Network Systems (201600146/201600197), Test 2

March 10, 2017, 13:45–15:15

- This is an open-book exam: you are allowed to use the book by Peterson & Davie and the reader that belongs to this module, and the handout about peer-to-peer communication (i.e., the part of the Kurose&Ross book distributed via Blackboard). Furthermore, use of a dictionary is allowed. Use of a simple (non-graphical) calculator is allowed.
- Other written materials, and laptops, tablets, graphical calculators, mobile phones, etc., are not allowed. ***Please remove any such material and equipment from your desk, now!***
- Visiting the toilet without explicit permission of the supervisor is not allowed. During the last 30 minutes of the exam, no toilet visits are allowed.
- Write your answers on this paper, in the provided boxes, and hand this in.
- Total number of pages: 7.

Your name:

(please underline your family name (i.e., the name on your student card), so that we know how to sort)

Your student number:

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1. Physical media and framing

1 pt (a) Copper wires are often twisted together to form a "twisted pair". Would it make sense to do the same with step-index glass fibers?

A. No, since the glass would break if it were bent.
B. Yes, it would cancel the effect of external fields.
C. No, since glass fibers are not sensitive to external fields.
D. Yes, but only with some non-transparent material between them.
E. Yes, it would be a good alternative for having cladding on the fiber.
F. No, since light would leak from one glass fiber into the other if they touch.

1 pt (b) If we increase the distance between a radio transmitter and receiver, the Shannon capacity of this link decreases. How is this explained by the formula for the Shannon capacity?

A. B increases.
B. B decreases.
C. S increases.
D. S decreases.
E. N increases.
F. N decreases.

1 pt (c) Consider a step-index glass fiber. Suppose we *increase* the *difference* between the index of refraction of the core and of the cladding, without changing anything else (like the cable length, diameter, etc.). What will this mean for the fiber's dispersion?

A. The dispersion will not change, since it only depends on the cable length.
B. The dispersion will not change, since it is a constant of nature.
C. The dispersion will increase, since light rays can now reflect more often.
D. The dispersion will increase, since light rays can now reflect less often.
E. The dispersion will decrease, since light rays can now reflect more often.
F. The dispersion will decrease, since light rays can now reflect less often.

2 pt (d) Suppose the following packet needs to be transmitted, using `01111110` flags and bit stuffing for framing, and NRZI-S for encoding:

`00111000001111110100011111100001`

What is the resulting transmitted signal, expressed as a sequence of high and low levels, denoted by + and − symbols: (the options are in alphabetical order, with + before −)

A. ++−−−++++−−−−−−+−+++−−−−−++++−
B. +−++++−++−++−+++−++++−−−++−+++−++−−−++++−
C. +−−−−+−+++−−−++++−−−−−+−+−+++−−−−++++−+−−−−−+−+
D. +−−−−−−+++−−−++++−−−−−+−+−+++−−−−++++−+−−−−−−+
E. +−−−−−−+++−−−++++−−−−−−+−++−−−−++++−+−−−−−−+
F. +−−−−−−++−+−−−−+−+−++++++−−++−+−−−−−−+−+−−+++++++−−+
G. +−−−−−−−+−+++−+−+−−−−−−++−−+−++++++−+−+−−+++++++−
H. +−−−−−−−+−+++−+−+−−−−−−++−+−−−−−−+−+−−+++++++−
I. +−−−−−−−+−−++++−−++−+−+−++−++−−−−−−++−−−+−+−+−−−+
J. −+++++++−++−−−−−++−−+−+−+−−−+−−+++++++−−+++−+−+−++−
K. −+++++++−+−−−−+−+−++++++−−+−++++++−+−++−−−−−−−+
L. −+++++++−+−−−−+−+−++++++−−++−+−−−−−−+−+−++−−−−−−−+
M. −+++++++−−+−+++++−+−+−−−−−−++−−+−++++++−+−++−−−−−−−++−
N. −+++++++−−−++−−−−−++++++−+−−−++++−−−−+−++++++−
O. −+++++++−−−++−−−−−++++++−+−+−−−++++−−−−+−++++++−
P. −+++++−+−−−++−−−−−++++++−+−+−−−++++−−−−+−++++++−+−
Q. −+−−−−−+−−+−−+−−−−+−−−−−+++−−+−−−−+−−−++++−−−−−+
R. −−+++−−−−−++++++−+−−−++++++−−−−+

If you think there are multiple possibilities, indicate them all.

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2. Medium access control

On a cable are 3 nodes, A, B, and C. A and C are at the two ends of the cable, and node B is in the middle, between them. The nodes use Carrier Sense Multiple Access (CSMA).

3 pt (a) Describe a scenario in a space-time diagram (analogue to Figure 5.12 in part 5 of the reader) where A and B both transmit a packet, and where A experiences a collision between the two packets, and B and C not. Note: So, the answer to be given should be the space-time diagram.

Consider a broadcast channel with $N = 10$ nodes (for polling there is an additional polling node) and a data rate of $R = 10^8$ bits/s. The size of a slot (in case of channel partitioning and slotted Aloha) or the maximum number of bits to transmit after being polled (in case of polling), is $Q = 10^5$ bits. For the polling protocol, the polling delay (amount of time between completion of transmission (of at most Q bits) and start of transmission by the subsequent node), $d_{poll} = 0.1$ ms. Propagation delay may be neglected. In the following 3 subquestions, suppose only *one* node has data to transmit, whereas the other $N - 1$ nodes do not have any data to transmit.

1 pt (b) What is the maximum throughput of the broadcast channel if channel partitioning is used? Give formula and final result (in Mbit/s).

1 pt (c) What is the maximum throughput of the broadcast channel if slotted Aloha is used? Give formula and final result (in Mbit/s).

2 pt (d) What is the maximum throughput of the broadcast channel if polling is used? Give formula and final result (in Mbit/s).

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3. (Inter)Networking

1 pt (a) Suppose a host receives the second fragment of a fragmented IP packet, and several minutes later still has not received the first fragment. What should it do?

A. Discard the received fragment.
B. Send an ICMP message to the source.
C. Deliver the incomplete packet to the higher protocol layer.
D. Ask the source for a retransmission of the missing fragment.
E. Elect a new president who does not allow such packets to enter the country.

1 pt (b) A host sending a single "DHCP discover" message, may receive "DHCP offer" packets from multiple DHCP servers. What's the (main) advantage of the fact that the DHCP protocol allows this?

A. Redundancy: if one DHCP server fails, it will not cause problems.
B. Privacy: the DHCP servers don't know which address the host uses.
C. Reliability: if there are bit errors in one response, the host can use the other.
D. Throughput: if the host has much traffic, it can spread this traffic over multiple IP addresses.
E. Popularity: a newly elected president feels there are many listeners to his discover messages.

1 pt (c) Which of the following statements about subnet notation is/are true?

A. One /16 network contains fewer routers than one /24 network.
B. One /16 network contains more routers than one /24 network.
C. One /16 network contains fewer addresses than one /24 network.
D. One /16 network contains more addresses than one /24 network.
E. One /16 network needs fewer forwarding table entries than one /24 network.
F. One /16 network needs more forwarding table entries than one /24 network.

1 pt (d) As a packet travels from one host via some routers to another over several ethernet LANs, which of the following is/are true?

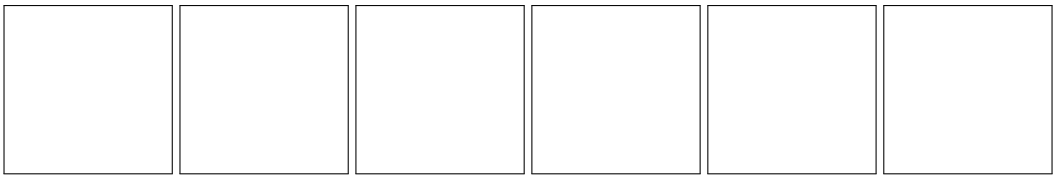
A. Its IP source address changes.
B. Its IP destination address changes.
C. Its MAC source address changes.
D. Its MAC destination address changes.

3 pt (e) Suppose a host with IP address 9.9.9.9 receives the following IP fragments:

nr.	source address	destination address	identifier	fragment offset	'more' flag	length
1	1.1.1.2	9.9.9.9	307	0	1	3
2	1.1.1.2	9.9.9.9	307	3	0	4
3	1.1.1.3	9.9.9.9	4093	0	1	3
4	1.1.1.3	9.9.9.9	4093	6	0	4
5	1.1.1.3	9.9.9.9	4093	3	1	3
6	1.1.1.4	9.9.9.9	4093	0	1	6
7	1.1.1.4	9.9.9.9	770	0	0	3
8	1.1.1.4	9.9.9.9	770	6	0	2
9	1.1.1.4	12.2.2.21	4093	6	0	2
10	1.1.1.5	9.9.9.9	4093	6	0	2
11	1.1.1.5	9.9.9.9	770	6	1	3
12	1.1.1.5	9.9.9.9	770	0	1	6

For simplicity, both the lengths and the fragment offsets in the table are in bytes (although in reality the fragment offset would be in multiples of 8 bytes).

Reassemble the packets. Indicate your result by using the following boxes to write the numbers (first column in the table) of the fragments which go together to form a *complete* packet; use one box per completed packet. (You may not need all boxes.)



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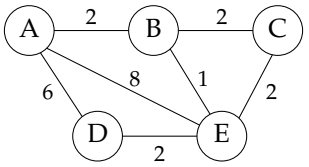
4. Dijkstra's algorithm



3 pt (a) Consider the Dijkstra algorithm running on node A of the sketched network. This algorithm maintains known paths to destinations (of the form `(Destination, Cost, NextHop)` in two lists: `Tentative` and `Confirmed`. Show for each iteration of the algorithm the entries in both lists, by making a table with 3 columns (`Step`, `Confirmed`, `Tentative`), and at least one row per iteration.

Step	Confirmed	Tentative

2 pt (b) If the cost of a single link is allowed to be negative, does the Dijkstra algorithm still always find the best paths (i.e., with lowest sum of the costs of the links on the path)?
If yes, explain why.
If no, give an example in which you make one link cost in the above network negative and show what goes wrong.

End of this exam.