Department of Computer Science
Computer Networks
Due: Sunday 30th August (23.59)

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TA Name: Jón Pétur
Time Taken: 23-30 august
Estimated Time: 20 hours

This is an individual assignment and should be submitted as a pdf, with accompanying code, using Canvas.

For those who like to dabble in the dark arts, the latex version is also available. You may submit in any legible form you wish, but please use tar to bundle files.

Practical programming exercises may be done on your local laptop, or using your account on skel.ru.is. Part of this assigment is getting your programming environment setup for the rest of this course. We strongly recommend that you create a suitable environment on your laptop or other machine which you can use to run client and monitoring software such as tcpdump. If you have any issues at all in getting setup, please contact us **immediately**.

Marks are awarded for question difficulty. While there is typically a relationship between difficulty and length of answer, it may not be a strong one. Always justify your answer if necessary, especially with somewhat open ended design questions.

All submissions must be bundled up using the *tar* command. If you submit an assignment using anything else (zip say), and persuade Canvas to accept the upload by renaming the file, you will receive an automatic 0.

Question:	1	2	3	4	Total
Points:	10	15	15	6	46
Score:					

Useful Network Commands (Linux)			
man	Online manual for command	man -k	keyword search on manual
whois	Domain registry information	htop	Enhanced top, show processes
iftop	Show top traffic/network	iptraf-ng	IP traffic monitor
route	show local routing	arp -v	Show address resolution cache(root)
ncat < *ip* >< *port* >	Connect to remote system	nmap	Scan remote host
netstat	Show network statistics	netstat -antup	Process path info
netstat -t	Show only tcp connections	netstat -u	show only udp connections
ss	Show detailed network info	ss -s	Summary of network info
ifconfig	Network Interface	ip	Enhanced ipconfig/network info.
nmap -A -T4 scanme.nmap.org		scan host ports - os, version and traceroute	
dig	DNS record lookup	dig < *domain* >	Get full record for < *domain* >
nslookup	interactively query DNS	set type=A	Specify A records
		server=	Specify server to query

Introduction

The commands above are a summary list of command line tools that can be used for networking purposes. In particular, nmap and ncat (note, another version of ncat called nc exists, but is not always as reliable), will be useful for this assignment. Some of these commands may need to be installed using the package management for your machine, and should be available via the bash console on Windows.

Network Connectivity

The goal of this exercise is to first introduce you to some useful network command line tools, to help you explore and debug network programs, and then get you to write your first very simple network program.

1 ..... *10 points*

Download the server.cpp file attached to this assignment. This is a very simple TCP/IP server, which listens for incoming TCP connections on port 5000. Compile and run it using the commands:

```
Linux and Windows/Bash:
    g++ -Wall -std=c++11 server.cpp -o server
OSX
    g++ -std=c++11 server.cpp -o server

./server
```

Note, you may need to install g++ (On OSX use brew).

Now connect to it from the same machine you ran the server on using the standard loopback network interface "127.0.0.1" by performing the following steps.

From a separate terminal, verify that you can connect to the server which is listening on port 5000, using the ncat command:

```
ncat 127.0.0.1 5000
```

The server should tell you a client has connected. Now on a third terminal, run the tcpdump command (which may require sudo privilege) to monitor the traffic between the client and the server, using the following incantation:

```
tcpdump -X -i lo host 127.0.0.10 and port 5000
```

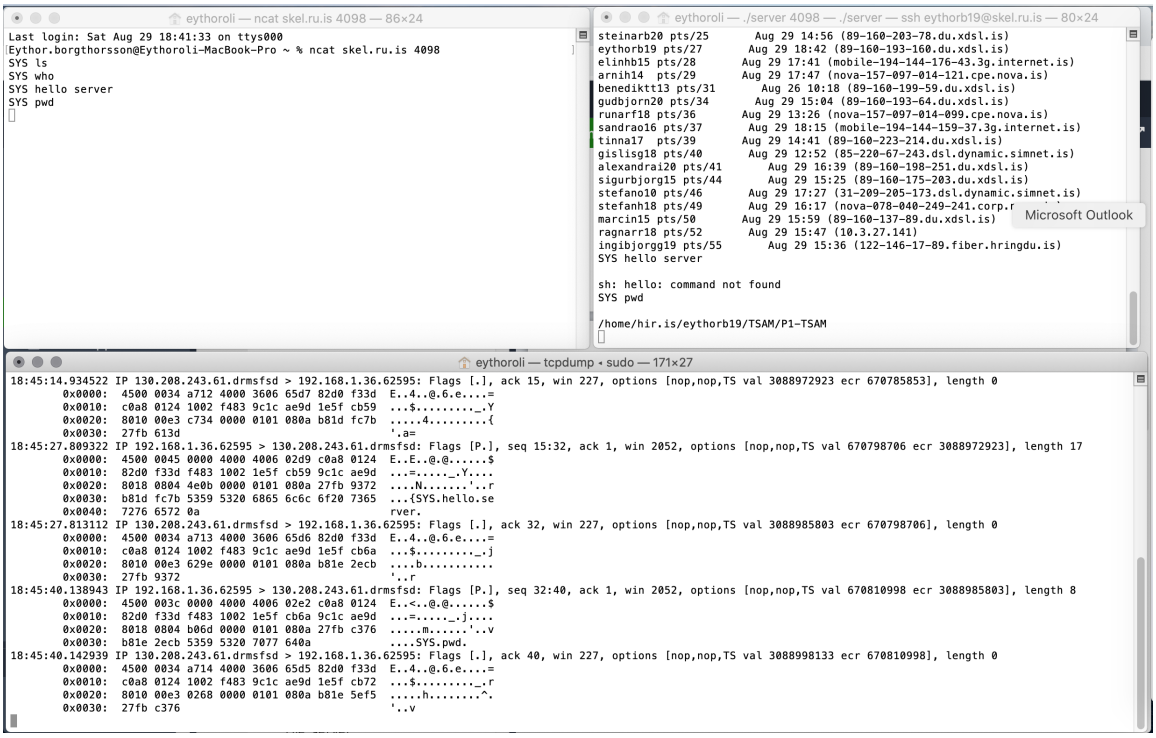
The server supports one command, SYS < *command* > which will run the one word command specified on the server. Enter a command of your choice (eg. who, ls, w, etc), and observe the results on your terminal.

