学　院
班　级
学　号
姓　名

密

封

线

东 北 大 学 考 试 试 卷（测 验 二）

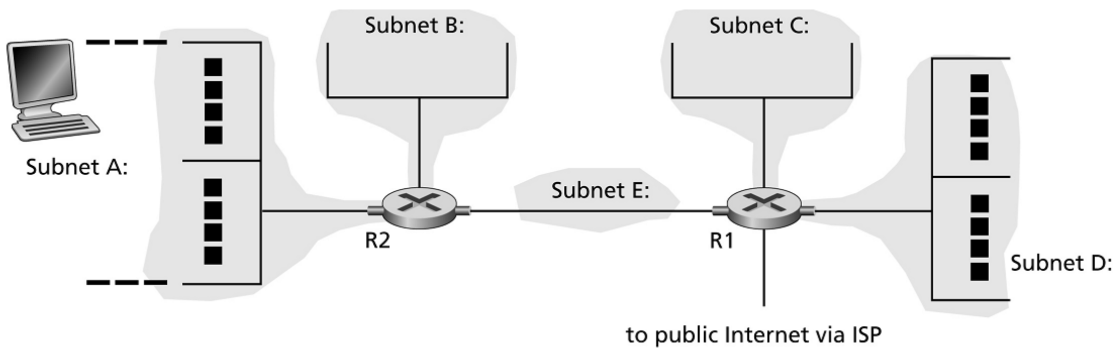
2015　—2016　学年　第　一　学期

课程名称：计算机网络（Computer Networks）

总分	一	二	三	四	五	六	七	八

1. **Addressing at the network and link layers, routing versus switching.**

Consider the network shown below. Each of the subnets A-D contains at most 31 hosts; subnet E connects routers R1 and R2.



a. Assign network addresses to the five subnets shown above (that is, write down the addresses you have assigned).

b. Assign (write down) a full (32-bit) IP address for each the two hosts shown in subnets A and D.

c. Assign (write down) a full IP address to the router interface on subnet E.

d. What is the network prefix advertised by router R1 to the public Internet?

e. Assign (write down) a MAC address to D.

f. Does the host in A ever need to know the MAC address of the R1's interface in subnet E in order to send an IP packet to the host in D? Explain your answer in one or two sentences. Now suppose that router R2 above is replaced by an Ethernet *switch*, S2 (Router R1 remains a router).

g. Are the interfaces that previously were in subnets A, B, and E still in the same separate three IP subnets now that R2 is replaced by S2? Explain your answer in a few sentences.

h. In order to send an IP packet to the host in D, does the host in A ever need to know the MAC address of the R1's left interface now that R2 is replaced by S2? If so, how does it get the MAC address of R1's left interface? Explain your answer in one or two sentences.

Answer:

a. Each subnet needs to address up to 31 hosts, using the rightmost 5 bits of the address. The five subnet addresses are thus x.y.z.000_/27, x.y.z.001_/27, x.y.z.010_/27, x.y.z.011_/27, x.y.z.100_/27, where the notation x.y.z.000_ means that the leftmost three bits of the fourth address byte are 000. Other answers with different bit values in bits 25, 26, 27 are also possible, as long as the five three-bit patterns used are unique.

b. If you chose an address range x.y.z.000_/27 for network A, then the address you choose here must have these 27 leading bits, and can have any 5 remaining bits you want. If you chose an address range x.y.z.011_/27 for network D, then the address you choose here must have these 27 leading bits, and can have any 5 remaining bits you want.

c. If you chose an address range x.y.z.100_/27 for network E, then the address you choose here must have these 27 leading bits, and can have any 5 remaining bits you want.

d. x.y.x.>24

e. Any 48 bit number is OK.

f. No. The host in subnet A needs to address a link-layer frame (containing the IP packet addresses to the host in D) to the R2 interface in subnet A only.

g. No. They are now all in the same subnet from an IP addressing point of view, since there is no longer any intervening router.

