

CSC/ECE 573

Spring 2023

Homework #1

Instructions

- You must do this assignment in groups of two as provided to the TA (except for the one group that will have three students).
- Submit your final codes and other documents (mentioned later in the description) via Moodle.
- The due date and time for this assignment: Feb 17, 2023, 11:45 PM ET.

Objectives

1. Get hands on experience with HTTP, GRPC, and BitTorrent protocols and see the differences in the performance achieved by the protocols.

Description

You will need two computers connected over a local area network for this assignment.

Please find attached eight files. Each file is named as X_y , where $X \in \{A, B\}$ and $y \in \{10\text{kB}, 100\text{kB}, 1\text{MB}, 10\text{MB}\}$, i.e., y represents the size of file;

In this assignment, you will transfer these files among computers using.

1. HTTP 1.1
2. HTTP 2
3. GRPC
4. Bittorrent

Files whose names start with A will be stored on **computer 1**, and files whose names start with B will be stored on **computer 2**. Both computers will fetch these files from each other several times using the four protocols listed above. *At any given time, there should be only one TCP connection between the two computers.*

For each of the three client server protocols, i.e., HTTP 1.1, HTTP 2, and GRPC conduct the following experiments:

1. Transfer the A_10kB file from **computer 1** to **computer 2** 1000 times. Transfer the B_1kB file from **computer 2** to **computer 1** 10,000 times.
2. Transfer the A_100kB file from **computer 1** to **computer 2** 100 times. Transfer the B_10kB file from **computer 2** to **computer 1** 1000 times.
3. Transfer the A_1MB file from **computer 1** to **computer 2** 10 times. Transfer B_1MB file from **computer 2** to **computer 1** 10 times.
4. Transfer the A_10MB file from **computer 1** to **computer 2** 1 time. Transfer B_10MB file from **computer 2** to **computer 1** 1 time.

Remember that in each run of each of these four experiments, you can only have one TCP connection between the pair of computers at any given time.

During each run of each experiment (i.e., every transfer of each file), record the time (programmatically, not by hand) that file transfer takes, divide the file size by this time, and record the result.

After completing all 1111 transfers of A files and 1111 transfers of B files, and recording the results, fill out the table in the attached excel file named "Results File.xlsx". Note that this table also asks you to report the total application layer data transferred from sender to receiver (including header content) per file divided by the file size. This will enable you to measure the overhead of each of these protocols and understand how the performance of these protocols compares with each other. Explore and learn various features that different protocols provide (such as multiplexing in the case of HTTP 2) and aim to complete the transfers using any given protocol in the smallest amount of time (i.e., achieve as high a throughput as possible).

For BitTorrent, you will need four computers. You can emulate four computers on two computers as well using VMWare/VirtualBox to create an extra virtual machine on each computer. For BitTorrent, one computer will initially have the file to be exchanged. The four computers will all use the BitTorrent

protocol to exchange the file, such that eventually, every computer will have a copy of the file. For BitTorrent, there is no restriction on how many TCP connections are opened between any pair of computers.

For the BitTorrent protocol, conduct the following experiments.

1. Transfer the A_10kB file from the peer that initially has it to each of the remaining three peers **333** times. For this, you will execute the torrent 333 times, i.e., every time the file transfer from the initial peer to all the other three peers completes, you start over, where the same initial peer has the A_10kB file and the remaining three peers obtain it again, and so on.
2. Transfer the A_100kB file from the peer that initially has it to the remaining three peers **33** times.
3. Transfer the A_1MB file from the peer that initially has it to the remaining three peers **3** times.
4. Transfer the A_10MB file from the peer that initially has it to the remaining three peers **1** time.

During each run of each experiment (i.e., every transfer of each file to the three other peers), record the time (programmatically, not by hand) it takes until all three peers have the file. To calculate throughput, divide the file size by this time and multiply with three (because three peers received file during this much time), and record the result. After completing all 370 experiment runs and recording the results, fill out the table in the attached excel file named "Results File.xlsx". Note that this table also asks you to report the total application layer data transferred among all four peers (including header content) during each run of each experiment divided by the file size and divided further by 3 (because three peers received the file in each experiment). This will enable you to measure the overhead of the BitTorrent protocol and understand how it compares with the three client-server protocols.

To complete this assignment, you will have to get onto internet and identify and learn how to implement the client and server for each protocol. Do not try to code the entire protocol yourself; that will take a long time. Find appropriate libraries that already implement the protocol and use them. For example, for BitTorrent, libtorrent (<https://libtorrent.org/>) is a well-known library that you can use.

What to submit

Please make only 1 submission per group, i.e., only one student in the group should submit. In a single .zip file, upload the following to Moodle submission page.

1. Code for all computers (VMs) for each experiment and readme files explaining how to execute the code files
2. Completed "Results File.xlsx"
3. A report containing the following.
 - a) On the first page
 - i. Names of each team member and percentage contribution of each team member. Please be fair and truthful. The grade of this assignment will be divided among team members according to their percentage contributions.
 - ii. What exactly did each team member do. Make a table. Assuming you have 2 members in your team, make a table with 3 columns. The first column should state various subtasks that your team undertook for this assignment and the next two columns should state the percentage contribution of the two team members for each subtask.
 - b) On page 2 and onward, first describe what libraries you used for each protocol and include references to where they can be publicly downloaded from. After that, describe your observations from the experiments and from the completed table in "Results File.xlsx". Discuss which protocols perform better in what scenarios, investigate why, and provide convincing arguments to justify your observations. Be concise and to-the-point. The description of your observations should not exceed three pages, double column, 10pt font.