# Computer Science 467

**Computer Networks**

**Fall 2020**

**PEX 1 - 80 Points**

**Due: Lesson 10 Midnight**

# Help Policy

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| **AUTHORIZED RESOURCES:**   Any, except another cadet/group’s program.  **NOTES:**   * Never copy another person’s work and submit it as your own. * You must document all help received from sources other than your instructor, or instructor-provided course materials (including your textbook), or your partner. * DFCS will recommend a course grade of F for any cadet who egregiously violates this Help Policy or contributes to a violation by others. |

# Documentation Policy

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| * You must document all help received from any source. **Include your documentation statement at the top of your programs**. Unless quoting directly or paraphrasing, you do not need to document your course text, lectures, or any other course materials provided by your instructor. * Each documentation statement must be specific enough that it explicitly describes **what** assistance was provided, **how** it was used in completing the assignment, and **who** provided the assistance. * If no help was received on this assignment, the documentation statement must state “NONE.” * If you checked answers with anyone, you must document with whom on which problems.  You must document whether or not you made any changes, and if you did make changes you must document the problems you changed and the reasons why. * Vague documentation statements must be corrected before the assignment will be graded, and will result in a 5% deduction on the assignment. |

# Learning Objectives:

* To learn how the socket API can be used to implement programs that communicate over a network using the UDP transport layer protocol.

# Project Description

The goal of this project is to implement a client/server UDP-based MP3 Streamer application. This will require the implementation of the client program—the functioning server will be provided as a standalone executable. The server will stream an MP3 file (an audio clip) by transmitting individual UDP datagrams to the client with each payload being a single MP3 frame (~400-600 bytes depending on the MP3’s bit rate and sample rate). **See the “Additional Information” section for specifics on how the server can do this.** Note, there is no requirement for the client to actually play the received MP3 audio. We will simulate streaming on the client by creating a binary file and simply appending the incoming stream data to that file. When the “stream” is done, you should be able to play the MP3 using Windows Media Player.

You are strongly encouraged to use the UDP demo programs presented in class as your starting point. The only requirement is that you remove the explanatory comments and add normal program comments to the code. You should run the instructor-provided server and client compiled executables first. When you run the compiled client and server, you should capture the UDP network traffic using Wireshark. This will allow you to see how the client and server interact, as well as how the UDP datagrams are structured when looking at them in Wireshark. More details are in the Gatecheck section below.

IMPORTANT: Your client must use communications that exactly match the provided StreamMP3 RFC. When implemented correctly, your client should be able to communicate with any server that implements the StreamMP3 protocol. As you develop your solution, you should follow incremental development processes…write a little code, test it, debug, and continue!

# Detailed Requirements

**Client functionality**

* Your client program must be command-line based user interaction
* Your client program must supply the user with options to list songs, stream a song (by name, including the .mp3 extension), or quit.
* Your client must use a single UDP socket.
* Your client must not “hang” waiting for a server that is not there or does not respond. Your client must use appropriate timeouts on the socket to stop waiting. A 5 second wait time is reasonable.
* Your client must communicate with the server using the protocol defined in the provided StreamMP3 RFC. User input and output should be well designed and user friendly. Simply printing the messages sent between the client and server is not sufficient for full credit.

**Programming requirements**

* Your client program must be written in C and compiled with Cygwin (on Windows) or gcc (on Linux/Mac) using Visual Studio Code.
* All errors returned by socket calls must be caught and dealt with properly. Your client program should never crash because of a socket error (or any other type of error). If there is a socket problem, your client should terminate gracefully.
* Name your files using your (and your partner’s, if you have one) last name and include “client”.

# ROE

* Use Visual Studio Code for C programming.
* Use incremental development. Get a small part of your program to work. Then add functionality, little by little.
* It is perfectly legal to use the example code presented by your instructor in class. Get help if the example code is confusing.

# Turn-in

* Gatecheck: answer Wireshark-based questions via Canvas “quiz”
* Final turn-in: Canvas

# Additional Information

MP3s are audio files that are compressed using a proprietary compression algorithm developed in the 1990s. It allows compression ratios on the order of 10:1. If you’re curious about the algorithm, see <https://en.wikipedia.org/wiki/MP3>.

It helps to understand the structure of an MP3 file in order to understand how the server streams the data to a client upon receipt of a START\_STREAM command. MP3 files consist of an optional header that may contain metadata about the file (called an ID3 tag). The remaining data consists of a series of *frames* that describe the compressed audio data. These frames are (mostly) independent of each other – you can chop an MP3 file on a frame boundary and the remaining file will still play. We don’t care what’s inside those frames – the MP3 decompression algorithms found in MP3 players handle that. However, we do care about the size of the frames. **The server will “stream” the MP3 by transmitting individual UDP datagrams to the client with its payload being a single MP3 frame (~400-600 bytes depending on the MP3’s bitrate and samplerate).**

**Frame Details.** Each frame is an independent chunk of data. Frames begin with a 4 byte header that describes the frame and contains information like MP3 version, bitrate, sampling rate, mono or stereo, etc. Please review <http://www.mp3-tech.org/programmer/frame_header.html> for details on how a frame’s header is organized. Here is a snapshot from that site:

