

TDTS21 – Advanced Networking [vt 2019 version of the course]

Final Examination: 14:00-18:00, Wednesday, June 5, 2019

Time: 240 minutes

Total Marks: 40

Grade Requirements: Three (20/40); four (28/40); and five (36/40).

Assistance: None (closed book, closed notes, and no electronics)

Instructor: Niklas Carlsson

**Instructions:**

- Read all instructions carefully (including these)!!!! Some questions have multiple tasks/parts. Please make sure to address *all* of these.
- The total possible marks granted for each question are given in parentheses. The entire test will be graded out of 40. This gives you 10 marks per hour, or six minutes per mark, **plan your time accordingly**.
- This examination consists of a total of  $7+1 = 8$  questions. Check to ensure that this exam is complete.
- When applicable, please explain how you derived your answers. Your final answers should be clearly stated.
- Write answers legibly; no marks will be given for answers that cannot be read easily.
- Where a discourse or discussion is called for, be concise and precise.
- If necessary, state any assumptions you made in answering a question. However, remember to read the instructions for each question carefully and answer the questions as precisely as possible. Solving the *wrong* question may result in deductions! It is better to solve the *right* question incorrectly, than the *wrong* question correctly.
- Please write your AID number, exam code, page numbers (even if the questions indicate numbers as well), etc. at the top/header of each page. (This ensures that marks always can be accredited to the correct individual, while ensuring that the exam is anonymous.)
- Please answer in English, and try to only use Swedish or "Swenglish" if needed to complement your answers when uncertain about language.
- Most questions are designed to be answered using concrete example figures/tables. Please try to be as precise as possible.
- If needed, feel free to bring a dictionary from an official publisher. Hardcopy, not electronic!! Also, your dictionary is not allowed to contain any notes; only the printed text by the publisher.
- Good luck with the exam.

**Question 1: Intro and address basics (8 points)**

Consider a scenario in which you view a video on the YouTube website. Assume that the video is served from a datacenter located in eastern USA and you are located on the LiU campus. Furthermore, consider the IPv4 packets associated with the video transfer, including both requests and video content.

First, please draw an image of the end-to-end data path and briefly (but clearly!) explain using this figure how the following five addresses are used to achieve end-to-end Internet routing of the packets: (i) your IP address, (ii) your MAC address, (iii) the YouTube host name, (iv) Google’s AS number, and (v) LiU’s AS number.

Second, explain which of these addresses are used in the control plane and which are used in the data plane.

Third, please show the address-related header information associated with a “packet” sent from your computer to the above YouTube server (using HTTPS) when it passes your network interface card. The image should clearly indicate how encapsulation is done and should include MAC addresses, IP addresses, port numbers, and web-related addresses. Here, also indicate what addresses would be visible (and not visible) to Wireshark or other packet analyzer (when using HTTPS).

Finally, using the above example, please explain how (and with help of which protocols) an end host (such as your computer) can learn about the other computers’ and routers’ (i) host names, (ii) IP addresses, and (iii) MAC addresses.

**Question 2: TCP basics (4 points)**

Use figures and examples to illustrate why TCP’s additive increase and multiplicative decrease (AIMD) mechanism provides some stability and fairness.

**Question 3: BGP basics and trends (4 points)**

First, please draw a figure that clearly shows an example where BGP may result in a sub-optimal routing path and use the figure to explain why BGP would result in a sub-optimal route in this case. Second, please show and explain how some content providers’ use of peering agreements has changed over time and the impact that this has had on the “distances” observed on the Internet.

**Question 4: TCP and QUIC (8 points)**

First, use a figure and example numbers to illustrate how Cubic TCP differs from TCP Reno under some example scenario. Your example scenario should illustrate all phases of a typical TCP connection and should cover both the initial handshake phase as well as loss events detected using both duplicate ACKs and timeouts.

Second, list and briefly explain the key ideas behind (i) BBR, (ii) compounded TCP, and (iii) QUIC. Please be concise and use a sentence or two per bullet.

**Question 5: Tail statistics (6 points)**

First, please explain how a heavy tailed distribution relates to an exponential distribution and support your answer with a plot of some well selected example distributions that illustrate this relationship. Second, please list and explain at least two papers from the class that considered heavy-tailed distributions, and give an example distribution for one such distribution per paper.

**Question 6: Third-party services and tracking (6 points)**

First, use the literature from the course to explain (i) how modern websites are built up, (ii) who deliver this content, (iii) how parallelism typically is achieved, and (iv) how a user may be tracked across a series of websites. Second, please discuss performance and privacy implications associated with the above aspects. Please describe these implications using a simple but concrete example scenario, ideally using a figure or two. Third, please provide discuss how a few example websites (or categories of websites) may differ with regards to these tradeoffs.

**Question 7: Use of top-1M lists (4 points)**

First, please describe and compare three different top-1M lists discussed during the course. Second, describe common uses (in the research literature) of such lists. Third, lists a few important aspects to consider when using such lists in your research.

**Bonus (only on original exam)**

**Question 8: HAS (4 points)**

First, use a figure to explain how HTTP-based adaptive streaming (HAS) conceptually works. Second, briefly explain how competing players may negatively impact player performance. Third, explain how use of individual bandwidth caps can improve player performance in some scenarios.

*Good luck!!*