Here we select some exercises from the textbook, and they may be helpful for you to prepare for the midterm exam. Note that you don't need to hand in these exercises, and we **WILL NOT** provide the answer.

## R4: TCP v.s. UDP

Real-time online games, real-time audio stuff

Describe why an application developer might choose to run an application over UDP rather than TCP.

## R7: UDP

The IP header contains source ip address,
and UDP header contains source port

Suppose a process in Host C has a UDP socket with port number 6789. Suppose both Host A and Host B each send a UDP segment to Host C with destination port number 6789. Will both of these segments be directed to the same socket at Host C? If so, how will the process at Host C know that these two segments originated from two different hosts?

## R9 and R10: Reliable data transfer (`rdt`)

To handled dropped packets

In our `rdt` protocols, why did we need to introduce sequence numbers? Why did we need to introduce timers?

To figure out whether the received data is new or retransmitted

## R11: Reliable data transfer (`rdt`)

Suppose that the roundtrip delay between sender and receiver is constant and known to the sender. Would a timer still be necessary in protocol `rdt 3.0`, assuming that packets can be lost? Explain.

Yes, since when the packet is dropped somewhere
during the transmission, sender and receiver still needs
to stop receiving after some amount of time.

## R14: TCP

True or false?

a. Host A is sending Host B a large file over a TCP connection. Assume Host B has no data to send Host A. Host B will not send acknowledgments to Host A because Host B cannot piggyback the acknowledgments on data. False, payload length could be 0

b. The size of the TCP `rwnd` never changes throughout the duration of the connection. False, it could change if the buffer starts filling up

c. Suppose Host A is sending Host B a large file over a TCP connection. The number of unacknowledged bytes that A sends cannot exceed the size of the receive buffer. True

d. Suppose Host A is sending a large file to Host B over a TCP connection. If the sequence number for a segment of this connection is $m$, then the sequence number for the subsequent segment will necessarily be $m + 1$. False, a re-transmission could happen

e. The TCP segment has a field in its header for `rwnd`. True

f. Suppose that the last `SampleRTT` in a TCP connection is equal to 1 sec. The current value of `TimeoutInterval` for the connection will necessarily be $\geq 1$ sec. False, TimeoutInterval = EstimatedRTT + 4*DevRTT

g. Suppose Host A sends one segment with sequence number 38 and 4 bytes of data over a TCP connection to Host B. In this same segment, the acknowledgment number is necessarily 42.

False, could be anything from 38 to 42

## R15: TCP sequence number

Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110.

a. How much data is in the first segment? 20 Bytes

b. Suppose that the first segment is lost but the second segment arrives at B. In the acknowledgment that Host B sends to Host A, what will be the acknowledgment number? 90

## P22: Go-Back-N

Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time $t$, the next in-order packet that the receiver is expecting has a sequence number of $k$. Assume that the medium does not reorder messages. Answer the following questions:

{k-4~k-1}, {k-3~k}, {k-2~k+1}, {k-1~k+2}, {k~k+3}

a. What are the possible sets of sequence numbers inside the sender's window at time $t$? Justify your answer.

b. What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time $t$? Justify your answer. k-4, k-3, k-2, k-1

## P40: TCP congestion control

Consider Figure 3a. Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

a. Identify the intervals of time when TCP slow start is operating. [0,6], [23, 26]

b. Identify the intervals of time when TCP congestion avoidance is operating. [6, 23]

c. After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? Triple Dup ACK

d. After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? Timeout
What is the initial value of ssthresh at the first transmission round?

e. What is the value of ssthresh at the 18th transmission round? 16

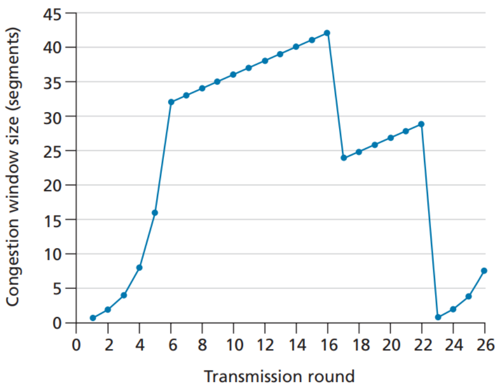
f. What is the value of ssthresh at the 24th transmission round? 8

g. During what transmission round is the 70th segment sent? 7

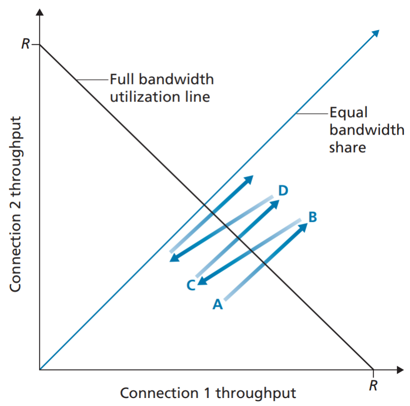
h. Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of `ssthresh`? window size = 4
ssthresh = 4

## P41: TCP congestion control

Refer to Figure 3b, which illustrates the convergence of TCP's AIMD algorithm. Suppose that instead of a multiplicative decrease, TCP decreased the window size by a constant amount. Would the resulting AIAD algorithm converge to an equal share algorithm? Justify your answer using a diagram similar to Figure 3b.




(a) TCP window size as a function of time




(b) Throughput realized by TCP connections 1 and 2

Figure 3: Figures for **P40** and **P41**

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## R3: Routing and forwarding

We made a distinction between the forwarding function and the routing function performed in the network layer. What are the key differences between routing and forwarding?

