

Grading Guidelines:

A right answer will get full credit when:

1. It is right (worth 25%)
2. It is right **AND** neatly presented making it easy and pleasant to read. (worth an **extra** 15%)
3. There is an **obvious and clear link** between 1) the information provided in the exercise and in class and 2) the final answer. A clear link is built by properly writing, justifying, and documenting an answer (worth an **extra** 60%).
4. Calculation mistakes will be minimally penalized (2 to 5% of full credit) while errors on units will be more heavily penalized.

Late Submission : as specified in the syllabus. Days counting starts one minute after the deadline.

You are welcome/encouraged to discuss exercises with other students or the instructor. But, ultimately, **personal** writing is expected.

- USE THIS FILE AS THE STARTING DOCUMENT YOU WILL TURN IN. **KEEP IN THE QUESTIONS** AND INSERT YOUR ANSWERS.
- IF USING HAND WRITING (STRONGLY DISCOURAGED), REWRITE THE QUESTIONS.
- FAILING TO FOLLOW TURN IN DIRECTIONS /GUIDELINES WILL COST A 30% PENALTY.

Objectives of this assignment:

- to learn consider some issues about port numbers
- to explore issues related to the maximum size of TCP segments.

What you need to do:

Answer the questions and/or solve the exercises described below.



KEEP THE GRADING GUIDELINES ABOVE TO REMEMBER THE DIRECTIONS AND HOW THE HOMEWORK IS GRADED.

Objective: The objective of this assignment is to explore some issues about port numbers and largest size of TCP segments.

Resources:

1. **Textbook:** Tanenbaum, Andrew S. and David J. Wetherall. *Computer Networks*.
2. Module 6 lectures
3. Your instructor
4. Wikipedia
5. Internet

Note that the textbook, Module 6 material, and your instructor are sufficient to answer all questions in this homework as well as the related self-study questions.

Question 1

Both UDP and TCP use port numbers to identify the destination entity when delivering a message.

- a) (10 points) Can a UDP Server and a TCP Server run simultaneously on the same port # 2500 on the same machine? Explain ... Since UDP and TCP ports are completely independent from one another, it is possible for a UDP server and a TCP server to run simultaneously on the same port # on the same machine. It's also possible to have both UDP and TCP requests on the same port because each request is identified by: (1) source IP, (2) destination IP, (3) source port, (4) destination port, and (5) protocol (UDP/TCP).
- b) (20 points) Rather than using a port number to identify the connection, why didn't the designers use the process identifier? ... The main reason why designers didn't use process identifiers to identify connections is due to stability. Port numbers need to be stable and with processes, there is not guarantee of what process ID would be assigned. Process identifiers are not static but are assigned dynamically. Process IDs tend to be specific to an OS and there using process IDs rather than a defined port number would make the protocol dependent on a particular operating system.

Question 2

The objective of this question is to determine the largest size of a TCP segment transported by IPv4.

- a) (10 points) Does the TCP Header have a field indicating the size of a segment? The TCP Header only contains a field indicating the Header length and does not have a field indicating the size of a segment.
- b) (10 points) Does the IPv4 Header have a field indicating the size of a segment packet? The IPv4 Header does have a field indicating the size of a segment packet. The Header has a total length field which determines the total size of the segment packet. It is a 16-bit field that indicates the entire size of the IP packet (header and data) in bytes. The minimum size is 20 bytes (if there isn't any data) and maximum size is 65,535 bytes which is the highest value that can be created with 16 bits.



- c) (10 points) Suppose you just received an IPv4 packet. What is the field/information in this packet that can allow you to determine the size of the TCP segment?
- Given an IPv4 packet, we have an IP header as well as the TCP segment. The size of the TCP segment can be determined using the total length field and the header length field present in the IP header. With the total length field, we are able to find the size of the entire packet, e.g. IP header + TCP segment. Next, using the header length field, we can find the size of the IP header. Finally, we can determine the size of the TCP segment by taking the difference between the total length and the header length.
- d) (20 points) What is the largest size of a TCP segment transported by an IPv4 packet?
- The maximum size of an IP packet is 65,535 bytes (which includes the header and segment) and minimum size is 20 bytes (without any data). In order to determine the largest size of a TCP segment transported by an IPv4 packet, you take the header length (minimum size in bytes) subtracted from the maximum size of an IP packet. So in this case: $65,535 - 20 = 65,515$ bytes.

Question 3

(20 points) Assume you are using a Unix system (Tux machine for example). Which command should you use to list all active TCP and UDP "connections"? Find the command and use it on a Tux machine. Take a screenshot and report it here. The netstat command is used to display network status, protocol statistics, stack settings, and information about open ports and established connections. A user can display the status of TCP and UDP endpoints in table format, as well as routing table information and interface information.

```
mto0006@tux250:~$ netstat -nat
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 0.0.0.0:46594            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:111             0.0.0.0:*               LISTEN
tcp        0      0 192.168.122.1:53        0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:22              0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:5910            0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:3350          0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:631           0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:25            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:6010            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:763             0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:3389            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:58269           0.0.0.0:*               LISTEN
tcp        0      0 131.204.14.250:34226    131.204.12.26:514       ESTABLISHED
tcp        0      0 131.204.14.250:870      131.204.12.29:2049      ESTABLISHED
tcp        0      0 131.204.14.250:852      131.204.12.120:2049     ESTABLISHED
tcp        0    172 131.204.14.250:22       131.204.110.72:55004    ESTABLISHED
tcp6       0      0 :::39877                :::*                    LISTEN
tcp6       0      0 :::34159                :::*                    LISTEN
tcp6       0      0 :::111                  :::*                    LISTEN
tcp6       0      0 :::22                   :::*                    LISTEN
tcp6       0      0 :::5910                 :::*                    LISTEN
tcp6       0      0 :::6010                 :::*                    LISTEN
```



```
mto0006@tux250:~$ netstat -a
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 0.0.0.0:46594           0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:sunrpc           0.0.0.0:*               LISTEN
tcp        0      0 tux250.eng.aubur:domain 0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:ssh              0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:cm               0.0.0.0:*               LISTEN
tcp        0      0 localhost:findviatv     0.0.0.0:*               LISTEN
tcp        0      0 localhost:ipp            0.0.0.0:*               LISTEN
tcp        0      0 localhost:smtp           0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:x11-ssh-offset  0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:cycleserv        0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:ms-wbt-server      0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:58269              0.0.0.0:*               LISTEN
tcp        0      0 tux250.eng.auburn:47962  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn:40566  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:40556  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:40560  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:52753  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.aub:cadlock2  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:34226  netlogger.eng.aub:shell ESTABLISHED
