Network Systems (201600146/201600197), Test 2

March 9, 2018, 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. 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 to open questions on this paper, in the provided boxes, and hand this in.
- Questions marked with (MC) must be answered on the separate multiple-choice form, at the number indicated in the circle.
  Since the multiple-choice form will not be available at the exam review session, we recommend to *also* mark the MC answers on this paper.
- Total number of pages: 8.
- Total number of points: 30.

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) Normal step-index glass-fibers have a round core (i.e., the core is a very long narrow cylinder). Suppose we'd make a glass-fiber with a square core (i.e., the core is a very long rectangular block). Would light in such a fiber stay nicely inside the core, just like in normal fiber?

MC**01**

A. No, because the critical angle is less than 90 degrees.
B. No, because the critical angle is more than 90 degrees.
C. No, because total internal reflection requires a curved surface.
D. Yes, if the core has a lower index of refraction than the cladding.
E. Yes, if the core has a higher index of refraction than the cladding.

1 pt (b) What is true about single-mode glass fiber (in general), compared to step-index fiber?

MC**02**

A. Its glass is purer.
B. Its core is thicker.
C. Its bandwidth is larger.
D. Its attenuation is larger.

1 pt (c) Consider Shannon's formula for the capacity of an analog channel. What is true?

MC**03**

A. Doubling the bandwidth doubles the capacity.
B. Doubling the Signal-to-Noise ratio doubles the capacity.
C. A and B are both true.
D. A and B are both false.

1 pt (d) Consider framing using flags and bit-stuffing. Suppose we want to change the flag from `01111110` to `0111110`, i.e., five instead of six `1`s. What is true?

MC**04**

A. This can work correctly, if we change the stuffing rule to insert a `0` after four `1`s.
B. This can work correctly, if we change the stuffing rule to insert a `0` after five `1`s.
C. This can work correctly, and we do not need to change the stuffing rule.
D. This cannot work correctly because the flag is not a complete byte.

1 pt (e) Consider a (hypothetical) 8B9B encoding. What would its efficiency be?

MC**05**

A. 71%
B. 80%
C. 84%
D. 89%
E. 94%
F. Such an encoding is not possible.

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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 C both transmit a packet, and where B experiences a collision between the two packets, and A and C not. Note: So, the answer to be given should be the space-time diagram.

Consider a broadcast channel with $N = 2$ nodes (for polling there is an additional polling node (or master)) 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 $Q = 3 \cdot 10^4$ 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.

1 pt (b) What is the throughput of the channel if only one of the two nodes is active and channel partitioning is used?

MC06

A. 10 Mbit/s
B. 20 Mbit/s
C. 50 Mbit/s
D. 60 Mbit/s
E. 75 Mbit/s
F. 100 Mbit/s
G. 200 Mbit/s

1 pt (c) What is the total throughput of the channel if both nodes are active and channel partitioning is used?

MC07

A. 10 Mbit/s
B. 20 Mbit/s
C. 50 Mbit/s
D. 60 Mbit/s
E. 75 Mbit/s
F. 100 Mbit/s
G. 200 Mbit/s

1 pt (d) What is the throughput of the channel if only one of the two nodes is active and polling is used?

MC08

A. 10 Mbit/s
B. 20 Mbit/s
C. 50 Mbit/s
D. 60 Mbit/s
E. 75 Mbit/s
F. 100 Mbit/s
G. 200 Mbit/s

1 pt (e) What is the total throughput of the channel if both nodes are active and polling is used?

MC09

A. 10 Mbit/s
B. 20 Mbit/s
C. 50 Mbit/s
D. 60 Mbit/s
E. 75 Mbit/s
F. 100 Mbit/s
G. 200 Mbit/s

1 pt (f) What is the throughput of the channel if only one of the two nodes is active and slotted Aloha with retransmission probability $p = 0.5$ is used? Note that the transmission probability for a "fresh" frame is assumed to be 1 here, whereas for a retransmission it is 0.5.

MC10

A. 10 Mbit/s
B. 20 Mbit/s
C. 50 Mbit/s
D. 60 Mbit/s
E. 75 Mbit/s
F. 100 Mbit/s
G. 200 Mbit/s

1 pt (g) What is the total throughput of the channel if both nodes are active and slotted Aloha with retransmission probability $p = 0.5$ is used?

MC11

A. 10 Mbit/s
B. 20 Mbit/s
C. 50 Mbit/s
D. 60 Mbit/s
E. 75 Mbit/s
F. 100 Mbit/s
G. 200 Mbit/s

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3. (Inter)Networking

1 pt (a) Suppose a host receives the first fragment of a fragmented IP packet, and then *two* copies of the second (and last) fragment. What should it do?

MC12
A. Send an ICMP message to the source.
B. Deliver all three fragments to the higher protocol layer.
C. Ask the source to transmit another copy of the first fragment.
D. Discard one copy of the second fragment, and deliver the rest.
E. Restart the routing algorithm since apparently the routing is not correct.

1 pt (b) Suppose a router receives an IP packet with TTL=2. It decrements TTL to 1 and then considers the packet for forwarding. What should it do?

MC13
A. Drop the packet, as the next router would make TTL=0 and then drop the packet anyway.
B. Increase the TTL so the packet won't be dropped at the next router.
C. Forward the packet, but also send an ICMP message to the source.
D. Simply forward the packet with TTL=1.

1 pt (c) Suppose we know the hostname of a host. Using which procols can we find its MAC address?

MC14
A. Only ARP.
B. Only DNS.
C. First ARP, then DNS.
D. First DNS, then ARP.
E. First ARP, then DNS twice.
F. First DNS, then ARP, then DNS again.
G. It is not possible.

1 pt (d) Which is the longest prefix match for 130.89.12.14 ?

MC15
A. 0.0.0.0/8
B. 130.0.0.0/8
C. 130.89.0.0/16
D. 130.89.8.0/21
E. 130.89.8.0/22
F. 130.89.8.0/23
G. 130.89.16.0/20

1 pt (e) Which is the longest prefix match for 13.8.10.4 ?

MC16
A. 0.0.0.0/2
B. 13.0.0.0/16
C. 13.8.1.0/24
D. 13.8.10.0/30
E. 13.9.0.0/16
F. 138.1.0.4/30
G. None of the above matches.

1 pt (f) Where is the number after the slash in notations like 130.89.0.0/16 stored?

MC17
A. In the IP header.
B. In the TCP header.
C. In the forwarding table of a router.
D. In the forwarding table of a bridge.
E. None of the above; it is only used by humans to plan the network.

1 pt (g) As a packet travels from one host via some *bridges* to another host over several ethernet LANs, which of the following is true?

MC18

A. Its IP source address changes.
B. Its IP destination address changes.
C. Both its IP source and IP destination address change.
D. Its MAC source address changes.
E. Its MAC destination address changes.
F. Both its MAC source and MAC destination address change.
G. No addresses change.

3 pt (h) 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	0	0	8
3	1.1.1.3	9.9.9.9	4093	0	1	3
4	1.1.1.3	9.9.9.9	4093	5	0	4
5	1.1.1.3	9.9.9.9	772	3	1	3
6	1.1.1.4	9.9.9.9	772	2	1	6
7	1.1.1.4	9.9.9.9	772	8	0	0
8	1.1.1.4	9.9.9.9	772	0	1	2
9	1.1.1.4	12.2.2.21	4093	3	1	2
10	1.1.1.5	9.9.9.9	661	3	0	3
11	1.1.1.5	9.9.9.9	4093	3	1	2
12	1.1.1.5	9.9.9.9	660	0	1	3

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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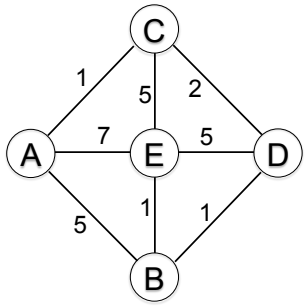
4. Dijkstra's algorithm

4 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

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Let us now assume that all nodes in the network above have used Dijkstra's algorithm to calculate the lowest-cost paths to all destinations. Changing the costs of links will have an impact on the costs of the lowest-cost paths found. We are now asking to what extent changing the link costs will also affect the lowest-cost paths themselves, i.e., will it change the sequence of links that constitute these paths?

1 pt (b) Will the shortest paths found be different in case all link costs would be increased with 1?

MC**19**

A. The lowest-cost paths are not changed.
B. The lowest-cost paths are changed, and some have more hops than before.
C. The lowest-cost paths are changed, and some have fewer hops than before.
D. The lowest-cost paths are changed, but have the same number of hops as before.

1 pt (c) Will the shortest paths found be different in case all link costs would be multiplied by 2?

MC**20**

A. The lowest-cost paths are not changed.
B. The lowest-cost paths are changed, and some have more hops than before.
C. The lowest-cost paths are changed, and some have fewer hops than before.
D. The lowest-cost paths are changed, but have the same number of hops as before.

End of this exam.