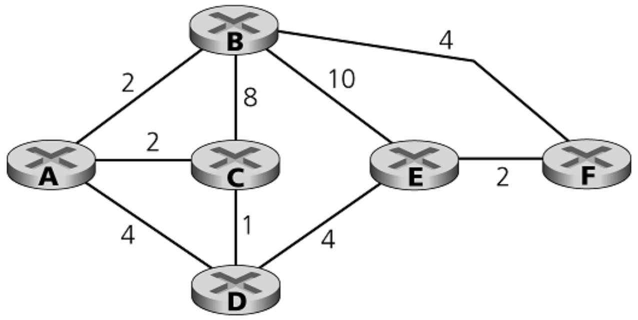
h. Yes. Now the host in A now needs to address its link-layer frame to the left interface of R1. The host in A gets the MAC address of the left interface of R1 using ARP. The host in A knows that in order to route its packet to the host in D, it must first send that packet (over Ethernet) to router R1, whose IP address is in the hosts routing table. Thus, it uses ARP to get the MAC address associated with the IP address of R1's left interface.

学 院	
班 级	
学 号	
姓 名	

密 封 线

2. **Dijkstra's (link-state) algorithm. (13.14.15)**

Consider the network shown below.



a. Show the operation of Dijkstra's (link-state) algorithm for computing the least cost path from D to all destinations. What is the shortest path from D to B, and what is the cost of this path?

b. Show the operation of Dijkstra's (link-state) algorithm for computing the least cost path from E to all destinations. What is the shortest path from E to B, and what is the cost of this path?

c. Show the operation of Dijkstra's (link-state) algorithm for computing the least cost path from B to all destinations. What is the shortest path from B to D, and what is the cost of this path?

Answer:

a.

N	D(A),p(A)	D(B),p(B)	D(C),p(C)	D(E),p(E)	D(F),p(F)
D	4,D	infty	1,D	4,D	infty
DC	3,C	9,C		4,D	infty
DCA		5,A		4,D	infty
DCAE		5,A			6,E
DCAEB					6,E

The shortest path from D to B is D C A B. The cost of this path is 5.

b.

N	D(A),p(A)	D(B),p(B)	D(C),p(C)	D(D),p(D)	D(F),p(F)
E	infty	10,E	infty	4,E	2,E
EF	infty	6,F	infty	4,E	
EFD	8,D	6,F	5,D		
EFDC	7,C	6,F			
EFDCB	7C				

The shortest path from E to B is E F B. The cost of this path is 6.

c.

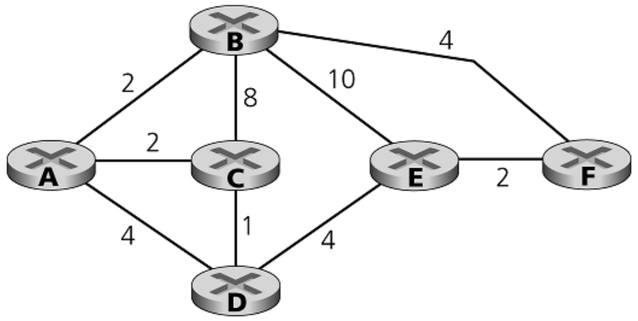
N	D(A),p(A)	D(C),p(C)	D(D),p(D)	D(E),p(E)	D(F),p(F)
B	2,B	8,B	infty	10,B	4,B
BA		4,A	8,A	10,B	4,B
BAC			5,C	10,E	4,B
BACF			5,C	6,E	
BACFD				6,E	

The shortest path from B to D is B A C D. The cost of this path is 5.

学　院
班　级
学　号
姓　名

密 封 线

3. **Distance vector algorithm.** Consider the network below.



a. What are A, B, C, D, E, and F's distance vectors? Note: you do not have to run the distance vector algorithm; you should be able to compute distance vectors by inspection. Recall that a node's distance vector is the vector of the least cost paths from itself to each of the other nodes in the network.

b. Now consider node C. From which other nodes does C receive distance vectors?

c. Consider node C again. Through which neighbor will C route its packets destined to E? Explain how you arrived at your answer, given the distance vectors that C has received from its neighbors.

d. Consider node E. From which other nodes does E receive distance
vectors?

e. Consider node E again. Through which neighbor will E route its packets destined to B.

Explain how you arrived at your answer, given the distance vectors that E has received from its neighbors.

Answer:

a.

	Destination					
node	A	B	C	D	E	F
A	0	2	2	3	7	6
B	2	0	4	5	6	4
C	2	4	0	1	5	7
D	3	5	1	0	4	6
E	7	6	5	4	0	2
F	6	4	7	6	2	0

b. From its neighbors, nodes A, B, and D. Note that C does not receive distance vectors from nodes E and F, since they are not direct neighbors.

c. See page 358 in the textbook for notation.

C's cost to E via B is c(C,B) + DB(E) = 8 + 6 = 14.

C's cost to E via A is c(C,A) + DA(E) = 2 + 7 = 9 (note that A's shortest path to E is through C!)

C's cost to E via D is c(C,D) + DD(E) = 1 + 4 = 5

Thus, C will route to E via D, since that path through D has minimum cost.

d. From its neighbors, nodes B, D, and F. Note that E does not receive distance vectors from nodes A and C, since they are not direct neighbors.

e. See page 358 in the textbook for notation.

E's cost to B via B is c(E,B) + DB(B) = 10 + 0 = 10.

E's cost to B via D is c(E,D) + DD(B) = 4 + 5 = 9.

E's cost to B via F is c(E,F) + DF(B) = 2 + 4 = 6.

Thus, E will route to B via F, since that path through F has minimum cost.

学　院
班　级
学　号
姓　名

密　封　线

4. **TCP sequence numbers.**

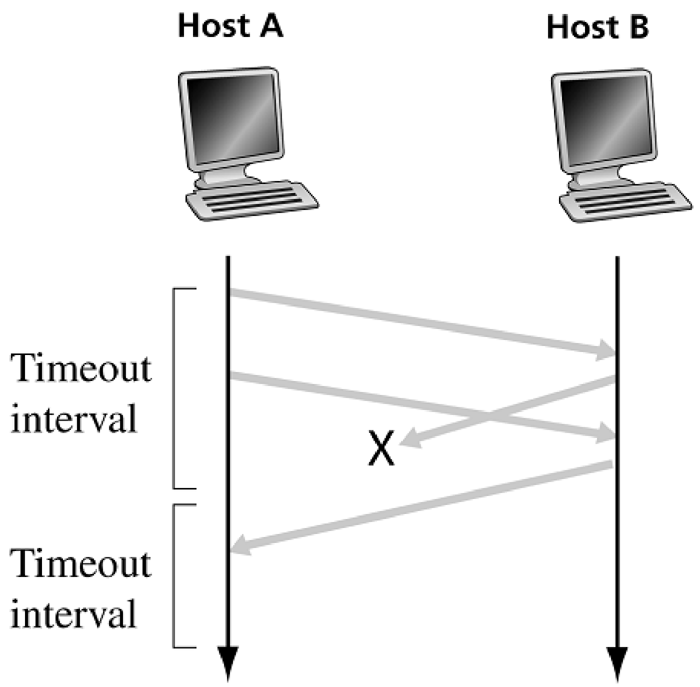
Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 144. Suppose that Host A then sends two segments to Host B back-to-back. The first and second segments contain 20 and 40 bytes of data, respectively. In the first segment, the sequence number is 145, source port number is 303, and the destination port number is 80. Host B sends an acknowledgement whenever it receives a segment from Host A.

a. In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?

b. If the first segment arrives before the second segment, in the acknowledgement of the first arriving segment, what is the acknowledgment number, the source port number, and the destination port number?

c. If the second segment arrives before the first segment, in the acknowledgement of the first arriving segment, what is the acknowledgment number?

d. Suppose the two segments sent by A arrive in order at B. The first acknowledgement is lost and the second segment arrives after the first timeout interval, as shown in the figure below. Complete the diagram, showing all other segments and acknowledgements sent. (Assume there is no additional packet loss.) For each segment you add to the diagram, provide the sequence number and number of bytes of data; for each acknowledgement that you add, provide the acknowledgement number.



