MIEEC / MIEIC

Communication Services / System and Network Services

Winter Semester 2016/2017

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Duration: 90 min

Instructions

Please write your name and student number on all answer sheets.

This exam is open book.

Each question is worth 1 value /20.

The use of communication devices (e.g., computer, smartphone, mobile phone, etc) during the exam is strictly forbidden.

The points assigned to each question are shown in parenthesis next to the question number. Partial credit is possible, so give each question a try.

Show all your work and reasoning. This is the only way to be able to give partial credit to your answers.

If you get stuck in a question, leave it for later and go on to solve the others.

Voluntary Code of Ethics

Please sign below if you agree to comply with the following sentence.

I give my word of honour that I shall not use any unauthorised means to answer this exam.

Good luck!

Name:

Short Questions

1. RED is form of active queue management that
   A. provides delivery guarantees to some flows
   B. provides a means for routers to interact with sending hosts
   C. reacts to congestion
   D. tries to avoid congestion collapse

   Mark the sentences as True or False.

2. RTP and RTCP are partner protocols used for multimedia streaming.
   A. RTCP is used for signaling, and RTP for both signaling and data.
   B. The amount of data sent by RTP depends on the rate of the receiver reports carried by RTCP.
   C. RTP packets cannot be played when no RTCP reports are received by a receiver.
   D. RTP and RTCP typically use two sequential TCP port numbers.

   Mark the sentences as True or False.

3. A content-delivery network (CDN) has higher hosting costs than a peer-to-peer network like gnutella, but there are advantages.
   a. The CDN can serve users from a wide geographic distribution with lower delays than the P2P network.
   b. The CDN is more resilient than a P2P network to DNS attacks.
   c. The CDN is faster at finding very popular contents even on first access.
   d. The CDN can avoid highly loaded servers.

   Mark the sentences as true or false.

4. Imagine that you have a network in which each link's capacity is larger than the sum of the input data rates of all end systems. Is congestion control needed? Why/ why not?

5. Explain how the following 2 HTTP2 mechanisms will improve the performance of the web, saying which performance metric will be improved and how.

   a. Requesting contents in any order and independently of replies

   b. Reduced header sizes

6. Routers must implement a scheduling policy to multiplex the packets from different ingress interfaces onto outgoing interfaces. Fair queueing or weighted fair queueing are often used for the purpose.

   a. A round robin scheduler is not sufficient to implement fair sharing of the link. Why?

   b. Explain how the scheduler implementation with virtual clock works.

   c. How do you implement the same scheduler so that different flows can have different shares of the available egress link rate?

7. Name 2 challenges to measure the quality of experience (QoE) on the Internet.

Problems

Please show all your calculations and justify your options.

1. Antonio starts streaming a video using his browser, which adapts the video bitrate to the available bandwidth after starting at the 2nd highest bitrate. The set of available bit rates is {2754241, 3709841, 5481044, 7451370} bps.
   a. After some time, Catarina, who sits in the same room and shares the router and connection to the Internet with Antonio starts downloading a file to her computer using FTP. What happens to the video rate when Catarina joins?
   b. Ricardo, who also sits in the same room, is load testing a remote service using UDP traffic. He initially uses a sensing rate of 1Mbps, and later increases it to 3Mbps. The other two flows are still ongoing. What happens to the video data rate in each case?

      You want to guarantee to Antonio enough bandwidth to use the 2nd lowest video bitrate, and decide to implement a token bucket in the router of the room.
   c. On which parameters could you identify the traffic to be filtered/ marked?
   d. Assuming that the UDP traffic will not exceed the mentioned bitrates, how would you dimension the rate of a token bucket and on which flow would you apply it?
   e. Assume now that the UDP traffic can grow its sending rate in an uncontrolled manner. How would you dimension the rate of a token bucket and on which flow would you apply it this time?

2. Rodrigo has decided to set up a CDN and he is trying to figure out a method that clients can use to find cached web pages. That is, given a URL U, how should the client identify which CDN node to fetch the content from.
   He has come up with a hash function h that takes a string and maps it to a real number in the range [0, 10). Assume there are 3 CDN nodes with names such that h(node1) = 1, h(node2) = 8.5, and h(node4) = 5. When a client needs to fetch a URL and has to decide which replica to query, it picks node i, such that the absolute value of the difference between h(node$_i$) and h(URL) is minimum. This scheme does not use circular mapping - it's just numeric closeness.
   a. Assuming all URLs are equally popular, how much load is each node likely to see?
   b. Is the load balanced across nodes?
   c. Rodrigo is also considering another arrangement. Let there be m CDN nodes in all; sort them using the h(nodei) values. If the rank of a node is r, $(0 \le r \le m - 1)$, it is responsible for storing all URLs that map to the interval [r/m, (r + 1)/m).
   d. Which would be the load in this case?
   e. Which scheme would be more adequate for a CDN with a large number of nodes that occasionally crash and are later repaired? Briefly justify your answer.