CSC 535
Advanced Computer Networking

University of Michigan-Flint
Department of Computer Science, Engineering, and Physics (CSEP)

Winter 2023

January 31, 2023

Homework 2
(100 points)

due by Feb 8, Wed 10:30am Eastern Time

Remarks:

- Zip all the required files for your homework into one file with the following format: **LastName-Firstname-535-hw1.zip**. For example, for me it would be **Uludag-Suleyman-535-hw1.zip**. 10% penalty for not following the zip file name convention. 10% penalty for uploading multiple files.
- No emailed homeworks will be accepted.
- Only submission is via the Canvas (https://canvas.flint.umich.edu/courses/15703) system.
- No late submissions will be accepted.
- No submission means automatic 0.
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- **Individual submission, not a group work! You cannot share your answers with anyone in the class. Both sharing and receiving will get zero and be reported to the university administration to seek the full invocation of the academic integrity violation rules.**

Questions for the deliverable:

1. (6 Points) The number of hosts in the Internet is reported in the following site: https://www.statista.com/statistics/264473/number-of-internet-hosts-in-the-domain-name-system/ (you can click on the link) What is the CAGR from 1993 to 2019? Define CAGR and show how you computed it. The statistics are accessible from campus directly. For off-campus, you need to use VPN or EZ-proxy (link is posted at Canvas). Also, diagrams (pdf, pptx, xlsx, png) are posted on Canvas.

2. (6 Points) Mobile phone network operators need to know where their subscribers' mobile phones (hence their users) are located. Explain why this is bad for users. Now give reasons why this is good for users.

3. (6 Points) Define throughput, goodput, peak rate, sustainable rate. Provide a concrete example from real products after doing an Internet search for the latter two (peak rate and sustainable rate).

4. (6 Points) Imagine that you have trained your dog to carry a box of three 8-mm tapes. (When your disk fills up, you consider that an emergency.) These tapes each contain 7 gigabytes. The dog can travel to your side, wherever you may be, at 18 km/hour. For what range of distances does the dog have a higher data rate than a transmission line whose data rate (excluding overhead) is 150 Mbps? How does your answer change if (i) the dog's speed is doubled; (ii) each tape capacity is doubled; (iii) the data rate of the transmission line is doubled.

5. (6 Points) Go to http://www.dslreports.com/speedtest run the speed test from home (or from the same location and device) at three different times of three different dates. Report date/time, location, and device together with screenshot of download and upload data rates. Were they identical? Why so or why not? Briefly explain.

6. (6 Points) The usual response to packet loss is the retransmission of the same packet. Given that the packet loss ratio is ρ and that the acknowledgements are always received, what is the expected number of transmissions to get one packet successfully delivered. Be clear, show your intuition and computation.

7. (6 Points) An image is 1600x1200 pixels with 3 bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over a 56-kbps modem channel? Over a 1-Mbps cable modem? Over a 10-Mbps Ethernet? Over 100-Mbps Ethernet? Over Gigabit Ethernet?

8. (6 Points) When an error is detected during a data exchange, what are the options available for recovery? Explain each and elaborate which one you would use under what circumstances.

9. (6 Points) Explain DAS, NAS, and SAN.

10. (6 Points) What are the methods to implement WANs? Explain each category together with use cases for each.

11. (6 Points) Assume that an end-to-end communications system is made up of three networks with date rate in Mbps ρ_1, ρ_2, and ρ_3, respectively. Ignoring the other delay components, what is the total end-to-end delay to transmit a packet size of λ?

12. (6 Points) A data channel at 5 Gbps is shared by two users. Assume that each user is transmitting at $2.5 Gbps$ data rate continuously. Each user only transmits only 30% of the time.

    (a) If circuit switching is used, how many users can be supported?

    (b) If packet switching is used, would there be queuing delay to accommodate these two users? If a third identical user is added will there be a queuing delay?

    (c) What is the probability that a user is sending data?

    (d) Now assume three users under packet switching. Compute the probability that at any given time all three are transmitting at the same time. What is the fraction of time when the queue is growing?

13. (28 Points) Create a free account at https://tryhackme.com/. And complete the following labs/learning modules:

    (a) Under Windows Fundamentals (https://tryhackme.com/module/windows-fundamentals), complete the following:

        i. **Windows Fundamentals Part 1** https://tryhackme.com/room/windowsfundamentals1xbx
        ii. **Windows Fundamentals Part 2** https://tryhackme.com/room/windowsfundamentals2x0x
        iii. **Windows Fundamentals Part 3** https://tryhackme.com/room/windowsfundamentals3xzx

    (b) **Introductory Networking** https://tryhackme.com/room/introtonetworking

    (c) **HTTP in Detail** https://tryhackme.com/room/httpindetail

    What to submit for the above:

    - Your usename and password
    - Screenshots of green buttons with the text of **Completed** and **Correct Answer** at the end of the tasks if any question to answer is displayed, as shown in Figure 1 for Task 2 under Linux 1 from hw1.

Figure 1: An example screenhsot to submit for Task 2 under Linux Part 1 lab from hw1 questions.