C/C++ Programming Exercise

Getting started

In this exercise you are required to understand, modify and write code in C and/or C++. To start this exercise download the *starter pack* from the following URL:

`http://www.cl.cam.ac.uk/teaching/current/CandC++/`

This ZIP file should contain the following files:

```
server.c
client.c
rfc0791.txt
rfc0793.txt
message1
message2
message3
message4
```

Important: You should avoid the use of any compiler-specific features in the exercise. Code written for this exercise should conform to ISO9899:1999 ("C99") or ISO14882:1998 ("C++98") and use standard libraries. The code should compile and run correctly using `gcc` or `g++` as available on PWF linux. Your code should not generate any warnings, even with all warnings turned on; in other words

`gcc -Wall sourcefile.c` *or* `g++ -Wall sourcefile.cc`

should produce no warnings for all source files you submit.

Exercise – Part 1

The exercise starter pack contains two computer programs written in C. The first program, `server.c` transmits data and the second program, `client.c` receives data. There are a few mistakes in these programs which prevent the code from compiling or functioning correctly. Do the following:

1. Describe in fewer than 100 words the intended functionality of the two programs `server.c` and `client.c`. Write this description into the file `answers.txt`. The format of this file should be plain ASCII text.
2. Find and list three programming errors in the code. (There are in fact more than three errors, but you only need to find three.) Modify the code to correct the errors. Compile and execute the code with suitable test data. (Hint: the IP address `127.0.0.1` can be used as a suitable

IP address if you want to run both the client and server components on the same machine.) A list of the three errors should be appended to the file `answers.txt`. Your corrected code should be saved into `server1.c` and `client1.c`.

Exercise – Part 2

A computer scientist writes a packet inspector to record every bit of data sent by (a corrected version of) `server.c` on machine A and received by (a corrected version of) `client.c` on machine B. The recorded data contains *all* the TCP/IP packets and includes the TCP and IP headers in *network byte order* together with the actual message payload.

The files `rfc0791.txt` and `rfc0793.txt` contain the specification of IP and TCP headers respectively. Your attention is drawn in particular to the layout, in bytes, of the contents of the header files as expressed in these documents. For convenience, the layouts are also shown in the Appendix.

The computer scientist invokes the server program on machine A and the client program on machine B once, and generates a log file of all the packets sent between the two machines. The log file contains the raw packet data in the order in which the packets were transmitted on machine A. Therefore the first packet is at the start of the file, and this is immediately followed by data from the second packet, and so on.

An example log file is `message1`. Your next task is to write a C or C++ program to read in *any* log file in this format and determine the following facts:

- The IP addresses of machines A and B (`source` and `destination`)
- The value of the first IP packet's header size field (`IHL` – IP header length)
- The length of the first IP packet in bytes (`total length`)
- The value of the first TCP packet's header size field (`data offset`)
- The total number of IP packets in the trace

You should save your program into a file called `summary.c`. Your program should output the above details in the same order as shown above by printing to `stdout` on a single line, using spaces to separate the fields. For example, if the IP addresses of machines A and B are `192.168.1.1` and `192.168.1.2`, the header length field value is `6`, the length of the IP packet is `52` bytes, the value in the TCP header length is `5`, and the total number of packets in the trace is `20`, your program should output:

```
192.168.1.1 192.168.1.2 6 52 5 20
```

Exercise – Part 3

Your final task is to write a second program in C or C++ to remove the IP and TCP headers from *any* log file conforming to the format described above and extract the data transmitted from

machine A to machine B. The source code for this program should be saved in `extract.c`. Your program must take two arguments on the command line, and open and read log data from the filename passed as the first argument, and write data into a file whose name will be passed as the second argument. Your program should print an error message if a file with the name of the first argument does not exist. Your program should overwrite the data in any file with the same name as the second argument, or create a file of this name if it does not exist. For example, if an executable form of your program was called `extract` then the following execution

```
./extract message1 message1.txt
```

will extract the data held in `message1` and write it into the file `message1.txt`.

Use your program to do the following:

- Extract the data from `message1` and save this data into a new file called `message1.txt`. Load this message into a text editor of your choice and read it. Does the message make sense? (If not, you probably need to debug your code!)
- Extract the data from `message2` and save this data into a new file called `message2.jpg`. By using a web-browser or otherwise, view this image. What does the image show? (If you cannot view the image you probably need to debug your code!)
- *(Optional)* Decipher the contents of `message3` and `message4` to claim the prize.

Submission

By the end of this tick you should have generated the following files: (No core files, temporary files, or Makefiles. All of these files and only these files to be submitted, please.)

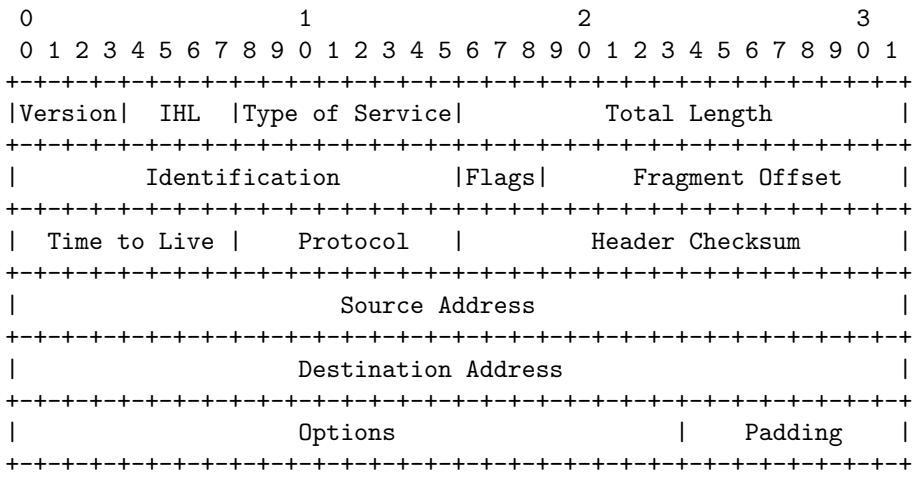
```
answers.txt
client1.c
server1.c
summary.c
extract.c
message1.txt
message2.jpg
```

Once you have correctly completed the exercise you should make a new ZIP file containing these files. This ZIP file should be named with your CRSID and end with the extension `.zip`. So if your CRSID is `awm22`, your ZIP file should be called `awm22.zip`. To submit your tick, email this file as an attachment to:

`c-tick@cl.cam.ac.uk`

Appendix

RFC 791 (`http://www.ietf.org/rfc/rfc0791.txt`) specifies the layout of packets in the IP Protocol. You may need to read portions of this document in order to complete this exercise. Of particular interest is the position of the packets in the Internet Protocol header:



RFC 793 (`http://www.ietf.org/rfc/rfc793.html`) specifies the layout of packets using the TCP protocol. You may need to read portions of this document in order to complete this exercise. Of particular interest is the position of the key data elements in the Transmission Control Protocol header: