Network Systems (201600146/201600197), Test 4

April 4, 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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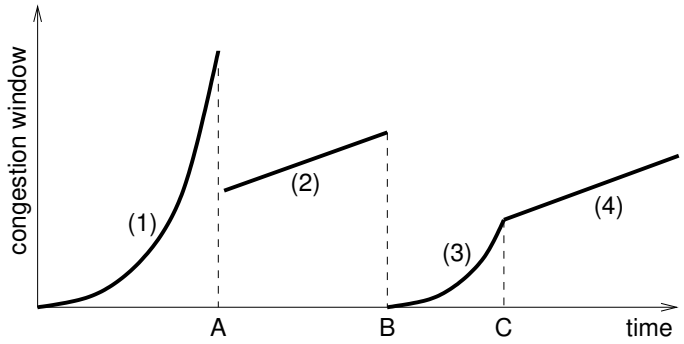
1. Congestion control



The above figure shows schematically how the TCP congestion window evolves over time. The following three questions are about this figure.

1 pt (a) Where is TCP in the "slow start" phase?

MC**01**

A. Only in (1) and (3).
B. Only in (2) and (4).
C. Only in (1) and (2).
D. Only in (3) and (4).
E. Only in (1).
F. Only in (2), (3) and (4).
G. None of the above.

1 pt (b) At which moment(s) did TCP notice a packet loss by a timeout?

MC**02**

A. Only at A.
B. Only at B.
C. Only at C.
D. At A and B.
E. At A and C.
F. At B and C.
G. None.

1 pt (c) At which moment(s) did TCP notice a packet loss by a triple duplicate ack?

MC**03**

A. Only at A.
B. Only at B.
C. Only at C.
D. At A and B.
E. At A and C.
F. At B and C.
G. None.

1 pt (d) During the "fast recovery" phase, TCP temporarily increases its congestion window, even though a loss has just been detected. What's up?

MC**04**

A. This is incorrect, TCP only reduces its congestion window then.
B. This is a design error, as it makes congestion worse, but it's now too late to fix it.
C. This makes it possible to smoothly reduce the number of packets in the network.
D. This ensures fairness by forcing competing TCP connections to also have packet loss.
E. The temporarily enlarged congestion window is needed to retransmit the lost packet.

2 pt (e) In slow start, the the congestion window is incremented by 1 MSS each time an ACK arrives. Unfortunately, taking this literally allows cheating by a receiver which wants to download faster. By sending multiple ACKs, each acknowledging a small part of a received data packet, the receiver can make the sender increase the congestion window extra quickly.

Give an algorithm which does not suffer from this problem, and explain why it works.

1 pt (f) Suppose two flows share a link, and one of them gets 75 % of the bandwidth while the other gets 25 %. Calculate Jain's fairness index.

1 pt (g) What is the advantage of using Explicit Congestion Notification?

MC**05**

A. It reduces or prevents packet loss.
B. Hosts become aware of congestion faster.
C. It's the only way to deal with congestion caused by UDP-based applications.
D. Hosts can adjust more precisely as routers tell them by how much they are congested.
E. It's more secure because a man-in-the-middle cannot fake this congestion notification.

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2. QoS

1 pt (a) Which of the following is true?

MC**06**

A. Elastic applications need a very large bandwidth.
B. Elastic applications can use as much bandwidth as is available.
C. Elastic applications do not work if the bandwidth is too small.
D. Elastic applications do not work if the bandwidth is too large.

1 pt (b) Which of the following is true?

MC**07**

A. Non-elastic applications need a very large bandwidth.
B. Non-elastic applications can use as much bandwidth as is available.
C. Non-elastic applications do not work if the bandwidth is too small.
D. Non-elastic applications do not work if the bandwidth is too large.

1 pt (c) Consider a (non-preemptive) priority queue with two priority classes. Which of the following is true?

MC08

A. A packet in the high-priority class never has to wait.
B. A packet in the low-priority class always has to wait.
C. A low-priority packet has to wait if there are high-priority packets.
D. The high-priority queue is never longer than the low-priority queue.

1 pt (d) Consider Fair Queueing scheduling, with two classes of packets. The available total bandwidth is 100 Mbit/s; one flow (let's call it red) sends at 40 Mbit/s, the other (blue) at 80 Mbit/s. What will happen?

MC09

A. Red gets 40 Mbit/s, blue gets 50 Mbit/s.
B. Red gets 40 Mbit/s, blue gets 60 Mbit/s.
C. Red gets 40 Mbit/s, blue gets 80 Mbit/s.
D. Red gets 20 Mbit/s, blue gets 80 Mbit/s.
E. Red gets 33 Mbit/s, blue gets 66 Mbit/s.
F. Depends on the packet lengths.
G. Depends on the packet arrival times.

1 pt (e) Same question, but with priority scheduling and blue having high priority.

