Department of Computer Science and Engineering

CSE 3214: Computer Network Protocols and Applications

Instructor: N. Vlajic

Midterm Examination

Instructions:

- Examination time: 75 min.
- Print your name and CSE student number in the space provided below.
- This examination is closed book and closed notes.
- There are 6 questions. The points for each question are given in square brackets, next to the question title. The overall maximum score is 100.
- Answer each question in the space provided. If you need to continue an answer onto the last page, clearly indicate that and label the continuation with the question number.

FIRST NAME: ____________________________

LAST NAME: ____________________________

STUDENT #: ____________________________

Question	Points
1	/ 20
2	/ 24
3	/ 12
4	/ 14
5	/ 14
6	/ 16
Total	/ 100

1. Multiple Choice [20 points]

Circle the correct answer(s) for the following statements. For each statement, you will obtain 0 marks if the number of circled answers is more/less than appropriate.

(1.1) A host wants to send a 3000 byte datagram onto a link with an MTU of 500 bytes. (MTU is the maximum size of an IP packet (IP header + data) passed from the network to data-link layer.) Assuming an IP header of 20 bytes, how many bytes of overhead does IP add to this transmission?

(a) 20
(b) 120
(c) 140
(d) 160

(1.2) How is a unique MAC address assigned to a Network Card?.

(a) It is built into the card when the card is manufactured.
(b) The network administrator must assign the address.
(c) A unique address is automatically assigned when the card drivers are installed.
(d) A unique address is automatically assigned whenever you boot up the computer.

(1.3) Routers (traditionally) operate on the following layers?

(a) data-link and physical
(b) network, data-link and physical
(c) transport, network, data-link and physical
(d) application, transport, network, data-link, and physical

(1.4) To check whether the Web server you are trying to reach is available or is down, which command-line utility should you use?

(a) ping
(b) ipconfig
(c) traceroute
(d) telnet

(1.5) Multiple TCP streams can be distinguished on a given machine using ________ .

(a) ports
(b) IP addresses
(c) NICs
(d) none of the above

(1.6) The checksum in the header of an IPv4 packet is used to ________________ .

(a) detect errors in the packet's payload
(b) detect errors in the packet's header
(c) detect and correct errors in the packet's payload
(d) detect and correct errors in the packet's header

(1.7) An IPv6 address can have up to __________________ hexadecimal digits.

(a) 16
(b) 32
(c) 8
(d) none of the above

(1.8) The recommended length of Interface Identifier in IPv6 is __________________ .

(a) 16 bits
(b) 32 bits
(c) 48 bits
(d) 64 bits

(1.9) In IPv6 fregmentation __________________ .

(a) is performed by both hosts and routers
(b) is performed by routers only
(c) is not done at all – there is no limit on packet size
(d) none of the above

(1.10) In IPv6, the use of Transport Mode Encryption implies that __________________ .

(a) only headers of transmitted packets are encrypted
(b) headers and extensions of transmitted packets are encrypted
(c) only payloads of transmitted packets are encrypted
(d) none of the above

2. Potpourri [24 points]

2.1 [4 points]
How would moving the entire Internet to MAC-address based routing - instead of IP-address based routing - affect the performance of Internet routers? (Clearly state whether this solution would be better or worse, and why.)

Solution:

This solution would be worse, as MAC addresses are not 'hierarchical'!
That is, each router would now have to know the location of every single machine (its MAC address), instead of knowing just the location of their respective network (NetID) in the current IP-address based routing.
Consequently, the routing tables would be considerably larger, and overall more 'routing' information would have to be exchanged among routers …

2.2 [5 points]
How would this new MAC-address based routing/operation of the Internet affect the end-user (i.e., end-host) privacy? Explain.

Solution:

There are some pros and cons here.
Cons: Reduced Privacy. Now the receiving machine would know the exact MAC-ID of the sending machine, including its make/manufacturer. (In the current Internet, only the IP of the sending machine is known, which is not unique and can change / be shared among multiple machines.)
Pros: Improved Privacy: Now the receiving machine would not know where the sending machine is geographically located.

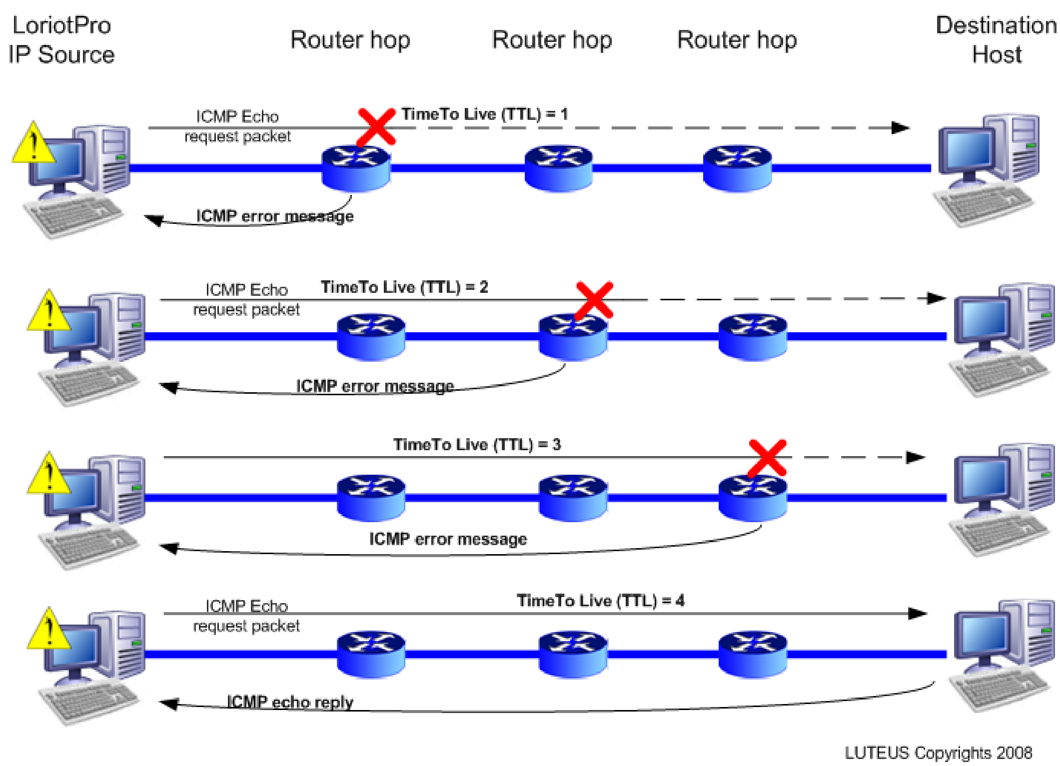
2.3 [7 points]
Recall, 'traceroute' is a tool that displays the addresses of all intermediate routers through which a packet travels on its way to a particular destination. In class, we have explained the exact mechanisms that traceroute relies on to accomplish its function.

Now, in reality, traceroute may report a path that does not exist. For example, traceroute could return a path A-B-C (where A, B, and C are IP addresses) when there is no link between routers B and C. Give one example where that could happen. (Draw a picture if useful.)

Solution:

To accomplish its function, traceroute relies on TTL value in the IP-packet header. (An intermediate router will drop a packet if/when its TTL reaches 0, and the given router will send an ICMP message back to the sender thus facilitating its identification ...)

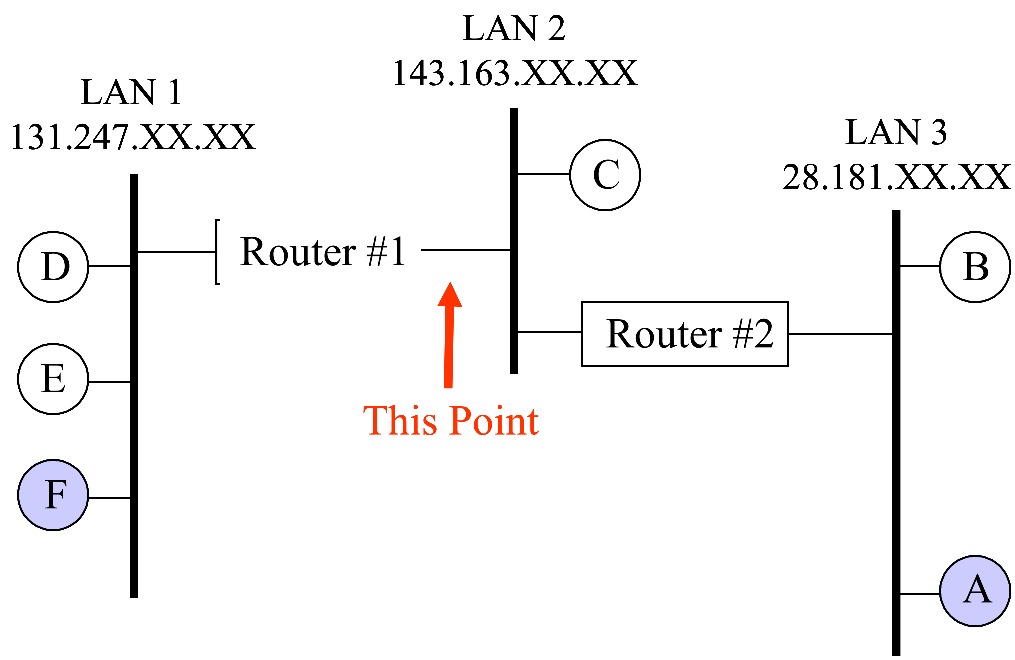
Based on this, by sending packets with gradually increased values of TTL 1, 2, …, the sending machine can identify the 1st, 2nd, … router on the path to the final destination.



Now, the route to the remote destination may have changed during the measurement process. For example, suppose the route from A to Z changed from A-B-Y-Z to A-D-C-Z. Then, the first traceroute probe would return "B" and the second would return "C", even though nodes B and C are not directly connected.

Note, for this to actually happen, the hop distance of A-to-C should be for 1 larger than the hop distance of A-to-B.

2.4 [8 points]
Suppose we have three networks connected by two routers (as shown below). Show the Source IP address, source MAC address, destination IP address and destination MAC address of packets at "This Point" if packets are transmitting from host A to F.



Assume the following network setting:

Host A: 28.181.1.1 (MAC address: 1050)
Host B: 28.181.1.2 (MAC address: 1ABC)
Router #2 (LAN 3 side): 28.181.1.100 (MAC address: 2019)
Router #2 (LAN 2 side): 143.163.32.99 (MAC address: 1021)
Host C: 143.163.32.1 (MAC address: 3082)
Router #1: (LAN 2 side): 143.163.32.98 (MAC address: 7547)
Router #1: (LAN 1 side): 131.247.68.99 (MAC address: 7546)
Host D: 131.247.68.1 (MAC address: ABCD)
Host E: 131.247.68.2 (MAC address: 9356)
Host F: 131.247.68.3 (MAC address: 5466)

Solution:

Source IP: 28.181.1.1
Source MAC: 1021
Destination IP: 131.247.68.3
Destination MAC: 7547 (or "BC")

3. Subnetting [12 points]

Given the following IP address and subnet mask, answer the below questions.

IP Address (decimal notation): 178.93.209.160
Subnet Mask (decimal notation): 255.255.255.224

IP Address (binary notation): 1011 0010 0101 1101 1101 0001 1010 0000
Subnet Mask (binary notation): 1111 1111 1111 1111 1111 1111 1110 0000

3.1 [3 points]
What is the subnet address? Provide this in the dotted IP notation, not in binary.