tcp        0      0 tux250.eng.auburn:50461  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn:34231  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn.e:870  rhea.eng.auburn.edu:nfs ESTABLISHED
tcp        0      0 tux250.eng.auburn:40562  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:48081  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn:40564  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:40558  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:60395  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn:40552  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:60635  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn:45959  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn.e:852  stor00.eng.auburn.e:nfs ESTABLISHED
tcp        0      0 tux250.eng.auburn:38754  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.auburn:40554  dragonfly:entrust-ash   TIME_WAIT
tcp        0      0 tux250.eng.auburn:48977  dragonfly:sunrpc        TIME_WAIT
tcp        0      0 tux250.eng.aubur:busboy  dragonfly:entrust-ash   TIME_WAIT
tcp        0      108 tux250.eng.auburn.e:ssh  ettin.eng.auburn.:55004 ESTABLISHED
tcp6       0      0 [::]:39877              [::]:*                  LISTEN
tcp6       0      0 [::]:34159              [::]:*                  LISTEN
tcp6       0      0 [::]:sunrpc              [::]:*                  LISTEN
tcp6       0      0 [::]:ssh                 [::]:*                  LISTEN
tcp6       0      0 [::]:cm                  [::]:*                  LISTEN
tcp6       0      0 [::]:x11-ssh-offset      [::]:*                  LISTEN
udp        0      0 0.0.0.0:10010           0.0.0.0:*               *
udp        0      0 0.0.0.0:44510           0.0.0.0:*               *
udp        0      0 tux250.eng.aubur:domain 0.0.0.0:*               *
udp        0      0 0.0.0.0:bootps          0.0.0.0:*               *
udp        0      0 0.0.0.0:bootpc          0.0.0.0:*               *
udp        0      0 0.0.0.0:sunrpc           0.0.0.0:*               *
udp        0      0 localhost:323            0.0.0.0:*               *
udp        0      0 0.0.0.0:sco-websrvrmgr  0.0.0.0:*               *
udp        0      0 localhost:717            0.0.0.0:*               *
udp        0      0 0.0.0.0:ns               0.0.0.0:*               *
udp        0      0 0.0.0.0:41573           0.0.0.0:*               *
udp6       0      0 [::]:sunrpc              [::]:*                  *
```




```
Active UNIX domain sockets (servers and established)
Proto RefCnt Flags      Type       State      I-Node   Path
unix   3        [ ]         DGRAM      15616     /run/systemd/notify
unix   2        [ ACC ]     STREAM     LISTENING  59078784  /tmp/ssh-zpyKy2isHqD6/agent.20449
unix   2        [ ACC ]     STREAM     LISTENING  59021248  /tmp/.X11-unix/X10
unix   2        [ ]         DGRAM      15618     /run/systemd/cgroups-agent
unix   2        [ ACC ]     STREAM     LISTENING  59060286  /tmp/.ICE-unix/20449
unix   2        [ ACC ]     STREAM     LISTENING  59075742  /tmp/.esd-482034/socket
unix   2        [ ACC ]     STREAM     LISTENING  16966     public/qmgr
unix   2        [ ACC ]     STREAM     LISTENING  15630     /run/systemd/journal/stdout
unix   2        [ ACC ]     STREAM     LISTENING  17006     private/error
unix   5        [ ]         DGRAM      15633     /run/systemd/journal/socket
unix  30        [ ]         DGRAM      15635     /dev/log
