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东北大学考试试卷（测验二）

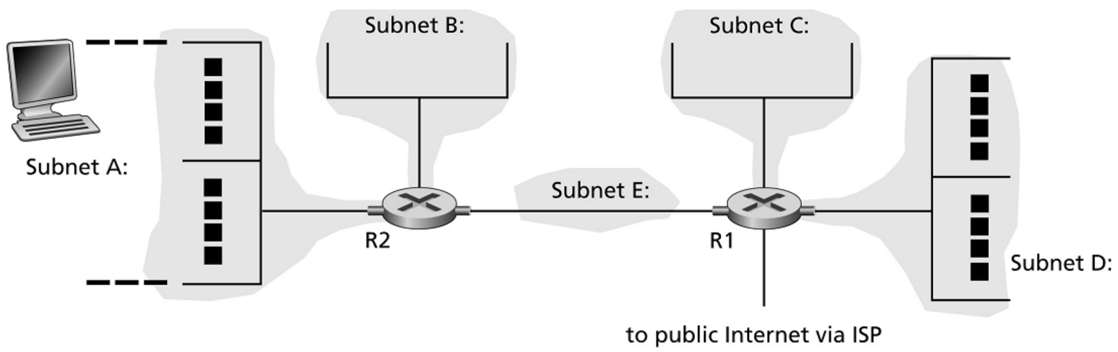
2015 —2016 学年 第 一 学期

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.

考虑如下所示的网络。每个子网A-D最多包含31个主机;子网E连接路由器R1和R2。

a.将网络地址分配给上面所示的五个子网(即写下你分配的地址)。

b.为子网a和D中显示的两台主机分配(写下)一个完整的(32位)IP地址。

c.给子网E上的路由器接口分配(写下)一个完整的IP地址。

d.路由器R1向公众互联网宣传的网络前缀是什么?

e.给D分配(写下)一个MAC地址。

f. A中的主机是否需要知道子网E中R1接口的MAC地址才能向D中的主机发送IP包?用一两句话解释你的答案。现在假设上面的路由器R2被以太网交换机替换,S2(路由器R1仍然是路由器)。

g.由于R2被S2取代，以前在子网A、B和E中的接口是否仍然在相同的三个独立的IP子网中?用几句话解释你的答案。

h.为了向D中的主机发送IP数据包，既然R2被S2取代，A中的主机是否需要知道R1左边接口的MAC地址?如果是，它如何得到R1左接口的MAC地址?用一两句话解释你的答案。

每个子网需要使用最多31个主机地址，使用地址的最右5位。因此，五个子网地址是x.y.z。000 _ / 27日x.y.z。001 _ / 27日x.y.z。010 _ / 27日x.y.z。011 _ / 27日x.y.z。100_/27，其中符号x.y.z。000_表示第四个地址字节的最左边三位是000。只要使用的5个3位模式是惟一的，那么在第25、26、27位中使用不同位值的其他答案也是可能的。

如果您选择了一个地址范围x.y.z。000_/27对于网络A，那么您在这里选择的地址必须有这27个前导位，并且可以有您想要的任何5个剩余位。如果您选择了地址范围x.y.z。011_/27对于网络D，那么您在这里选择的地址必须有这27个前导位，并且可以有您想要的任何5个剩余位。

c.如果您选择了一个地址范围x.y.z。100_/27对于网络E，那么您在这里选择的地址必须有这27个前导位，并且可以有您想要的任何5个剩余位。

d . x.y.x。> 24

任何48位的数字都可以。

f。不。子网A中的主机只需要向子网A中的R2接口寻址一个链路层帧(包含到D中的主机的IP包地址)。

g。不。从IP寻址的角度来看，它们现在都在同一子网中，因为不再有任何介入路由器。

h。是的。现在A中的主机需要将它的链路层帧定位到R1的左接口。A中的主机使用ARP获取R1左接口的MAC地址。A中的主机知道，为了将包路由到D中的主机，它必须首先将包(通过以太网)发送到路由器R1，路由器R1的IP地址在主机路由表中。因此，它使用ARP获取与R1左接口的IP地址相关联的MAC地址。

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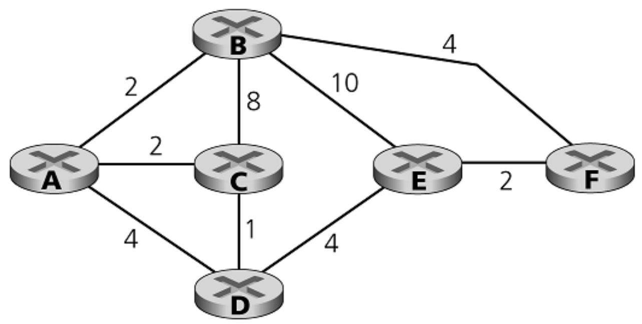
2. **Dijkstra's (link-state) algorithm. (13.14.15)**

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.

a.演示Dijkstra (link-state)算法的操作，计算从D到所有目的地的最小代价路径。从D到B的最短路径是什么，这条路径的代价是多少？

b.展示Dijkstra (link-state)算法的操作，计算从E到所有目的地的最小代价路径。从E到B的最短路径是什么，这条路径的代价是多少？

c.展示Dijkstra (link-state)算法的操作，计算从B到所有目的地的最小代价路径。从B到D的最短路径是什么，这条路径的代价是多少？

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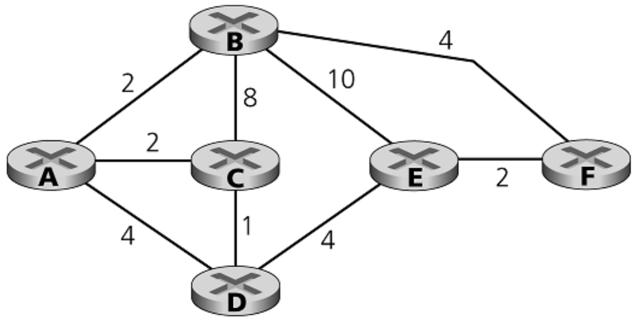
3. **Distance vector algorithm.** Consider the network below.



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.

a, a B C D E F的距离向量是什么?注意:你不需要运行距离向量算法;你应该能够通过检查来计算距离向量。回想一下，节点的距离向量是从节点自身到网络中其他节点的最小成本路径的向量。

现在考虑节点C C从哪个节点接收距离向量?

再次考虑节点c。C通过哪个邻居将它的包路由到E?解释你是如何得到答案的，给出C从它的邻居那里接收到的距离向量。

d.考虑节点E, E从哪个节点接收距离向量?

再次考虑节点e。E通过哪个邻居将它的包路由到B。

解释一下你是如何得到答案的，给出E从它的邻居那里接收到的距离向量。

。注意，C不接收节点E和F的距离向量，因为它们不是直接邻居。

参见教科书第358页中的符号。

C通过B到达E的代价是C (C,B) + DB(E) = 8 + 6 = 14。

C通过A到达E的代价是C (C,A) + DA(E) = 2 + 7 = 9通过C!)

C通过D到达E的代价是C (C,D) + DD(E) = 1 + 4 = 5

(注意A到E的最短路径是

因此，C将通过D路由到E，因为通过D的路径成本最小。

d.节点B、d和f从其邻居处接收距离向量，注意E没有接收到节点A和C的距离向量，因为它们不是直接邻居。

e.符号见教科书第358页。

E通过B给B的代价是c(E,B) + DB(B) = 10 + 0 = 10。

E通过D到达B的代价是c(E,D) + DD(B) = 4 + 5 = 9。

E通过F给B的代价是c(E,F) + DF(B) = 2 + 4 = 6。

因此，E将通过F路由到B，因为通过F的路径成本最小。

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4. **TCP sequence numbers.**

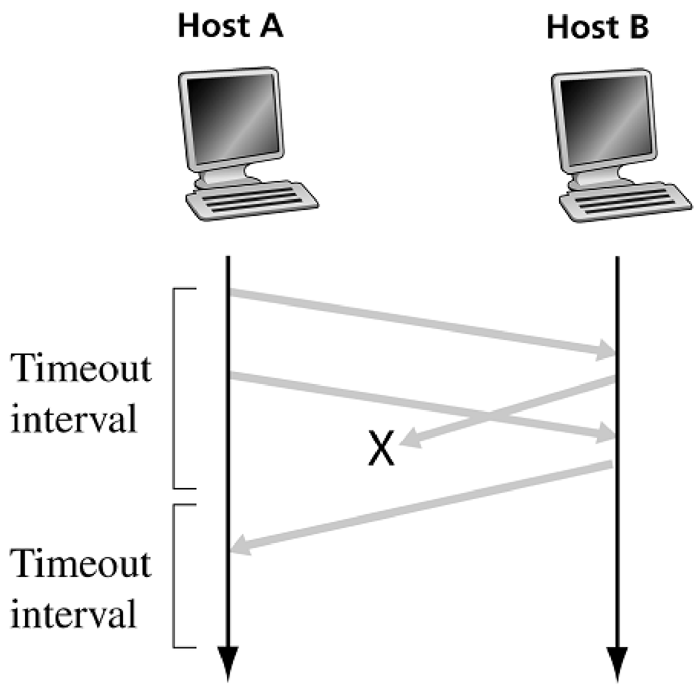
Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 144. Suppose that Host A then sends two segments to Host B back-to-back. The first and second segments contain 20 and 40 bytes of data, respectively. In the first segment, the sequence 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:

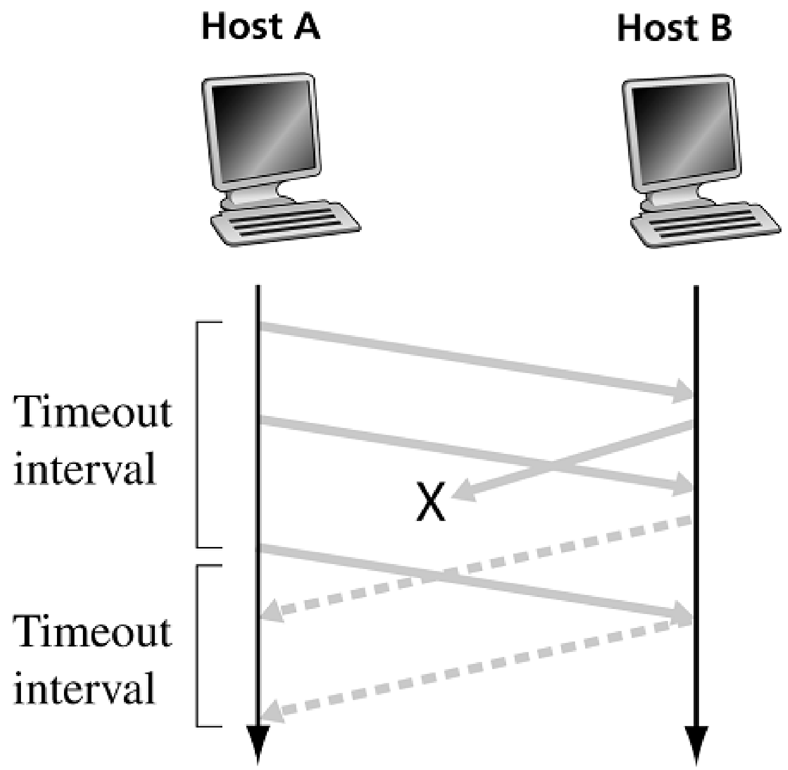
a. The first and second segments contain 20 and 40 bytes of data, respectively. In the second segment sent from A to B, the sequence number is 165, the source port number is 303, and the destination port number is 80.

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.



主机A和主机B通过TCP连接进行通信，主机B已经从A接收了所有字节，一直到字节144。假设主机A将两个段背对背地发送给主机B。第一段和第二段分别包含20和40字节的数据。在第一个段中，序列号为145，源端口号为303，目标端口号为80。每当主机B从主机a接收到一个段时，它就发送一个确认。

a.主机a发送到B的第二段中，序列号、源端口号、目的端口号是什么?

b.如果第一个段先于第二个段到达，在第一个到达段的确认中，确认号、源端口号和目的端口号是什么?

c.如果第二段在第一段之前到达，在第一个到达段的确认中，确认号是多少?

d.假设A发送的两个段按b的顺序到达，第一个确认丢失，第二个段在第一个超时间隔之后到达，如下图所示。完成图表，显示所有其他部分和发送的确认。(假设没有额外的包丢失。)对于添加到图中的每个段，提供序号和数据字节数;对于您添加的每个确认，请提供确认号。

a.第一段和第二段分别包含20字节和40字节的数据。在从A发送到B的第二段中，序列号为165，源端口号为303，目标端口号为80。

b.第一个确认有确认号165，源端口

80，目的港303。

c.确认号为145，表示它仍在等待字节145并继续。

d.重传的序号为145，它携带20字节的数据。附加应答的应答号为205。

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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.

考虑两个TCP连接，一个在主机a(发送方)和主机B(接收方)之间，另一个在主机C(发送方)和主机D(接收方)之间。A和B之间的RTT是C和d之间RTT的一半。假设发送方(A和C)的拥塞窗口大小相同。它们的吞吐量(每秒传输的段数)相同吗?解释一下。

现在假设A和b, C和D之间的平均RTT是相同的。A和B之间的RTT是常数(从不变化)，但是C和D之间的RTT变化很大。这两个连接的TCP计时器值会不同吗?如果会，它们有何不同?为什么会不同?

c.给出TCP使用三向(SYN、SYNACK、ACK)握手而不是双向握手来启动连接的原因之一。

据说TCP连接“探测”它用于可用带宽的网络路径。这是什么意思?

当我们说TCP使用“累积确认”是什么意思?请给出累积承认优于选择性承认的两个原因。

一个,没有。两届会议将每一RTT传送相同数目的段。但是由于A-B连接的RTT是另一个会话的一半，它的吞吐量将是另一个会话的两倍。

TCP定时器计算RTT的估计值，并添加一个因素来解释RTTs的变化。因此，C-D连接超时值将更大。

c.假设一个客户机传输多个SYN消息，这些消息需要很长时间才能在服务器上接收到，因此客户机终止(认为服务器已经死亡)。然后服务器接受这些SYN连接(只有双向握手，服务器需要在收到SYN后立即提交)。然而，客户端不再存在，因此服务器现在打开多个连接，而另一端没有客户端。

d. TCP的锯齿行为是由于TCP不断增加它的传输速率，直到网络中的某个链接被阻塞(也就是说，直到该链接上没有未使用的带宽)，这时就会发生损耗。然后TCP后退并继续增加带宽。

e. TCP中对X的确认告诉发送方，X之前的所有数据都已正确接收。累积ACK可以减少ACK开销。例如，TCP接收器将等待一小段时间，希望下一个按顺序排列的包将到达，然后将只生成一个ACK(针对第二个包)，它将确认两个包。而且，即使接收方分别对包X进行ACK操作，如果X的ACK丢失，但是ACK被接收，发送方也会知道接收方已经接收了X。