Computer Networks
7 January 2014

- This exam consists of 8 questions with subquestions. Every subquestion counts for 10 points.
- Mark every page with name and student number.
- Use of books, additional course material, and calculator is prohibited.
- Always explain your answers. At the same time, keep your answers short and to the point. Do not use pencil or red ink. Give your answers on the exam paper (if needed, you may request additional paper.)
- Answers can be in English or Dutch.

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1. **TCP.**

   "Happy new year!". As the champagne corks fly, that is the message your Romanian friend wants to send you over a TCP connection. Of course, the time difference between Bucharest and Amsterdam is 1 hour and the message takes a bit of time to send, so your friend is trying to figure out what time to send the message in order to have it arrive at 0:00h (Amsterdam time) exactly. In the following subquestions, assume that:

   - the bandwidth between your friend's smartphone and yours is 1 Mbps;
   - receiving a message (of any size) together with all protocol processing takes a constant 0.1 ms, while tranmission takes place at the link rate;
   - no connection has been established yet and slow start starts only *after* the connection is established;
   - the latency between Amsterdam and Bucharest is 50 ms;
   - the MSS is 1000 bytes (but a segment may contain fewer bytes than that).

   (a) At what time should your friend start the transmission for you to have received it at 0:00h exactly? Be as exact as possible and give your answer in Bucharest time. →Assume ideal circumstances

A single text message is boring and your friend decides to record an elaborate video greeting of 3.6 Gbit of *data*. Moreover, he makes sure that a TCP connection is pre-established by 0:00h (Bucharest time) and then starts transmitting at the maximum rate.

(b) To his surprise, the video is nowhere near completely transmitted at 1:00h. He calls you and explains how he did the calculation, saying: "Look, 3.6 Gb of data at 1 Mbps during one hour: it should fit!" Explain to your friend what he did wrong.

(c) "I get it", your friend says. "I will use UDP instead of TCP and everything should be fine." Explain whether or not your friend's UDP transmission that starts at 0:00h Bucharest time will be finished by 0:00h Amsterdam time.→Assume ideal case and no delays on your end (so ignore the 0.1 ms).

(d) Is it possible in TCP that the value of the threshold before and after a packet loss is detected remains the same? If not, why not? If so, under what circumstances

2. **Reference models** Central to the study of networks is the layered model. In this class we have at least two layered models that we work with. They are the OSI model and the IP model (or Kurose/Ross model) that structures our text book. Sketch these two models. For the OSI model, describe the function of the layers with one sentence for each layer.

3. **Ethernet** Explain (in detail) what happens in the case of collisions in Ethernet.

4. **IP** Why do we need fragmentation in IPv4? Describe how fragmentation and defragmentation works in IPv4.

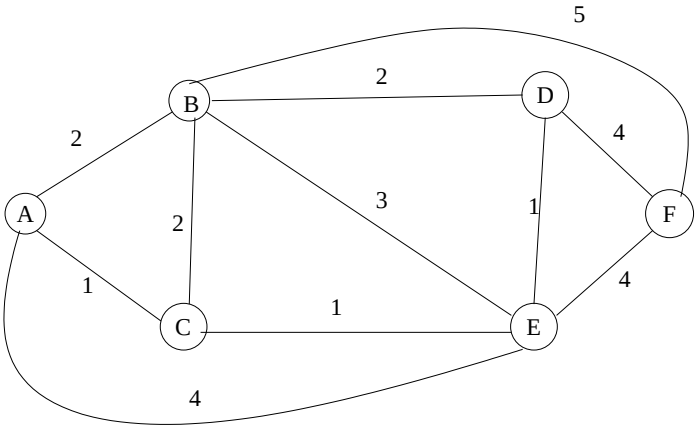
5. **Sliding windows**. Explain the sliding window protocol. What is the interest of using it when compared to a stop-and-wait protocol (i.e., in what way is it better)?

6. **Reliable transmission and TCP** Why is it important to get a good value for the retransmission

timeout? How is this value set in TCP?

7. **Mobile** What are the advantages and disadvantages of direct routing over indirect routing?

8. **Routing** The Dijkstra Routing Algorithm is a link state routing algorithm where every node knows the topology of the network and the cost of every link. Consider the topology below.



(a) Use Dijkstra to calculate the shortest routes from node **F** to every other node. Show all steps.

(b) Assume that C is buggy and erroneously (and consistently) announces that it has a direct connection of cost 1 to D. Otherwise, the node behaves correctly. Question: What will be the

consequences? Specifically, which nodes can no longer be reached by which nodes (if any)?

(c) Same as above, but now assume that C announces erroneously (and consistently) that it has a direct connection of cost 1 to F.

Extra question (no points, only answer if time permits).

I am very curious to hear what you think you have learned in this course (if anything). Please list the three main things you got out of this course: