

Part 1: Short problems [All problems unless noted otherwise, are worth 5 points each.]

1. List 2 advantages of using hubs with ports that connect to each host by twisted pair wiring for Ethernet rather than a coaxial cable with taps that connect to each host.

#1)

#2)

2. Place a check mark on one line to indicate which single statement below is most accurate.

If two datagrams are sent back-to-back between hosts on distinct networks in the Internet, they:

- ☐ a. are guaranteed to follow the same route
- ☐ b. are somewhat more likely to follow the same route than a different route
- ☐ c. may or may not follow the same route with the same likelihood
- ☐ d. are more likely to follow a different route than the same route
- ☐ e. are guaranteed to follow a different route

Justification:

3. List three functions of the session layer in the OSI ISO protocol model.

#1)

#2)

#3)

4. Why does the U.S. telephone system (1) use analog (rather than digital) channels from individual telephones in homes to the central switching offices, and (2) use digital (rather than analog) channels between switching offices?

Answer for (1):

Answer for (2):

5. Which layers (or sub-layers) of the ISO OSI protocol model are normally implemented in:

a. hardware

b. the operating system

6. Why, in TCP, is ignoring round trip time (RTT) samples of segments that are retransmitted like "pouring gas on a fire" (quote due to Van Jacobsen), when the true RTT in the network suddenly spikes?

7. FDDI has a higher data rate than the IBM token ring. Suppose we slowed the clocks in an FDDI network so that the FDDI network has the *same* data rate. Which LAN (i.e., FDDI or token ring) has higher latency for the same offered load? Assume the two LANS have identical number of stations and distance between stations.

Check one: ☐ FDDI ☐ token ring

Justification:

8. [7 points] Define the following (for acronyms, (1) say what they stand for and (2) define it):

a) Protocol

b) MAC sublayer

d) dotted decimal notation

e) indirect delivery

f) segment

g) acknowledgment ambiguity

h) memoryless property

8. Give an example of an “error” (detected or undetected) that might occur at each layer of the International Standards Organization’s Open Systems Interconnection model.

9. Briefly state the advantages and the disadvantages of using a large window size in a go-back n ARQ protocol.

Advantages:

Disadvantages:

Part 2: Long problems

1. [30 points] Consider a communication link capable of transmitting at a rate of C bits per second that accommodates two sessions, each generating Poisson traffic at a rate of λ packets per second. (Therefore the total traffic arrival rate to the link is 2λ .) Packet lengths are exponentially distributed with a mean length of L bits.

(a) Will a packet experience lower delay (i.e., the sum of the queueing delay and link delay) with statistical multiplexing (SM) or time division multiplexing (TDM)?

Your answer: ____ SM ____ TDM

Give an *intuitive* justification for your answer.

(b) Let the delay in (a) be denoted s for SM and t for TDM. Find the ratio of s to t . (Hints: If you solve the problem correctly, you will write integers in the blanks below (e.g., 100 to 2). Also, check your work by seeing if your ratio satisfies your answer to (a).)

Your answer: ratio is ____ to ____.

Selected Answers:

Part 1:

1. Advantages:

- Security: hub can trash data copy sent to non-destination nodes
- Network management: hub ports can be detached from the network under software control.
- Wiring: Resembles telephone wiring (twisted pairs in point-to-point), simplifying installation.
- Possibility of transmitting video to each port via a dedicated 10Mb/sec point to point link.

Note: Whether cost is an advantage is unclear. There is only one wire to be run, rather than a separate wire for each host, with the coaxial cable. On the other hand, traneivers may cost more than hubs.

2. Answer: b.

The only time IP changes a route is when its routing table changes, which occurs slowly and only in the backbone nodes.

3.

- charging for service
- checking access rights (such as during remote log in)
- a "411" service: directoy lookup
- using one transport connection for multiple session connections
- more orderly connection release than transport layer release
- token management: whose turn is it to send data next?
- synchronization: move session entities back to known state if an upper layer error occurs
- activity management (partition message stream into files)
- exception reporting

4.

(1) Cost: no D/A and A/D converters are required in customer telephones

(2) Reliability: A digital signal is recovered and retransmitted at a repeater, rather than amplifying the noise in an analog signal. This is important over long distances.

5.

hardware: layers 1-2

operating system: layers 3-4, and possibly a commitment protocol from layer 7

6.

True RTT increases when congestion increases. In response to congestion, hosts should reduce their rate of traffic injection. But when congestion develops, the estimated RTT is less than the true RTT, so losses occur, and thus hosts do not reduce but actually increase their injection rate.

7. Answer: token ring

Token ring allows one message on the ring at a time. FDDI allows multiple messages to be prepended by different stations to the token.

8.

Protocol: rules for exchanging data

Dotted decimal notation: Denotes an IP address as a.b.c.d, where a,b,c, and d are decimal values of one byte of IP address

Indirect delivery: IP host A has a datagram destine for IP host B, but A and B are not on same network, so A asks layer 2 to deliver datagram to a gateway rather than to B.

Segment: unit of data transfer in TCP

Acknowledgement ambiguity: The uncertainty of which transmission corresponds to an arriving ACK acknowledging a retransmitted segment

Memoryless property: The fact that an exponentially distributed random variable's distribution function, conditioned on the variable's value being greater than a certain value, is equal to the unconditional distribution function.

Part 2:

1.

(a)

Statistical multiplexing will have lower delay.

One reason is that a packet arriving to an idle link is immediately transmitted in SM, but must wait for the start of the next time slot assigned to the session in TDM. A second reason is that one session could use idle bandwidth in the other session's time slots.

(b)

The ratio s to t is 1 to 2.

The ratio is calculated as $s=D_s$ to $t=D_t$, where D_s is the time T in one M/M/1 system with arrival rate 2λ and service rate C/L , and D_t is the time T in one M/M/1 system with arrival rate λ and service rate $\mu=C/(2L)$. Simplifying the expression D_s/D_t yields 1/2.

From [BG], $T=1/(\lambda-\mu)$

$D_s= 1/(2\lambda -C/\lambda)$

$D_t= 1/(\lambda-C/(2\lambda))$

$D_s/D_t = 1/2$

[Grading: -5 if answer is ok, but reason leaves something unstated or unjustified; -7 if m is wrong, from Ex. 3.7; -15 if lots of errors but 1:2 ratio is obtained.]