(a) (10 points) For full marks on this question, repeat the above series of steps, connecting to the server from a **different** machine than the one the server is running from, and submit a screen capture of each terminal, ncat, ./server and tcpdump (three in total).

If for **any** reason you are not able to connect from a different machine, submit the screen captures from the same machine as above, and a convincing explanation, including the name of the TA you spoke to to get help, of the issue you ran into.

Solution

Below is a screenshot of:
a) The client (ncat skel.ru.is 4098)
b) The server running on skel.ru.is and port 4098 (./server 4098)
c) tcpdump (sudo tcpdump -X -i en0 host skel.ru.is and port 4098)



2 ..... *15 points*

For the second part of this assignment, you need to write a client program that connects to the server remotely, in the same way you used ncat to do. All the client needs to do is to connect to the server, and send a SYS command to the server. For full marks for this question submit:

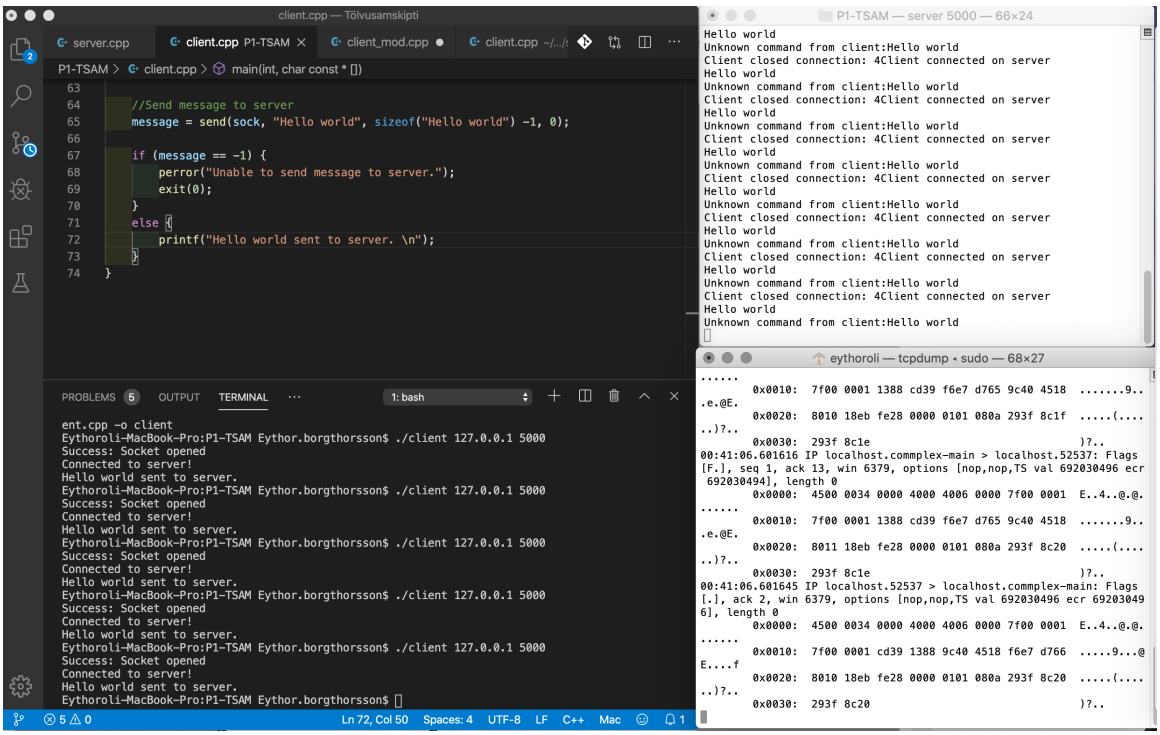
(a) (10 points) Client code connecting as described above

(b) (2 points) Screen shot of server receiving command and executing it

(c) (3 points) tcpdump of command being sent to server

Solution

Below is a screenshot of:
a) The client, connecting and sending message to the server. (./ client 127.0.0.1 5000)
b) The server running on 127.0.0.1 and port 5000 (./server 5000)
c) tcpdump (sudo tcpdump -X -i lo0 host 127.0.0.1 and port 5000)



3 ..... *15 points*

For the third part of this assignment, you need to modify both the server, and the client you have just written.

