

# MCS-377 Intra-term Exam 1 Solutions

1. [ **10 Points** ] Identify which general layer of the protocol stack corresponds to each of the following specific protocols, technologies, or functions:
- (a) UDP
  - (b) retrieving email
  - (c) Ethernet
  - (d) IP
  - (e) fiber optics
  - (f) TCP
  - (g) routers
  - (h) delivering bytes in their proper sequence
  - (i) DNS
  - (j) end-to-end flow-control

**Answer:**

- (a) UDP: transport
- (b) retrieving email: application
- (c) Ethernet: link
- (d) IP: network
- (e) fiber optics: physical
- (f) TCP: transport
- (g) routers: network
- (h) delivering bytes in their proper sequence: transport
- (i) DNS: application
- (j) end-to-end flow-control: transport

2. [ **10 Points** ] Suppose a computer is transmitting 1 KB packets on a 64 kb/s network, with a fixed congestion window size of two packets. What is the absolute maximum RTT that might allow transmission to continue steadily, without any pauses to wait for an ACK?

**Answer:**

Two 1 KB packets would contain 16 kb and hence take .25 seconds to transmit. For steady transmission, the ACK needs to be back before the second packet is completely transmitted, so the RTT must be less than .25 seconds.

3. [ **10 Points** ] Give the transmission rates and propagation delays for two networks, such that the first has higher bandwidth than the second, but a longer latency for 1250-byte packets. Calculate the latency for each network. Ignore all delays except for transmission and propagation.

**Answer:**

The packet length translates to 10000 bits, so the transmission delay would be .1 ms on a 100 Mb/s network and 1 ms on a 10 Mb/s network. Thus, if the propagation delays were 15 ms and 10 ms, the the total latencies would be 15.1 ms and 11 ms.

4. [ **10 Points** ] Explain, with some specificity, what issues allow a web browser to get better download performance when accessing a single web server

- (a) using a persistent connection rather than sequential connections
- (b) using parallel connections rather than sequential connections

**Answer:**

Persistent connections save the connection establishment time, including three-way handshake and the pauses during slow start. Parallel connections obtain a proportionately greater share of the bandwidth through a congestion bottleneck.

5. [ 9 Points ] List at least three different kinds of Resource Record (RR) types stored in the Domain Name System, and explain briefly what each is used for.

**Answer:**

Type A records map domain names to numeric addresses. Type MX records specify the mail hosts to try for delivery to domain mailboxes. Type CNAME records specify the canonical name to use in place of a domain name that is an alias. (Other types include PTR, SOA, and TXT.)

6. [ 9 Points ] What two mechanisms does Gnutella use to prevent queries from traveling in infinite loops? What are the relative advantages and disadvantages of each?

**Answer:**

Gnutella prevents loops by keeping local tables of already-forwarded query IDs, and by using a TTL field. The TTL field is more foolproof, but allows some wasteful looping to happen, just not infinitely.

7. [ 8 Points ] Consider a router that responds to congestion early by dropping occasional packets before its queue is full, as contrasted with one that waits until the queue is full and then drops all arriving packets. The former router is likely to cause some senders to lose a single packet from a congestion window's worth, whereas the latter router likely will cause senders to lose many packets from a single window—perhaps even the entire window's worth. Explain why the former kind of loss is likely to be detected by the sender more quickly than the latter.

**Answer:**

Single dropped packets are likely to be detected by triple-duplicate ACKs, because the packets after the dropped one in the window will still get through and trigger the duplicate ACKs. Dropping a whole window's worth, on the other hand, can only be recovered from by timeout.

8. [ 10 Points ] Two hosts have established a TCP connection. The current sequence number for the left-hand host is 100, while that of the right-hand host is 600. The left-hand host sends a 100-byte segment to the right-hand host. After receiving acknowledgment of that segment, the left-hand host sends a second 100-byte segment, which the right-hand host echos back. As many acknowledgments as possible are piggybacked with data flowing the opposite direction. No segments are lost, corrupted, or unreasonably delayed. Draw a diagram of the segments exchanged, labeling each with sequence number, ack number, and length.

**Answer:**

```
seq 100, ack 600, len 100 ->
<- seq 600, ack 200, len 0
seq 200, ack 600, len 100 ->
<- seq 600, ack 300, len 100
seq 300, ack 700, len 0 ->
```

9. [ 8 Points ] Suppose a TCP sender uses exclusively 1000-byte segments, and has a current congestion window of 4000 bytes. How many bytes does the congestion window expand by if one non-duplicate acknowledgment is received and the current mode is
- (a) slow start
  - (b) congestion avoidance

**Answer:**

slow start: 1000 bytes; congestion avoidance: 250 bytes

10. [ 8 Points ] Give two ways a sender can become aware of congestion without packet loss.

**Answer:**

A sender can detect increased RTT or receive explicit notification from the network layer.

11. [ 8 Points ] Duplicate acknowledgments in TCP can be a sign of a lost packet.
- (a) How many duplicates are needed before TCP will assume a packet was lost?
  - (b) What happens to the congestion window size when a lost packet is detected in this way?
  - (c) If a lost packet is detected in this way, will the sender then go into slow start mode or congestion avoidance?
  - (d) What other than a lost packet might account for a single duplicate acknowledgment?

**Answer:**

- (a) Three duplicate ACKs signal a loss.
- (b) The window is cut in half.
- (c) The sender goes into congestion avoidance mode.
- (d) A duplicate ACK could result from out of order packet delivery.