Network Systems (201600146/201600197), Test 1

February 15, 2019, 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 Canvas). Furthermore, use of a dictionary is allowed. Use of a simple (non-graphical) calculator is allowed.
- For accessing the on-line books, use of the UT-provided Chromebook 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.
- Total number of pages: 6.
- Total number of points: 34.

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. Drexit voting information

The (fictitious) country Great Drittain is considering separating itself from the Deuropean Union, a process also known as Drexit. It is decided that the population needs to vote about this, using computerized voting stations distributed all over the country. Each voting station has three buttons, for 'Remain', 'Leave' and 'I don't care'. It is your task to design the communication network to send the votes to Donlon, the capital city of Great Drittain.

1 pt (a) Assuming each vote is sent as a separate message, would you choose packet switching or circuit switching for this network?

MC**01**

A. Packet switching because of statistical multiplexing.
B. Packet switching because it is more reliable.
C. Packet switching because it allows shorter cables.
D. Circuit switching because of statistical multiplexing.
E. Circuit switching because it is more reliable.
F. Circuit switching because it allows longer cables.

Let's assume it is expected that the three possible messages (votes) have the following probabilities:

`Remain` 49% `Leave` 50% `I don't care` 1%

3 pt (b) Down to how few bits (on average) can each message be compressed? Show your calculation.

3 pt (c) The table below proposes five codes for encoding the messages. Which of them can be made suitable for encoding the messages into **less than 1.6 bits** per message on average? Answer this question by selecting, for each of the proposed message encodings, a suitable codeword for the `I don't care` message from the following multiple-choice options; if more than one answer is suitable, choose the first suitable one:

A. 1 B. 01 C. 11 D. 000 E. 100 F. send nothing G. no suitable choice is possible

message	probability	code	code	code	code	code
`Remain`	49%	0	0	10	001	00
`Leave`	50%	1	10	01	010	1
`I don't care`	1%	MC**02**	MC**03**	MC**04**	MC**05**	MC**06**

1 pt (d) Now suppose that the real voting results are very different from expected, with `I don't care` getting 80% of the votes, while still an encoding designed for the original probabilities is used. What is the consequence?

MC**07**

A. All information will be lost.
B. Some information will be lost, and fewer bits will be needed than expected.
C. Some information will be lost, and the number of bits needed is as expected.
D. Some information will be lost, and more bits will be needed than expected.
E. No information will be lost, and fewer bits will be needed than expected.
F. No information will be lost, and the number of bits needed is as expected.
G. No information will be lost, and more bits will be needed than expected.

1 pt (e) So far, we assumed that the votes would be sent to Donlon in individual binary (i.e., consisting of one or more bits) messages. Now assume you're allowed to collect the results from 10 votes and send them as a single binary message (without losing anything, so not just sending total number of votes per option, but all 10 individual votes). Assuming the best possible encodings are used in either case, compare the number of bits needed for sending ten messages individually, and for encoding ten of them together:

MC**08**

A. Encoding together needs more bits on average.
B. Encoding together needs equally many bits on average.
C. Encoding together needs fewer bits on average.
D. This depends on whether there are more `Remain` or more `Leave` votes.

3 pt (f) Assume the link between Dristol and Donlon is a binary symmetric channel with a bit rate of 2000 bit/s, and a bit-error probability of 2%. Assuming optimal coding, how many voting results can be sent over this channel per second with a negligible error probability? Show your calculation.

1 pt (g) What happens if we try to use an error-correcting coding with fewer parity bits, in order to send even more voting results per second through the channel than calculated in the previous question?

MC**09**

A. The error probability can be made arbitrarily small.
B. All parity bits will be received incorrectly.
C. Some voting results will be decoded incorrectly.
D. All voting results will be decoded incorrectly.
E. War breaks out in Northern Direland.

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2. Protocols and performance

In order to negotiate the conditions for Drexit, a communication link is set up between Donlon and Drussel (the capital of the Deuropean Union). The link itself may occasionally drop packets, but will not reorder them. Of course, the negotiations require that no message should ever be lost or duplicated, so a sliding-window system with sequence numbers and acknowledgement packets is used.

The glass fiber cable between Donlon and Drussel is about 800 km long, and signals travel at 200 000 km/s through it. The datarate is 1 gigabit/s, and packets are 10000 bits long.

2 pt (a) Compute the propagation time of a packet.

2 pt (b) Compute the transmission time of a packet.

2 pt (c) Suppose the alternating-bit protocol is used, i.e., a sliding-window protocol with a window-size of 1 packet. Compute the maximum possible throughput.

2 pt (d) Compute the minimum value of the Send Window Size that will allow the link to be fully utilized.

Next, assume we use Send Window Size = 400, Receive Window Size = 100, and 9-bit sequence numbers (allowing for $2^9 = 512$ different sequence numbers).

1 pt (e) What do you think of this idea?

MC**10**

A. It is not good, it may cause data to be lost, but not duplicated.
B. It is not good, it may cause data to be duplicated, but not lost.
C. It is not good, it may cause data to be lost and may also cause data to be duplicated.
D. It is correct (no data loss or duplication possible).

1 pt (f) Same, but assume we use SWS=100, RWS=400, and 9-bit sequence numbers.

MC**11**

A. It is not good, it may cause data to be lost, but not duplicated.
B. It is not good, it may cause data to be duplicated, but not lost.
C. It is not good, it may cause data to be lost and may also cause data to be duplicated.
D. It is correct (no data loss or duplication possible).

1 pt (g) Same, but assume we use SWS=400, RWS=400, and 9-bit sequence numbers.

MC**12**

A. It is not good, it may cause data to be lost, but not duplicated.
B. It is not good, it may cause data to be duplicated, but not lost.
C. It is not good, it may cause data to be lost and may also cause data to be duplicated.
D. It is correct (no data loss or duplication possible).

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3. Application protocols

Information about the Drexit is published on a number of websites, which can be accessed via the HTTP protocol.

1 pt (a) What does the 'HT' part of the abbreviation HTTP mean?

MC13

A. That it is very fast.
B. That user privacy is ensured.
C. That HTeresa May is the author.
D. That the information is objective.
E. That documents can be of any size.
F. That advertisements can be included.
G. That documents can refer to each other.

1 pt (b) HTTP requests contain a `Referer` header, which indicates the URL of the page on which the user found the URL he/she is currently fetching. Which statement is true?

MC14

A. This improves security.
B. This compromises the user's privacy.
C. This is an alternative to sending a cookie.
D. This speeds the protocol up by allowing caching.
E. This is needed for the web server to deliver the correct file.

1 pt (c) Compare HTTP/1.0 without parallel connections, to HTTP/1.1 with persistent and parallel connections, for loading an HTML page with 2 images.

MC15

A. 1.1 is faster than 1.0 regardless of where the images are hosted.
B. 1.1 is faster than 1.0 only if the images are hosted on a different server than the HTML.
C. 1.1 is faster than 1.0 only if the images are hosted on different servers.
D. In this case, 1.1 and 1.0 are equally fast.
E. In this case, 1.0 is faster than 1.1.

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4. Client-server and peer-to-peer file distribution

Given the result of the Drexit voting, the British government and the DU have negotiated an agreement for the withdrawel of Great Drittain from the Deuropean Union, the so-called Drexit-deal. This agreement, which is a rather lengthy text of 585 pages, in total $F = 500$ Mbyte, needs to submitted to the British Parliament for approval. The file server of the British government is somewhat outdated, and has a rather slow internet connection with both an uplink datarate u_s and a downlink data rate d_s of 10 Mbit/s. The $M = 650$ members of parliament (MPs) have computers with an Internet connection with $u_{mp} = d_{mp} = 50$ Mbit/s up- and download.

2 pt (a) Neglecting RTT's, how long will it take for the Drexit deal to be distributed to all MPs if a traditional client-server approach is used for file distribution?

MC16

A. 80 s
B. 400 s
C. a bit more than 14 hours (52000 s)
D. approximately 72 hours (260000 s)
E. until March 29, 2019

The Deuropean Union has invested a bit more in their ICT infrastructure (this waste of money is what prompted Great Drittain to leave). They have two high-speed servers that also function to archive all agreements. These servers have high-speed Internet connections, with uplink data rate u_{s2} and a downlink data rate d_{s2}. Like the British MPs, the N Deuropean MPs also have computers with Internet connections with d_{mp} download data rate, and u_{mp} uplink data rate. The configuration is such that both Deuropean servers download the file from the British government server using a client server architecture. As soon as the Deuropean servers have received the first bit of the file, they can start serving the Deuropean MP's computers, again using a client server architecture.

2 pt (b) Which of the following expressions provides the best estimate of the minimum download-time of the Deuropean members of parliament? (Denoted by D_{CSCS} since the file now goes through two client-server systems, one in Drittain and one in Deurope.)

A. $D_{\text{CSCS}} \geq \max\left\{\frac{F}{d_{s2}}, \frac{NF}{u_{mp}}, \frac{F}{d_{mp}}\right\}$.

B. $D_{\text{CSCS}} \geq \max\left\{\frac{F}{d_{s2}}, \frac{NF}{2u_{s2}}, \frac{F}{d_{mp}}\right\}$.

C. $D_{\text{CSCS}} \geq \max\left\{\frac{2F}{u_s}, \frac{F}{d_{s2}}, \frac{NF}{2u_{s2}}, \frac{F}{d_{mp}}\right\}$.

MC17 D. $D_{\text{CSCS}} \geq \max\left\{\frac{2F}{u_s}, \frac{F}{d_{s2}}, \frac{NF}{u_{mp}+2u_{s2}}, \frac{F}{d_{mp}}\right\}$.

E. $D_{\text{CSCS}} \geq \frac{2F}{u_s} + \max\left\{\frac{F}{d_{s2}}, \frac{NF}{2u_{s2}}, \frac{F}{d_{mp}}\right\}$.

F. $D_{\text{CSCS}} \geq \max\left\{\frac{2F}{u_s}, \frac{F}{d_{s2}}, \frac{NF}{u_{mp}+2u_{s2}}\right\} + \frac{F}{d_{mp}}$.

G. $D_{\text{CSCS}} \geq \max\left\{\frac{2F}{u_s}, \frac{F}{d_{s2}}\right\} + \max\left\{\frac{NF}{2u_{s2}}, \frac{F}{d_{mp}}\right\}$.

Now suppose we would use a peer-to-peer (P2P) architecture to download the file containing the Drexit deal to all MPs. For a standard situation like distributing the file from the British server to all members of the British parliament, the minimum download time can be found in a textbook (in yours, or actually in the separate excerpt from the book by Kurose and Ross that is made available to you). We are interested in the special case where the file of size F is distributed from the British server to all N members of the Deuropean parliament with the help of the 2 Deuropean servers using a P2P architecture.

2 pt (c) Provide an equation giving the minimum time to download the Drexit deal from the **British** server to all **Deuropean** MPs, **including the two Deuropean** (archive) **servers**, if the British server (which has the original document) communicates with both the Deuropean servers and the Deuropean MPs in a P2P architecture.

End of this exam.