The server should be modified to send the client the output from the command executed as a response and also to handle parameters on the command being sent from the client. For example, "ls -sal". The client should be modifed to receive the output of the commend from the server, and to print it out on the comand line, and then be ready to accept and send another command. That is, the client operates in a loop, send command, receive results, print, send command, etc., as network clients often do.

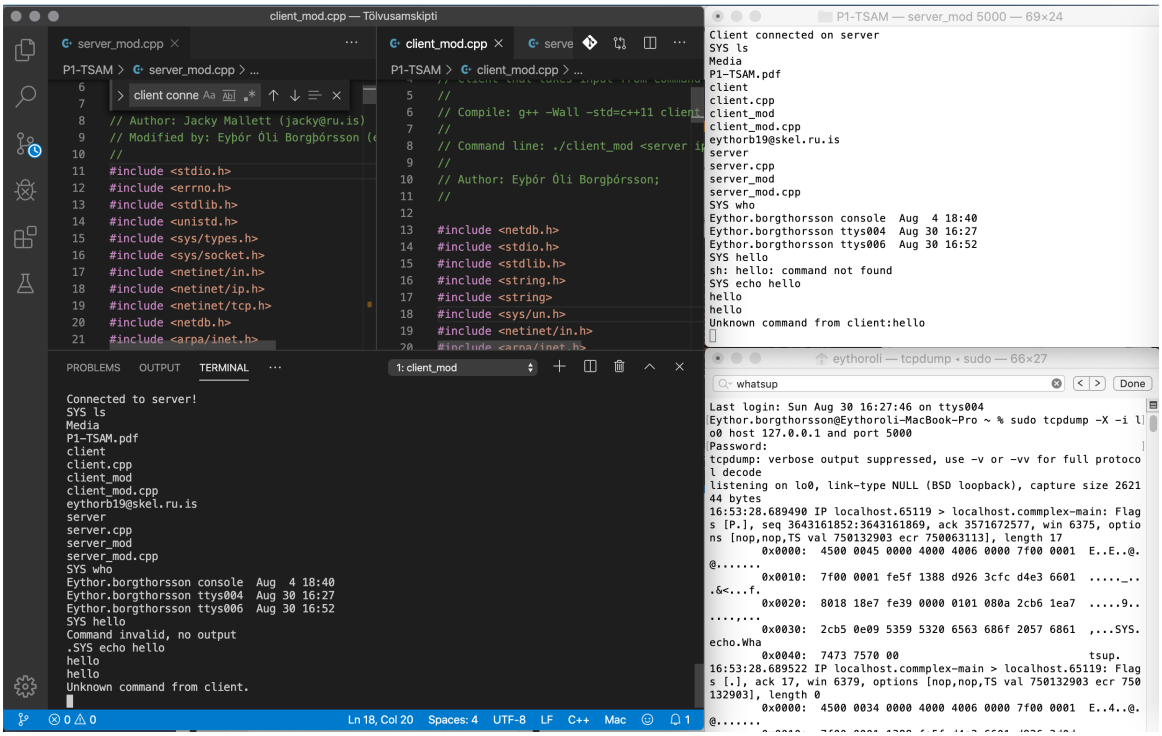
(a) (5 points) Modified server code meeting above specification

(b) (5 points) Modified client code meeting above specification

(c) (5 points) tcpdump of at least two commands being sent to server and response being received.

Solution

Below is a screenshot of:
a) The client, connecting and sending requests to the server, *SYS ls, SYS hello, SYS echo hello, hello.* (./client_mod 127.0.0.1 5000)
b) The server running on 127.0.0.1 and port 5000 (./server_mod 5000)
c) tcpdump (sudo tcpdump -X -i lo0 host 127.0.0.1 and port 5000)



4 . . . . . *6 points*

In addition to the marks for the individual questions, the following marks will be awarded:

(a) (2 points) A Makefile is included which compiles the code submitted

(b) (2 points) README file is provided explaining how to compile and run submitted code. File should include command line commands used to compile (IDE's will not be accepted), and instructions on how to run the programs.

(c) (2 points) Code compiles using the Makefile, and runs following instructions in README file names are informative, and each function/class has a header describing its purpose.

Solution

Makefile and README file is included. Compile by using make all and you will get further instructions.