Routing is deciding the path a packet should take.
Forwarding is moving a incoming packet to the correct next stop.

## R25: Datagram

Suppose an application generates chunks of $40$ bytes of data every $20$ msec, and each chunk gets encapsulated in a TCP segment and then an IP datagram. What percentage of each datagram will be overhead, and what percentage will be application data?

40 Bytes data + 20 Bytes TCP header + 20 Bytes IP header
50% data, 25% IP overhead, 25% TCP overhead

## P11: Subnet

Consider a router that interconnects four subnets: Subnet 1, Subnet 2, Subnet 3. Suppose all of the interfaces in each of these four subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support at least 60 interfaces, Subnets 2 is required to support at least 90 interfaces, Subnet 3 is to support at least 12 interfaces. Provide three network address (of the form a.b.c.d/x) that satisfy these constraints.

Subnet 1: 223.1.17.128/25
Subnet 2: 223.1.17.0/26
Subnet 3: 223.1.17.64/26

## P14: Subnet

Consider a subnet with prefix $128.119.40.128/26$. Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network.

128.119.40.129

## P17: IP datagram fragmentation

Suppose datagrams are limited to $1,500$ bytes (including header) between source Host A and destination Host B. Assuming a $20$-byte IP header, how many datagrams would be required to send an MP3 consisting of $5$ million bytes? Explain how you computed your answer.

ceil( (5 MB)/(1500-20-20 B) ) = 3425

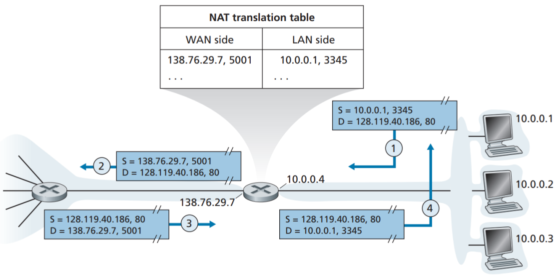
## P18: Network address translation

Consider the network setup in Figure 4. Suppose that the ISP instead assigns the router the address 24.34.101.225 and that the network address of the home network is 192.168.0/24.

a. Assign addresses to all interfaces in the home network.

b. Suppose each host has two ongoing TCP connections, all to port 80 at host 128.119.40.86. Provide the six corresponding entries in the NAT translation table.

| WAN | LAN |
|---|---|
| 24.34.101.225:3001 | 192.168.0.1:4001 |
| 24.34.101.225:3002 | 192.168.0.1:4002 |
| 24.34.101.225:3003 | 192.168.0.2:4001 |
| 24.34.101.225:3004 | 192.168.0.2:4002 |
| 24.34.101.225:3005 | 192.168.0.3:4001 |
| 24.34.101.225:3006 | 192.168.0.3:4002 |




192.168.0.1
192.168.0.2
192.168.0.3

Figure 4: Network address translation

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## R1 and R2: Types of control plane

- What is meant by a control plane that is based on per-router control? In such cases, when we say the network control and data planes are implemented "monolithically," what do we mean?
- What is meant by a control plane that is based on logically centralized control? In such cases, are the data plane and the control plane implemented within the same device or in separate devices? Explain.

## R5: Distance vector–"count to infinity"

A ~~—~~ B — C

- What is the "count to infinity" problem in distance vector routing?
- ***R5****–extend:* Will the count-to-infinity problem occur if we decrease the cost of a link? Why? How about if we connect two nodes which do not have a link?

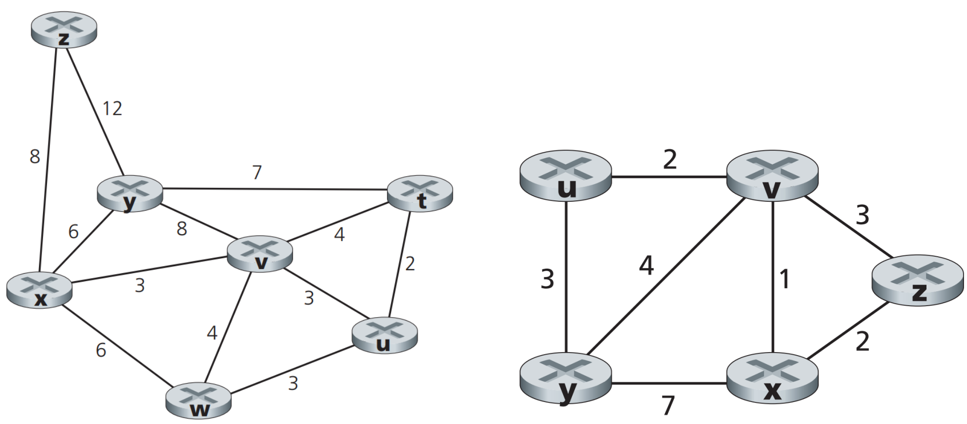
In both cases, no. Because we always choose the shorter path, when the cost is decreased, it is immediately chosen.

## P3: Link state

Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from $x$ to all network nodes. Show how the algorithm works by computing a table similar to Table 5.1 (which contains $N'$: subset of nodes , $p(v)$: previous node of $v$, and $D(v)$: least cost from source to $v$ in each iteration).

## P5: Distance vector

Consider the network shown in Figure 5b, and assume that each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance table entries at node $z$.




(a) Network for **P3**

(b) Network for **P5**

Figure 5: Network topologies