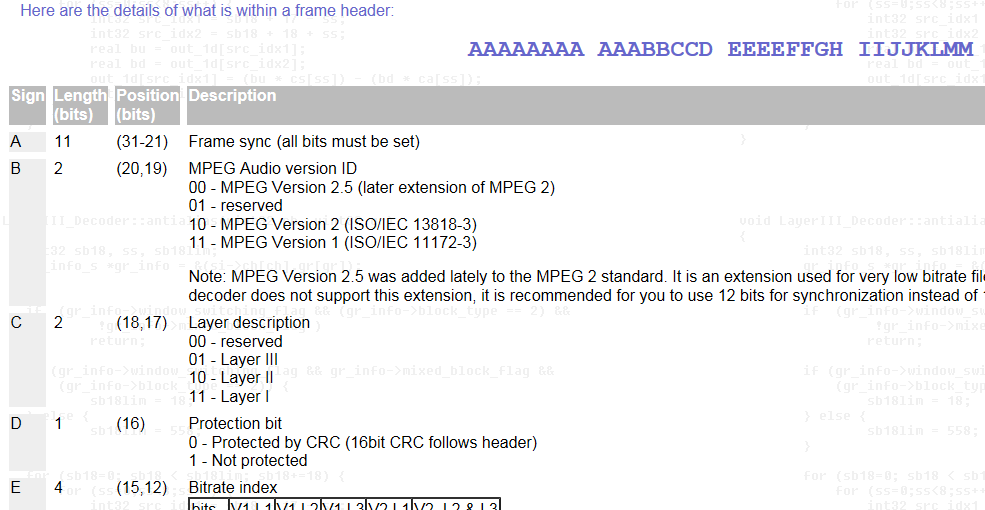


Figure 1 - mp3 Header Contents

To detect frames, the server program must search for the Frame sync (11 bits set to 1), Audio version ID (MPEG Version 1), Layer Description (Layer III), and Protection bit (not protected). This equates to two bytes equaling 0xFF and 0xFB. You may assume that all MP3 files the server handles will use these settings. As such, all valid frames will start with these two bytes! Once the server program locates the first frame in the file, it then can search for the next frame by starting at the last byte of the current frame.

An mp3 frame can be viewed using Wireshark or hexdump for VS Code.

A close up of text on a white background

Description automatically generated

Figure 2 - UDP packet containing an mp3 frame implementing the StreamMP3 RFC.

**Other Hints**

If your client and server are operating in the same directory, I suggest that when the client receives a song from the server it adjusts the file name so that the original doesn’t get stomped.

*Socket Timeouts*

* A UDP socket should never wait forever for an expected response from a server.
* If a server does not respond in a timely manner, the socket should "timeout" and allow processing to continue.
* A socket timeout generates an error and causes the sending/receiving function to return -1. The error can then be handled accordingly.
* Demo code setting socket timeout in C:

![A screenshot of a cell phone

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RFMRXhpZgAATU0AKgAAAAgABAE7AAIAAAArAAAISodpAAQAAAABAAAIdpydAAEAAABWAAAQ7uocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFJvb3NtYSwgQWxleGFuZGVyIEMgTWFqIFVTQUYgVVNBRkEgREYvREZDUwAAAAWQAwACAAAAFAAAEMSQBAACAAAAFAAAENiSkQACAAAAAzk1AACSkgACAAAAAzk1AADqHAAHAAAIDAAACLgAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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pjwD/0Af8Aycn/APi6APlOivqz/hTHgH/oA/8Ak5P/APF0f8KY8A/9AH/ycn/+LoA+U6K+rP8AhTHgH/oA/wDk5P8A/F0f8KY8A/8AQB/8nJ//AIugD5Tor6s/4Ux4B/6AP/k5P/8AF0f8KY8A/wDQB/8AJyf/AOLoA+U6K+rP+FMeAf8AoA/+Tk//AMXR/wAKY8A/9AH/AMnJ/wD4ugD5Tor6s/4Ux4B/6AP/AJOT/wDxdH/CmPAP/QB/8nJ//i6APlOivqz/AIUx4B/6AP8A5OT/APxdH/CmPAP/AEAf/Jyf/wCLoA+U6K+rP+FMeAf+gD/5OT//ABdH/CmPAP8A0Af/ACcn/wDi6APlOivqz/hTHgH/AKAP/k5P/wDF0f8ACmPAP/QB/wDJyf8A+LoA+U6K+rP+FMeAf+gD/wCTk/8A8XR/wpjwD/0Af/Jyf/4ugD//2Q==)

Figure 3. Socket timeout example in C

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CS467 – PEX 1 - Cut Sheet**

**80 Points**

|  |  |  |
| --- | --- | --- |
| **Grading Criteria** | **Pts** | **Comments** |
| **Gatecheck** | **10** | See Gatecheck grade in Canvas |
| **Client** | **70** |  |
| Provides command-line UI allowing “list”, “stream”, and “quit” options | 12 |  |
| “list” command retrieves and prints list of stream-able songs (>= 2) | 12 |  |
| “stream” command receives, frame-by-frame, the song in its entirety | 15 |  |
| “stream” command correctly saves the stream data to a file | 10 |  |
| Client implements StreamMP3 RFC correctly (LIST\_REQUEST, START\_STREAM, etc) | 15 |  |
| Code is well-organized and commented | 6 |  |
| Errors not handled, or hung process, or crashes | -1 to -10 |  |
| **Total** | **80** |  |
|  |  |  |
| Poor or missing documentation (-5%) | -4 |  |
| Late Penalty Cap  (25% per 24 hour period) (60, 40, 20, 0) |  |  |
| **Final Grade** |  |  |