MC10

A. Red gets 40 Mbit/s, blue gets 50 Mbit/s.
B. Red gets 40 Mbit/s, blue gets 60 Mbit/s.
C. Red gets 40 Mbit/s, blue gets 80 Mbit/s.
D. Red gets 20 Mbit/s, blue gets 80 Mbit/s.
E. Red gets 33 Mbit/s, blue gets 66 Mbit/s.
F. Depends on the packet lengths.
G. Depends on the packet arrival times.

1 pt (f) Consider a source whose traffic is described by a token bucket with r=1000 tokens/ms and B = 2000 tokens, and counting 1 token per bit:

MC11

A. In any 1 ms interval, the source will send precisely 1000 bits.
B. In any 1 ms interval, the source will send precisely 2000 bits.
C. In any 1 ms interval, the source will send precisely 3000 bits.
D. In any 1 ms interval, the source will send at most 1000 bits.
E. In any 1 ms interval, the source will send at most 2000 bits.
F. In any 1 ms interval, the source will send at most 3000 bits.

1 pt (g) About the same source as the previous question:

MC12

A. In the long run, the source will send 1000 bits/ms on average.
B. In the long run, the source will send at least 1000 bits/ms on average.
C. In the long run, the source will send at most 1000 bits/ms on average.
D. Every packet from this source will be delayed by at most 1 ms.
E. Every packet from this source will be delayed by at most 2 ms.
F. Every packet from this source will be delayed by at most 3 ms.

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3. Security

1 pt (a) Consider PGP for e-mail security, but let's only use its digital signature, not the encryption of the message.

MC13

A. This is useless: without encryption the signature can easily be falsified by a man-in-the-middle.
B. This is useless: without encryption, the recipient cannot verify the signature.
C. This is still useful: if a man-in-the-middle modifies the message, the recipient can detect this.
D. This is still useful: if a man-in-the-middle modifies the message, the recipient can still find out what the original message was.

1 pt (b) Consider PGP for e-mail security, this time with both the digital signature and the message encryption.

MC14

A. This authenticates the sender (to the recipient) and the recipient (to the sender).
B. This authenticates only the sender but not the recipient.
C. This authenticates only the recipient but not the sender.
D. This provides no authentication.

(By recipient, we mean any person who receives the mail *and* can correctly decrypt it.)

1 pt (c) Consider HTTPS.

MC15

A. This authenticates the server to the browser, and the other way around.
B. This authenticates the server to the browser, but not the other way around.
C. This authenticates the browser to the server, but not the other way around.
D. This provides no authentication.

1 pt (d) A company wants to achieve the following by using a (stateless) firewall:
- people from outside can only reach their web server, running on TCP port 80, but not their file server running on port 137;
- their own staff can freely access TCP servers (web, mail, etc.) on the outside internet.
They configure their firewall to drop all incoming packets unless they are destined for TCP port 80, and never to drop outgoing packets. Is this a good configuration?

MC16

A. Yes, this achieves what they want.
B. No, they should also allow incoming packets with destination port ≥ 1024.
C. No, they should also allow incoming packets with source port ≥ 1024.
D. No, they should also drop outgoing packets with source port 80.
E. No, they should also drop outgoing packets unless the source port is 80.
F. No, they need a stateful firewall.

1 pt (e) Consider DDoS (Distributed Denial-of-Service) attacks, in which a large number of hosts send lots of data to a single destination to bring it (or its internet connection) down. Is this easier to do with UDP packets or with TCP packets?

MC17

A. UDP, because TCP would run out of sequence numbers too quickly.
B. UDP, because it is hard to synchronize the TCP sequence numbers among all those hosts.
C. TCP, because after an ACK, automatically the next packet is sent.
D. TCP, because TCP packets are larger than UDP.
E. The above are all nonsense.

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1 pt (f) Which of the following risks can a firewall (looking at both the IP and TCP headers) protect against?

MC18

A. A DDoS attack.
B. A virus in an e-mail attachment.
C. Brute-force cracking of WLAN keys.
D. Attempts to hack your network-attached camera (webcam).
E. Traffic analysis (eavesdropper trying to find out who is communicating with whom).
F. None of the above.
G. All of the above.

There are more questions, on a separate form! (for parallel grading)

If you did not get that separate piece of paper, ask a supervisor.

4. Localisation and timing

Please write your name and student number again, so we can grade the work in parallel, because of the tight schedule until the resit.

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:

Please be brief in your answers!

Time synchronisation is important for many applications and protocols.

1.5 pt (a) Mention three methods used in protocols and technologies in network systems in which time synchronization is essential.

1.5 pt (b) What are the typical requirements of synchronization in those methods (in terms of accuracy)?

Synchronisation can be achieved by message exchange between two devices.

1.5 pt (c) Why is it so difficult to maintain accurate synchronisation?

1.5 pt (d) What are the 5 main causes of uncertainties involved with such an approach?

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GPS is a solution that works commonly well in an outdoor environment.

1.5 pt (e) In what circumstances does it not work well, and what are the reasons?

1.5 pt (f) Time plays an important role for the operation of GPS. Explain why.

End of this exam.