Solution:

178.93.209.160

3.2 [3 points]
How many hosts can be on this subnetwork?

Solution:

32 (though if they say 30, give them credit since the first host is the network address and the last host is the broadcast address)

3.3 [6 points]
What is the range of IP addresses for this subnet? In other words, what is the starting IP address and ending IP address of this subnet? Provide this in the dotted IP notation, not in binary.

Solution:

start address - 178.93.209.160
end address - 178.93.209.191

http://www-scf.usc.edu/~csci201/exams/final-written-spring2015-SOLUTION.pdf

4. IPv4 Fragmentation [14 points]

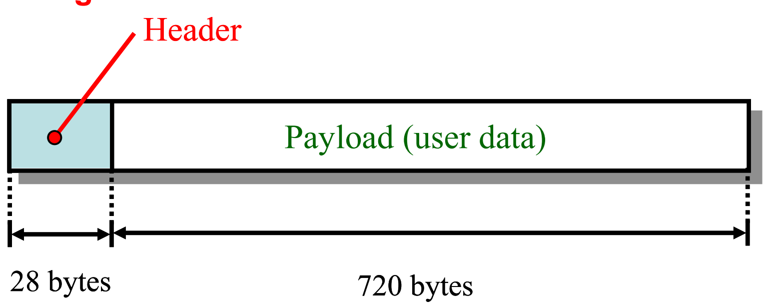
Suppose an IP packet with the below properties/values will be forwarded to another network where the maximum packet size (MTU = IP header + data) is only 252 bytes.

The original packet values:
(1) Total Length = 748
(2) IHL = 7
(3) Fragment Offset = 0
(4) More = 0

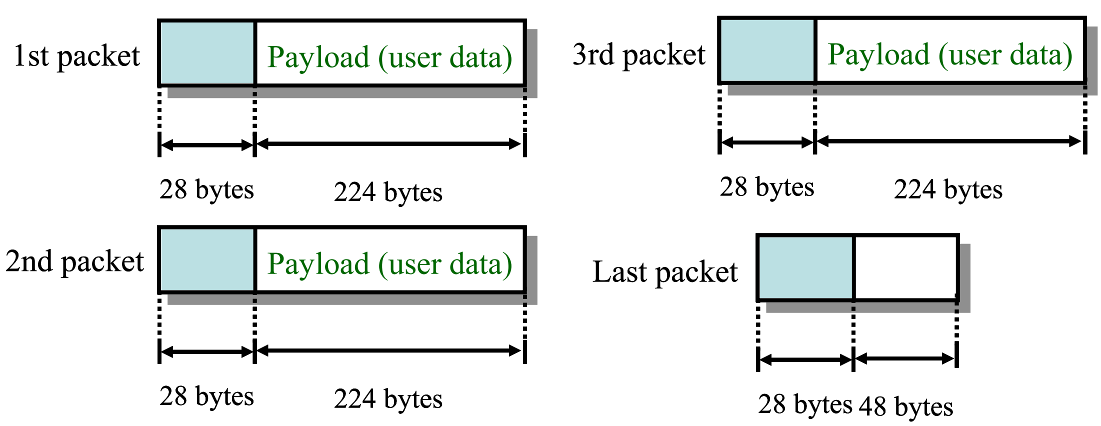
Your task is to find/show (1) Total length, (2) IHL, (3) Fragment offset and (4) More fields in the **last packet** after fragmentation. Assume IHL = 7 for every packet.