unix   2        [ ACC ]     STREAM     LISTENING  59079715  @/tmp/dbus-C7ZNpK5mj0
unix   2        [ ACC ]     STREAM     LISTENING  23577     /run/lvm/lvmetad.socket
unix   2        [ ACC ]     STREAM     LISTENING  16970     private/tlsmgr
unix   2        [ ACC ]     STREAM     LISTENING  17009     private/retry
unix   2        [ ACC ]     STREAM     LISTENING  16973     private/rewrite
unix   2        [ ACC ]     STREAM     LISTENING  28210     /var/run/libvirt/virtlogd-sock
unix   2        [ ACC ]     STREAM     LISTENING  28213     /var/run/libvirt/virtlockd-sock
unix   2        [ ACC ]     STREAM     LISTENING  28215     /var/run/cups/cups.sock
unix   2        [ ACC ]     STREAM     LISTENING  28561     /var/lib/gssproxy/default.sock
unix   2        [ ACC ]     STREAM     LISTENING  28209     @ISCSID_UIP_ABSTRACT_NAMESPACE
unix   2        [ ACC ]     STREAM     LISTENING  31823     /var/run/NetworkManager/private-dhcp
unix   2        [ ACC ]     STREAM     LISTENING  31058     /var/run/libvirt/libvirt-sock
unix   2        [ ACC ]     STREAM     LISTENING  31060     /var/run/libvirt/libvirt-sock-ro
unix   2        [ ACC ]     STREAM     LISTENING  17012     private/discard
unix   2        [ ACC ]     STREAM     LISTENING  88330326  /run/systemd/private
unix   2        [ ACC ]     STREAM     LISTENING  31062     /var/run/libvirt/libvirt-admin-sock
unix   2        [ ACC ]     STREAM     LISTENING  17015     private/local
unix   2        [ ACC ]     STREAM     LISTENING  58785544  @/tmp/dbus-AP7iDv16J5
unix   2        [ ACC ]     STREAM     LISTENING  17018     private/virtual
unix   2        [ ACC ]     STREAM     LISTENING  17021     private/lmtp
unix   2        [ ACC ]     STREAM     LISTENING  17024     private/anvil
unix   2        [ ACC ]     STREAM     LISTENING  16976     private/bounce
unix   2        [ ACC ]     STREAM     LISTENING  59021247  @/tmp/.X11-unix/X10
unix   2        [ ACC ]     STREAM     LISTENING  16959     public/pickup
unix   2        [ ACC ]     STREAM     LISTENING  16979     private/defer
unix   2        [ ACC ]     STREAM     LISTENING  16982     private/trace
unix   2        [ ACC ]     STREAM     LISTENING  25986     /var/run/rpcbind.sock
unix   2        [ ACC ]     STREAM     LISTENING  28547     /var/run/acpid.socket
unix   2        [ ACC ]     STREAM     LISTENING  17027     private/scache
unix   2        [ ACC ]     STREAM     LISTENING  16963     public/cleanup
unix   2        [ ACC ]     STREAM     LISTENING  28562     /run/gssproxy.sock
unix   2        [ ACC ]     STREAM     LISTENING  16985     private/verify
unix   2        [ ACC ]     STREAM     LISTENING  26011     /run/dbus/system_bus_socket
unix   2        [ ACC ]     STREAM     LISTENING  59079839  @/tmp/dbus-GS793xMM
unix   2        [ ACC ]     STREAM     LISTENING  16988     public/flush
unix   2        [ ACC ]     STREAM     LISTENING  59075744  /run/user/482034/pulse/native
unix   2        [ ]         DGRAM      29874     /var/run/chrony/chronyd.sock
unix   2        [ ACC ]     STREAM     LISTENING  16991     private/proxymap
unix   2        [ ACC ]     SEQPACKET  LISTENING  88115893  /run/udev/control
unix   2        [ ACC ]     STREAM     LISTENING  23736     /run/lvm/lvmpolld.socket
unix   2        [ ACC ]     STREAM     LISTENING  28602     /var/run/lsm/ipc/simc
unix   2        [ ACC ]     STREAM     LISTENING  16994     private/proxywrite
unix   2        [ ACC ]     STREAM     LISTENING  28604     /var/run/lsm/ipc/sim
unix   2        [ ACC ]     STREAM     LISTENING  25985     @ISCSIADM_ABSTRACT_NAMESPACE
```

What you need to turn in:

- Electronic copy of this file (including your answers) (standalone). Submit the file as a Microsoft Word or PDF file.
- Recall that answers must be well written, documented, justified, and presented to get full credit.
- How this assignment will be graded:
- A right answer will get full credit when:
- It is right (worth 25%)
- It is right AND neatly presented making it easy and pleasant to read. (worth 15%)
- There is an obvious and clear link between 1) the information provided in the exercise and in class and 2) the final answer. A clear link is built by properly writing, justifying, and documenting an answer (worth 60%).
- Calculation mistakes will be minimally penalized (2 to 5% of full credit) while errors on units will be more heavily penalized.
- You are welcome/encouraged to discuss exercises with other students or the instructor. But, ultimately, personal writing is expected.

Appendix: Grading: What is an OBVIOUS and CLEAR LINK?

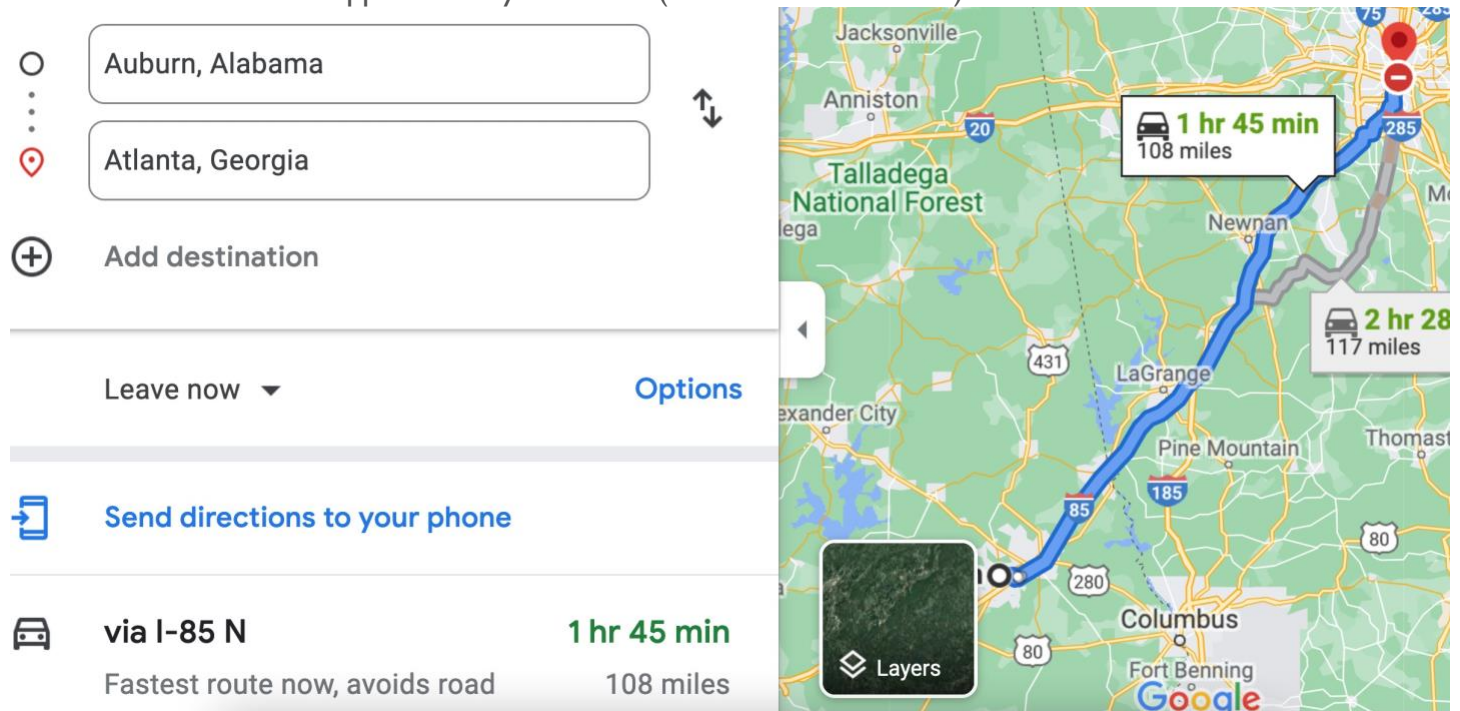
Here is an example to explain what an **obvious and clear link** is and how we grade your work.

Consider the following problem:

"(100 points) John travels from Auburn to Atlanta in his car at a speed of 60 mph. Leaving at 8am, at what time will John reach Atlanta".

Here are the answers of three students and their scores:

- **Student 1** answers: "9:48am". Student 1 will get 25 points.
- **Student 2** answers : "John will reach Atlanta at 9:48am". Student 2 will get 25+15 = 40 points
- **Student 3** answers: "The time t to travel a distance d at speed v is equal to $d/v = d/60\text{mph}$. The problem does not provide the distance d from Auburn to Atlanta. Based on GoogleMaps, the distance from Auburn to Atlanta is approximately 108 miles (document is attached).



Therefore, the time $t = 108 \text{ miles} / 60 \text{ mph} * 60 \text{ minutes/hour} = 108 \text{ minutes}$. Since John left at 8am, he will then reach Atlanta at $8\text{am} + 108 \text{ minutes} = 8 \text{ am} + 60 \text{ minutes} + 48 \text{ minutes} = 9:48"$.

Student 3 will get $25 + 15 + 60 = 100$ points

Do you see the **direct link** going from the data provided in the question to the final answer, using general knowledge/formula and documents?.... Can you now solve the following problem and get 100 points?

"(100 points) Alice travels from Auburn to Atlanta in her car at a speed of 60 mph. Leaving at 8am, at what time will Alice reach Atlanta assuming that she had a flat tire that delayed her 30 minutes".