Answer:

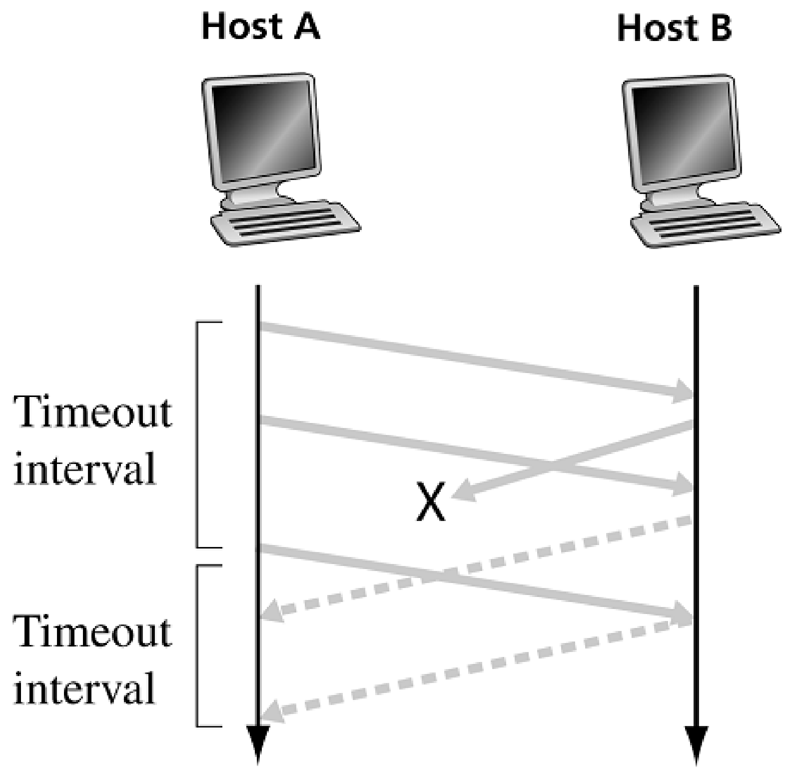
a. The first and second segments contain 20 and 40 bytes of data, respectively. In the second segment sent from A to B, the sequence number is 165, the source port number is 303, and the destination port number is 80.

b. The first acknowledgment has acknowledgment number 165, source port

80, and destination port 303.

c. The acknowledgment number will be 145, indicating that it is still waiting for bytes 145 and onward.

d. The sequence number of the retransmission is 145 and it carries 20 bytes of data. The acknowledgment number of the additional acknowledgment is 205.



学　院

班　级

学　号

姓　名

密 封 线

5. **TCP Potpourri.**

a. Consider two TCP connections, one between Hosts A (sender) and B (receiver), and another between Hosts C (sender) and D (receiver). The RTT between A and B is half that of the RTT between C and D. Suppose that the senders' (A's and C's) congestion window sizes are identical. Is their throughput (number of segments transmitted per second) the same? Explain.

b. Now suppose that the *average* RTT between A and B, and C and D are identical. The RTT between A and B is constant (never varies), but the RTT between C and D varies considerably. Will the TCP timer values of the two connections differ, and if so, how are they different, and why are they different?

c. Give one reason why TCP uses a three-way (SYN, SYNACK, ACK) handshake rather than a two-way handshake to initiate a connection.

d. It is said that a TCP connection "probes" the network path it uses for available bandwidth. What does this mean?

e. What does it mean when we say that TCP uses "cumulative acknowledgement"? Give two reasons why cumulative acknowledgment is advantageous over selective acknowledgment.

Answer:

a. No. The two sessions will transmit the same number of segments per RTT. But since the RTT of the A-B connection is half that of the other session, its throughput will be twice as large.

b. The TCP timer takes the estimate of the RTT and adds on a factor to account for the variation in RTTs. Therefore, the C-D connection timeout value will be larger.

c. Suppose a client transmits multiple SYN messages that take a long time to be received at the server, so the client terminates (thinking the server is dead). The server then accepts these SYN connections (with only a two-way handshake, the server needs to commit as soon as the SYN is received). However, the client side is no longer present, so the server now has multiple connections opened with no client on the other side.

d. TCP's sawtooth behavior results from TCP continuing to increase its transmission rate until it congests some link in the network (that is, until there is no unused bandwidth on that link) at which point a loss occurs. TCP then backs off and continues to increase its bandwidth again.

e. An acknowledgement of X in TCP tells the sender that all data up to X has been correctly received. Cumulative ACKs can decrease the amount of ACK overhead. For example, a TCP receiver will wait a short time before ACKing in the hope that the next in-sequence packet will arrive, and then will just generate a single ACK (for the second packet), which will acknowledge both packets. Also even if the receiver separately ACKs packets X and if the ACK of X is lost but the ACK of is received, the sender will know that X was received by the receiver.