCP ensures reliable data transfer, it should be used.

10. Propagation time = $\frac{2500\times10^3}{2.5\times10^8}$ = 0.01
    Transmission time = $\frac{1000\times8}{2\times10^6}$ = 4×10^{-3}
    Total time = 0.014 s.

11. 100 kbps

12. Express the host address 150.32.64.34 and subnet mask in binary form:
10010110 00100000 01000000 00100010
11111111 11111111 11110000 00000000

With the AND operation, subnet address is:
10010110 00100000 01000000 00000000 => 150.32.64.0

The first host address is:
10010110 00100000 01000000 00000001 => 150.32.64.1

The last host address is:
10010110 00100000 01001111 11111110 => 150.32.79.254

13.
128.56.24.0/24 = 10000000.00111000.00011000.00000000
128.56.25.0/24 = 10000000.00111000.00011001.00000000
128.56.26.0/24 = 10000000.00111000.00011010.00000000
128.56.27.0/24 = 10000000.00111000.00011011.00000000
Mask = 11111111.11111111.11111100.00000000
The resulting prefix is 128.56.24.0/22

14. Given:
IP packet = 1600 data bytes , with 20 bytes of header and 1580 of payload
MTU = 500 bytes
IP header = 20 header bytes
Maximum possible data length per fragment = MTU – IP header = 500 – 20 = 480 bytes.
The data length of each fragment must be a multiple of eight bytes; since 480 is a multiple of 8, the number of data bytes that can be carried per fragment is 480.

The data packet must be divided into 4 frames, as shown by the following calculations:

480 + 480 + 480 + 140 = 1580
20 + 20 + 20 + 20
500 500 500 160

The sequence of frames and packet headers is shown below:

	Total length	Id	Mf	Fragment Offset
Original Packet	1600	291	0	0
Fragment 1	500	291	1	0
Fragment 2	500	291	1	60
Fragment 3	500	291	1	120
Fragment 4	160	291	0	180

15. IPv6, DHCP and NAT

16. Handles error and control messages.

17. Forwarding has two main operations: match and action. With destination-based forwarding, the match operation of a router looks up only the destination IP address of the incoming datagram, and the action operation of the router involves sending the packet into the switching fabric to a specified output port. With generalized forwarding, the match can be made over multiple header fields associated with different protocols at different layers in the protocol stack, and the action can include forwarding the packet to one or more output ports, load-balancing packets across multiple outgoing interfaces, rewriting header values (as in NAT), purposefully blocking/dropping a packet (as in a firewall), sending a packet to a special server for further processing and action, and more.