Solution:

(1) BEFORE fragmentation:



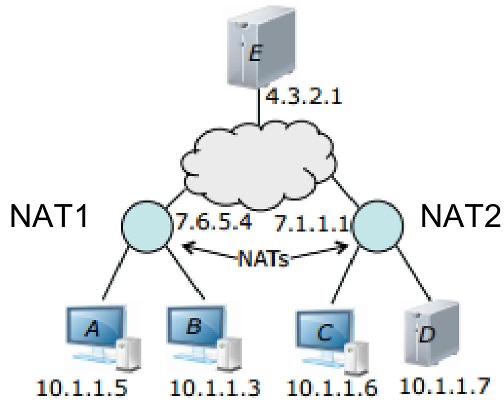
(2) AFTER fragmentation:



- The total packet length of the last packet = 76 (28-byte header + 48-byte payload), IHL = 7 (given)
- Fragment Offset = $(224 \times 3) / 8 = 672/8 = 84$
- More = 0

5. NAT [14 points]

The figure below shows two residential networks with routers that implement NAT.



(a) [4 points]
Suppose that host A wants to connect to the web server at host E. In the below tables of NAT1, add an entry that would allow A to communicate with E.
In cases where the value of a field is not predefined/known, you may choose any value that you think is reasonable.

Source Computer Address	Source Computer Port	NAT Router's IP	NAT Router's Port	Destination Computer Address	Destination Computer Port	Transport Protocol
		7.6.5.4				
		7.6.5.4				
		7.6.5.4				
		...				

Solution:

Source Computer Address	Source Computer Port	NAT Router's IP	NAT Router's Port	Destination Computer Address	Destination Computer Port	Transport Protocol
10.1.1.5	7777	7.6.5.4	2222	4.3.2.1	80	TCP

(b) [2 points]
For a typical packet sent from A to E, show the values of the address and port fields in the diagram below (before the packet reaches NAT1).

Solution:

src adr	dest adr	src port	dest port
10.1.1.5	4.3.2.1	7777	80

(c) [2 points]
Show the values of the address and port fields in the packet from (b) once it reaches (arrives at) E.

Solution:

src adr	dest adr	src port	dest port
7.6.5.4	4.3.2.1	2222	80

(d) [6 points]
Now, suppose that host A in NAT1 network is communicating with host D in NAT2 network. For a packet sent from A to D, show the values of the address and port fields of this packet as the packet moves between A to NAT1, NAT1 to NAT2, and NAT2 to D.
(Again, in cases where the value of a field is not predefined/known, you may choose any value that you think is reasonable.)

Solution:

src adr	dest adr	src port	dest port
10.1.1.5	7.1.1.1	7777	5555

src adr	dest adr	src port	dest port
7.6.5.4	7.1.1.1	3333	5555

src adr	dest adr	src port	dest port
7.6.5.4	10.1.1.7	3333	4444

http://www.eng.utah.edu/~cs5480/homeworks/hw3_soln.pdf

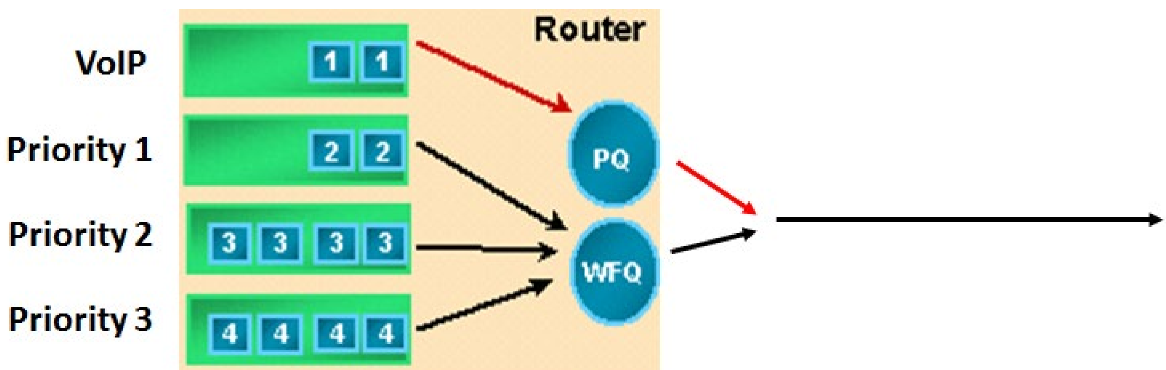
6. PQ and WFQ [16 points]

6.1 [8 points]

Consider a queueing (packet scheduling) system shown in the below figure. In this system, the router recognizes VoIP traffic and places it into the strict Priority Queue (PQ). The other classes/types of traffic are placed in the remaining three queues, as indicated in the figure.
When processing the queues/packets, the router processes PQ until it is empty, at which point it starts processing the other queues according to standard Weighted Fair Queueing (WFQ) discipline. The weights of the three WFQ queues are:

- Priority 1: w=0.4
- Priority 2: w=0.4
- Priority 3: w=0.2

(You can assume that the router accesses the queues in the order of their indexes – 1, 2, 3, and all packets require equal processing time/resources.)



If the packets shown in the above figure are already in their respective queues, give the order in which packets will be served/transmitted.

Solution:

Order of serving/transmission: **1 1 2 2 3 3 4 3 3 4 4 4**

Another possible solution: **1 1 2 3 2 3 4 3 3 4 4 4**

6.2 [8 points]

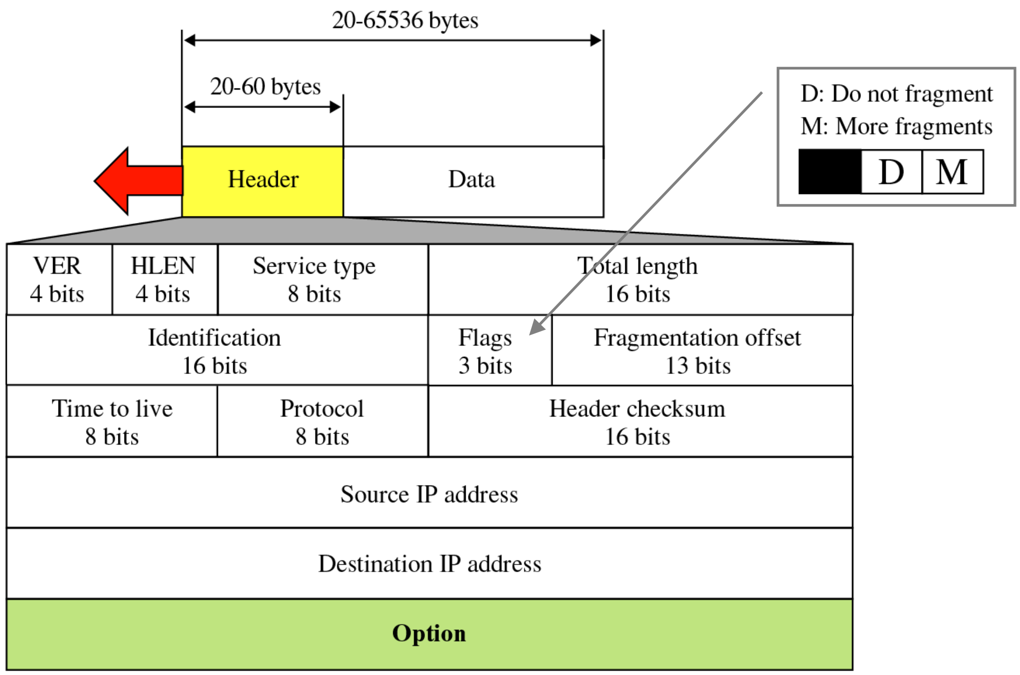
Now, for the system from 6.1, assume the weights of the three WFQ queues change to:

- Priority 1: w=0.2
- Priority 2: w=0.2
- Priority 3: w=0.6

Solution:

Order of serving/transmission: **1 1 2 3 4 4 4 2 3 4 3 3**

IPv4 PACKET FORMAT:



IPv6 PACKET FORMAT: