计算机网络习题课

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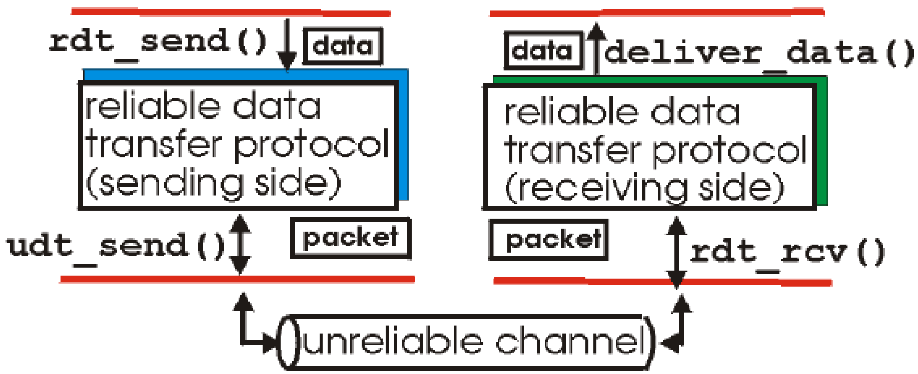
Homework 3

P7. Draw the FSM for the receiver side of protocol rdt 3.0.



version	problem	solution
rdt 1.0	trivial	
rdt 2.0	bit errors	error detection receiver feedback
rdt 2.1	corrupted ACK/NAK	sequence number
rdt 2.2	corrupted ACK/NAK	NAK-free
rdt 3.0	lost or delayed packets	countdown timer

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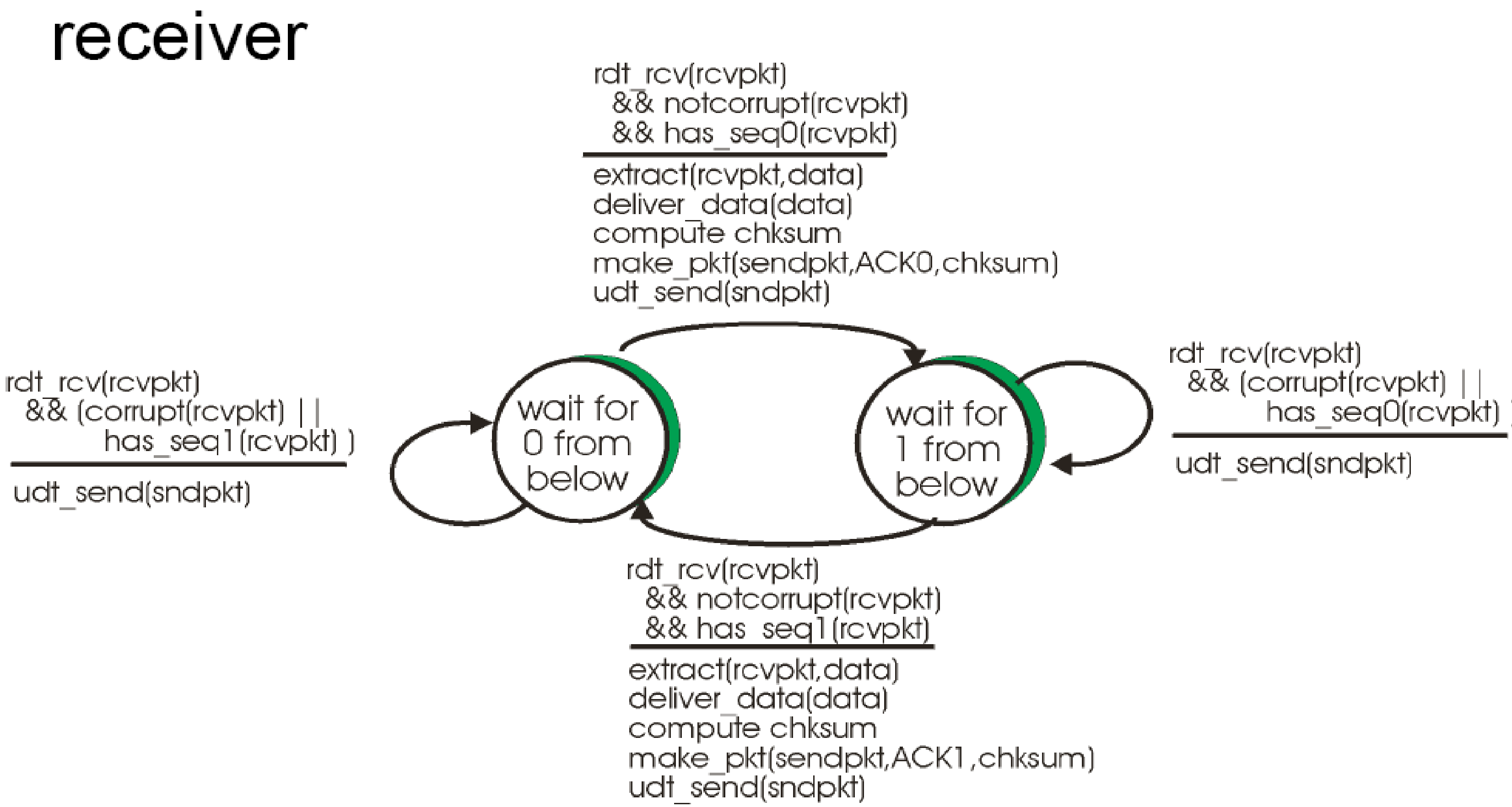
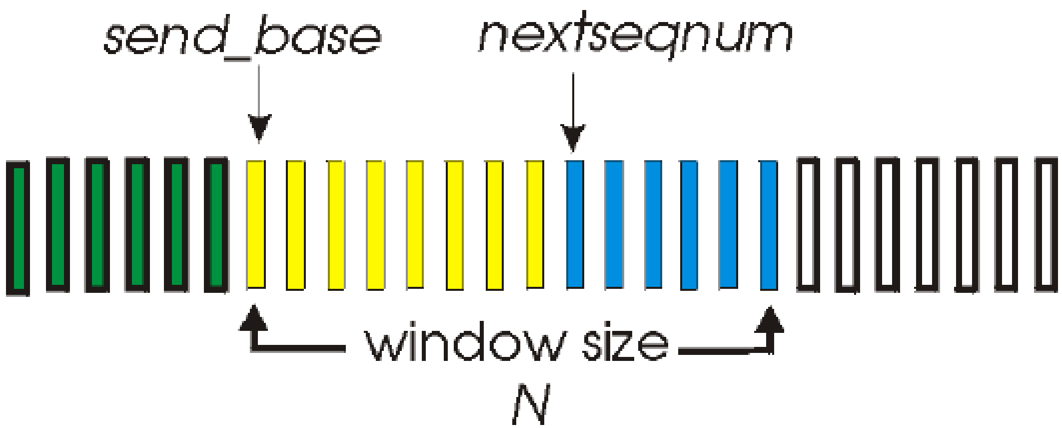

receiver
rdt_rcv(rcvpkt)
&& notcorrupt(rcvpkt)
&& has_seq0(rcvpkt)
extract(rcvpkt,data)
deliver_data(data)
compute chksum
make_pkt(sendpkt,ACK0,chksum)
udt_send(sndpkt)
rdt_rcv(rcvpkt)
&& (corrupt(rcvpkt) ||
has_seq1(rcvpkt))
udt_send(sndpkt)
wait for
0 from
below
wait for
1 from
below
rdt_rcv(rcvpkt)
&& (corrupt(rcvpkt) ||
has_seq0(rcvpkt))
udt_send(sndpkt)
rdt_rcv(rcvpkt)
&& notcorrupt(rcvpkt)
&& has_seq1(rcvpkt)
extract(rcvpkt,data)
deliver_data(data)
compute chksum
make_pkt(sendpkt,ACK1,chksum)
udt_send(sndpkt)

Homework 3

P18. Consider the GBN protocol with a sender window size of 3 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:



Homework 3

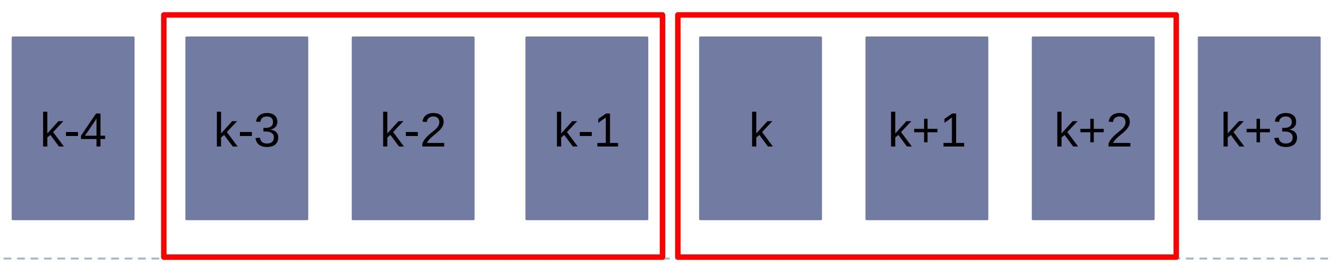
a. What are the possible sets of sequence numbers inside the sender's window at time *t*? Justify your answer.

Answer:

the sender's window begins somewhere in the range [k-N,k].

Suppose the receiver has received packet k-1 and has ACKed that and all other preceeding packets.

- If all of these ACKs have been received by sender
- If none of the ACKs have been received at the sender.



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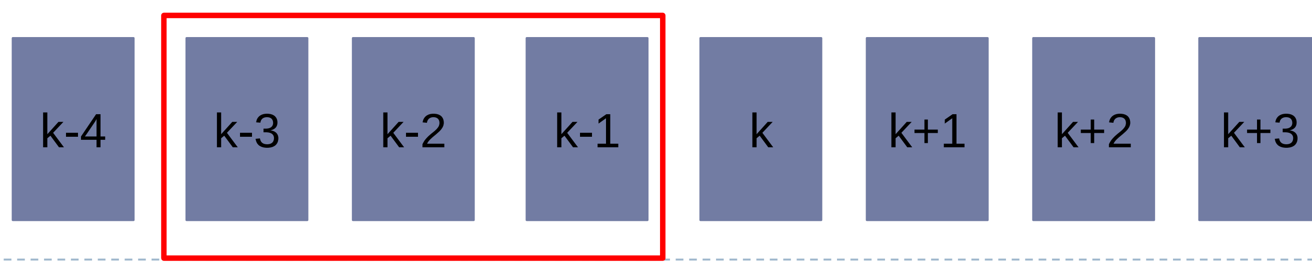
b. What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time *t*? Justify your answer.

Answer:

ACK messages with values of [k-N,k-1] may still be propagating back.

If the receiver is waiting for packet k, then it has received (and ACKed) packet k-1 and the N-1 packets before that.



Homework 3

P24. Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 358. Suppose Host A then sends two segments to Host B back-to-back. The first and second segments contain 50 and 80 bytes of data, respectively. In the first segment, the sequence number is 359, the source port number is 1028, and the destination port number is 80. Host B sends an acknowledgement whenever it receives a segment from Host A.

Homework 3

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

sequence number is 409, source port number is 1028 and destination port number is 80.

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?

acknowledgement number is 409, source port number is 80 and destination port number is 1028.

Homework 3

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

acknowledgement number is 359, indicating that it is still waiting for bytes 359 and onwards.

d. Suppose the two segments sent by A arrive in order at B. The first acknowledgement is lost and the second acknowledgement arrives after the first timeout interval. Draw a timing diagram, showing these segments and all other segments and acknowledgements sent.

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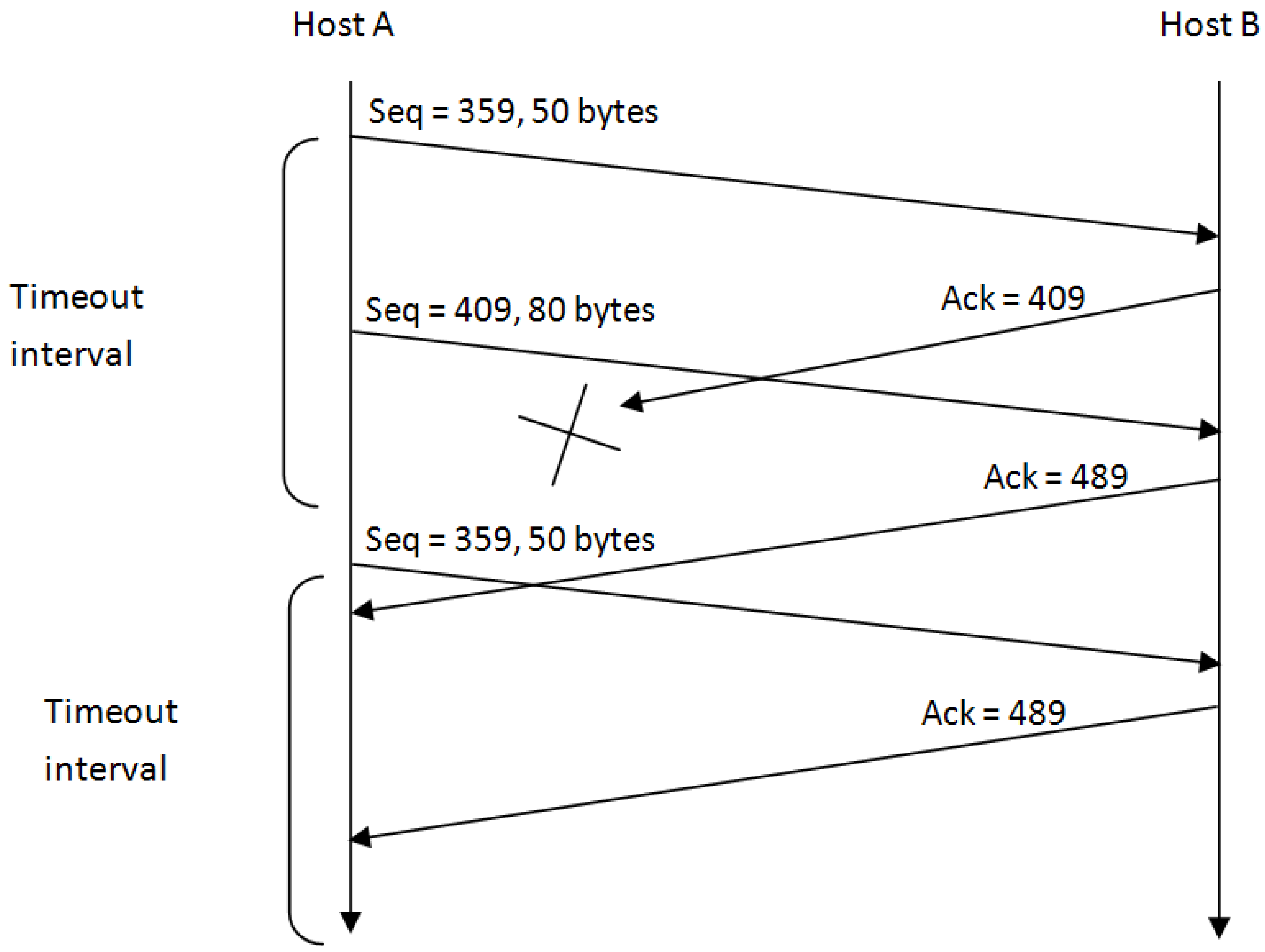
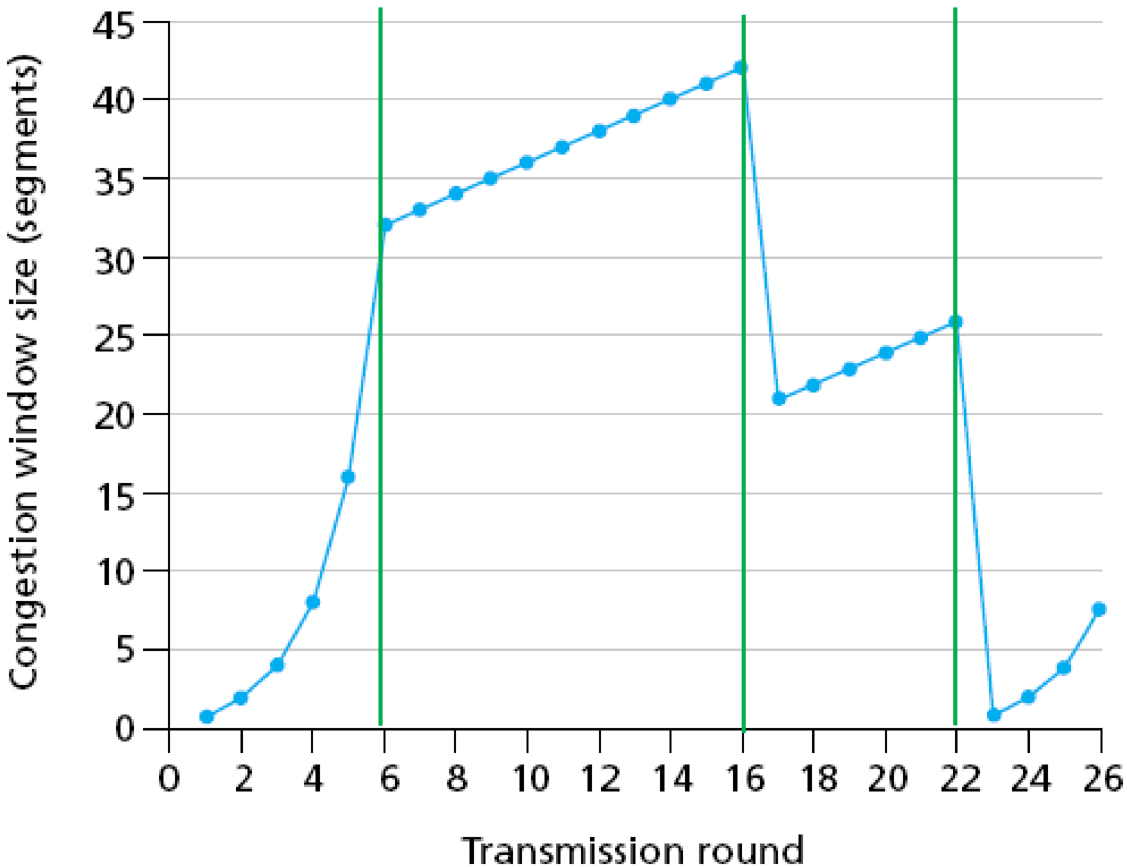


Host A
Host B
Seq = 359, 50 bytes
Timeout
interval
Seq = 409, 80 bytes
Ack = 409
Ack = 489
Seq = 359, 50 bytes
Timeout
interval
Ack = 489

Homework 3

P34. Consider the following plot of TCP window size as a function of time.

Page P311 Table 3.3



Homework 3

a. Identify the intervals of time when TCP slow start is operating.

[1,6] and [23,26]

b. Identify the intervals of time when TCP congestion avoidance is operating.

[6,16] and [17,22]

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

a triple duplicate ACK

d. After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?

timeout

Homework 3

e. What is the initial value of Threshold at the first transmission round? 32

f. What is the value of Threshold at the 18th transmission round? 21

g. What is the value of Threshold at the 24th transmission round? 13

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

i. 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 Threshold?

4 and 4

Homework 3

P39. Recall the macroscopic description of TCP throughput. In the period of time from when the connection's rate varies from $W/(2 * \text{RTT})$ to W/RTT, only one packet is lost (at the very end of the period).

a. Show that the loss rate (fraction of packets lost) is equal to

$$L = \text{loss rate} = \frac{1}{\frac{3}{8}W^2 + \frac{3}{4}W}$$

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Answer:

a. In a cycle, 1 packet is lost. The number of packets sent in a cycle is:

$$\frac{W}{2}+\left(\frac{W}{2}+1\right)+\cdots+W=\sum_{n=0}^{W/2}\left(\frac{W}{2}+n\right)$$

$$=\left(\frac{W}{2}+1\right)\frac{W}{2}+\sum_{n=0}^{W/2}n$$

$$=\left(\frac{W}{2}+1\right)\frac{W}{2}+\frac{W/2(W/2+1)}{2}$$

$$=\frac{3}{8}W^2+\frac{3}{4}W$$

Thus the loss rate is

$$L=\frac{1}{\frac{3}{8}W^2+\frac{3}{4}W}$$

Homework 3

b. Use the result above to show that if a connection has loss rate *L*, then its average rate is approximately given by

$$\approx \frac{1.22 \cdot MSS}{RTT\sqrt{L}}$$

Answer:

For W large, $\frac{3}{8}W^2 >> \frac{3}{4}W$. Thus $L \approx 8/3W^2$ or $W \approx \sqrt{\frac{8}{3L}}$.

From the text, we therefore have average throughput $= \frac{3}{4}\sqrt{\frac{8}{3L}} \cdot \frac{MSS}{RTT}$

$$= \frac{1.22 \cdot MSS}{RTT \cdot \sqrt{L}}$$

Homework 4

P10. Consider a datagram network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the following forwarding table:

Prefix Match	Interface
1	0
11	1
111	2
otherwise	3

For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

Homework 4

Answer:

Link Interface	Address Range	Number
0	10000000 10111111	64
1	11000000 11011111	32
2	11100000 11111111	32
3	00000000 01111111	128

Homework 4

P16. Consider sending a 4,000-byte datagram into a link that has an MTU of 400 bytes. Suppose the original datagram is stamped with the identification number 422. How many fragments are generated? What are their characteristics?

Answer:

- The maximum size of data field in each fragment = 380 (20 bytes IP header). Thus the number of required fragments

$$\left\lceil \frac{4000-20}{376} \right\rceil = 11$$

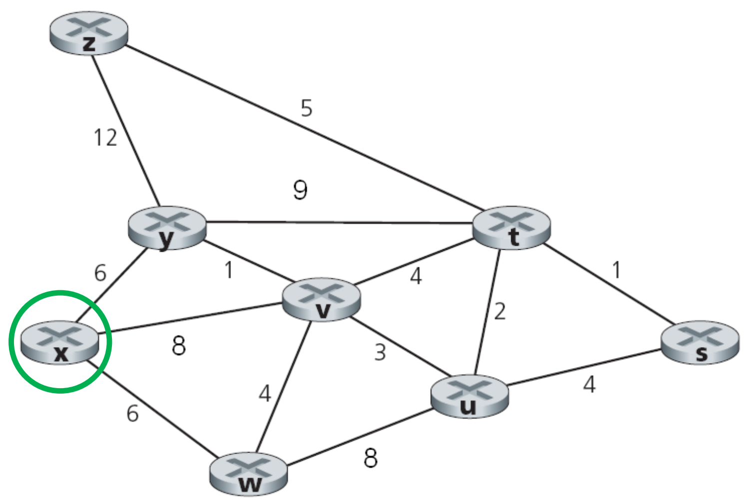
Homework 4

Answer:

- Each fragment will have Identification number 422.
- Each fragment except the last one will be of size 396 bytes (including IP header). The last datagram will be of size 240 bytes (including IP header).
- The offsets of the 11 fragments will be 0, 47, 94, 141, 188, 235, 282, 329, 376, 423, 470.
- Each of the first 10 fragments will have flag=1; the last fragment will have flag=0.

Homework 4

P22. 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 toTable 4.3.



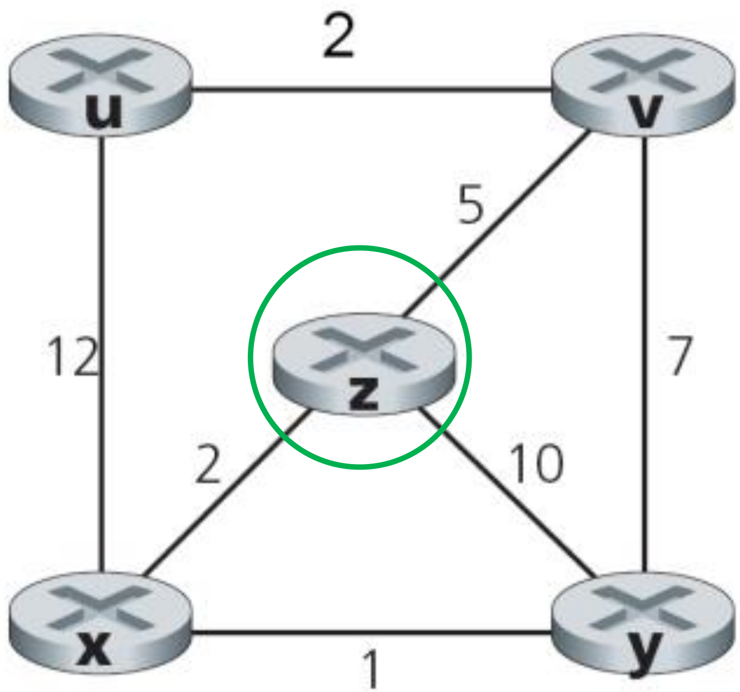
Homework 4

Answer:

Step	*N'*	*D(s),p(s)*	*D(t),p(t)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*
0	X	∞	∞	∞	8,x	6,x	6,x	∞
1	xw	∞	∞	14,w	8,x		6,x	∞
2	xwy	∞	15,y	14,w	7,y			18,y
3	xwyv	∞	11,v	10,v				18,y
4	xwyvu	14,u	11,v					18,y
5	xwyvut	12,t						16,t
6	xwyvuts							16,t
7	xwyvutsz							16,t

Homework 4

P24. Consider the network shown below, 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.



Homework 4

Node x

	x	y	z	v	u
x	0	1	2	∞	12
y	∞	∞	∞	∞	∞
z	∞	∞	∞	∞	∞
u	∞	∞	∞	∞	∞

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	10	7	∞
z	2	10	0	5	∞
u	12	∞	∞	2	∞

	x	y	z	v	u
x	0	1	2	7	9
y	1	0	3	7	9
z	2	3	0	5	7
u	12	∞	∞	2	∞

Node y

	x	y	z	v	u
x	∞	∞	∞	∞	∞
y	1	0	10	7	∞
z	∞	∞	∞	∞	∞
v	∞	∞	∞	∞	∞

	x	y	z	v	u
x	0	1	2	∞	12
y	1	0	3	7	9
z	2	10	0	5	∞
v	∞	7	5	0	2

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
z	2	3	0	5	7
v	∞	7	5	0	2

Node z

	x	y	z	v	u
x	∞	∞	∞	∞	∞
y	∞	∞	∞	∞	∞
z	2	10	0	5	∞
v	∞	∞	∞	∞	∞

	x	y	z	v	u
x	0	1	2	∞	12
y	1	0	10	7	∞
z	2	3	0	5	7
v	∞	7	5	0	2

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
z	2	3	0	5	7
v	∞	7	5	0	2

Node v

	x	y	z	v	u
x	∞	∞	∞	∞	∞
y	∞	∞	∞	∞	∞
u	∞	∞	∞	∞	∞
v	∞	7	5	0	2

	x	y	z	v	u
x	0	1	2	∞	12
y	1	0	10	7	∞
u	12	∞	∞	2	∞
v	∞	7	5	0	2

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
u	12	∞	∞	2	∞
v	7	7	5	0	2

Homework 4

Node x

	x	y	z	v	u
x	0	1	2	7	9
y	1	0	3	7	9
z	2	3	0	5	7
u	12	∞	∞	2	∞

Node y

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
z	2	3	0	5	7
v	7	7	5	0	2

Node z

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
z	2	3	0	5	7
v	7	7	5	0	2

Node v

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
u	12	∞	∞	2	∞
v	7	7	5	0	2

Answer:

	x	y	z	v	u
x	∞	∞	∞	∞	∞
y	∞	∞	∞	∞	∞
z	2	10	0	5	∞
v	∞	∞	∞	∞	∞

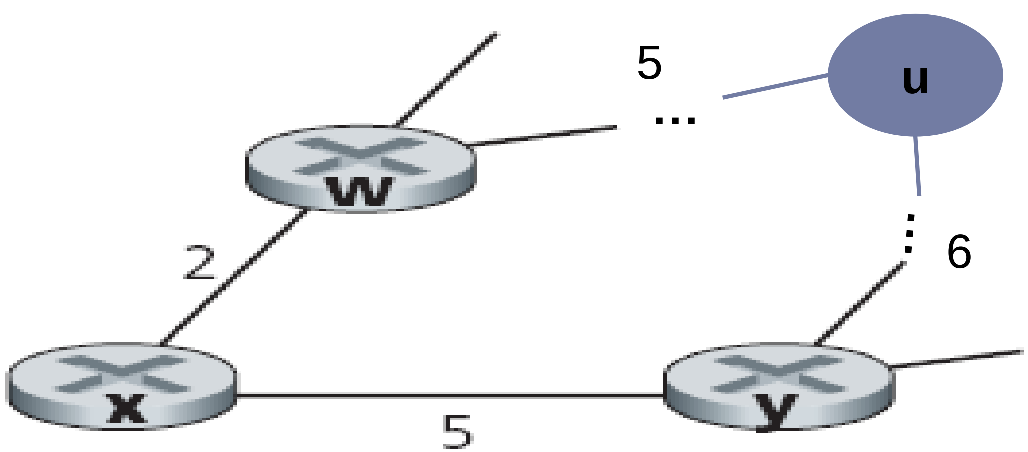
	x	y	z	v	u
x	0	1	2	∞	12
y	1	0	10	7	∞
z	2	3	0	5	7
v	∞	7	5	0	2

	x	y	Z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
z	2	3	0	5	7
v	∞	7	5	0	2

	x	y	z	v	u
x	0	1	2	7	12
y	1	0	3	7	9
z	2	3	0	5	7
v	7	7	5	0	2

Homework 4

P25. Consider the network fragment shown below. *x* has only two attached neighbours, *w* and *y*. *w* has a minimum-cost path to destination *u* (not shown) of 5,and *y* has a minimum-cost path to *u* of 6. The complete paths from *w* and *y* to *u* (and between *w* and *y*) are not shown. All link costs in the network have strictly positive integer values.



Homework 4

a. Give *x*'s distance vector for destinations *w*, *y*, and *u*.

Answer:

$D_x(y) = 5$, $D_x(w) = 2$, $D_x(u) = 7$

b. Give a link-cost change for either $c(x,w)$ or $c(x,y)$ such that *x* will inform its neighbors of a new minimum-cost path to *u* as a result of executing the distance-vector algorithm.

Answer:

Any change in link cost c(x,w) will cause x to inform its neighbors of a new minimum-cost path to u .

Homework 4

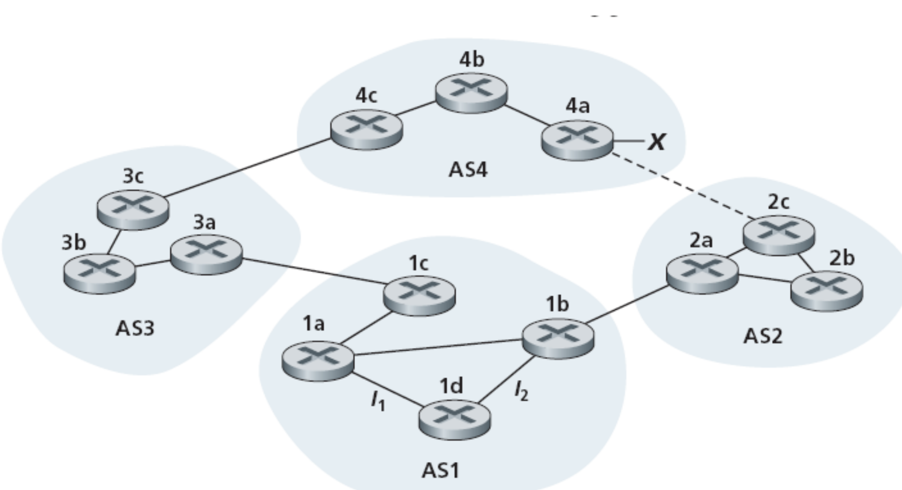
c. Give a link-cost change for either $c(x,w)$ or $c(x,y)$ such that x will *not* inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm.

Answer:

Any change in link cost c(x,y) will not cause x to inform its neighbors of a new minimum-cost path to u .

Homework 4

P29. Consider the network shown below. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is *no* physical link betweenAS2 and AS4.



Homework 4

a. Router 3c learns about prefix *x* from which routing protocol: OSPF, RIP,eBGP or iBGP?

Answer: eBGP

b. Router 3a learns about *x* from which routing protocol?

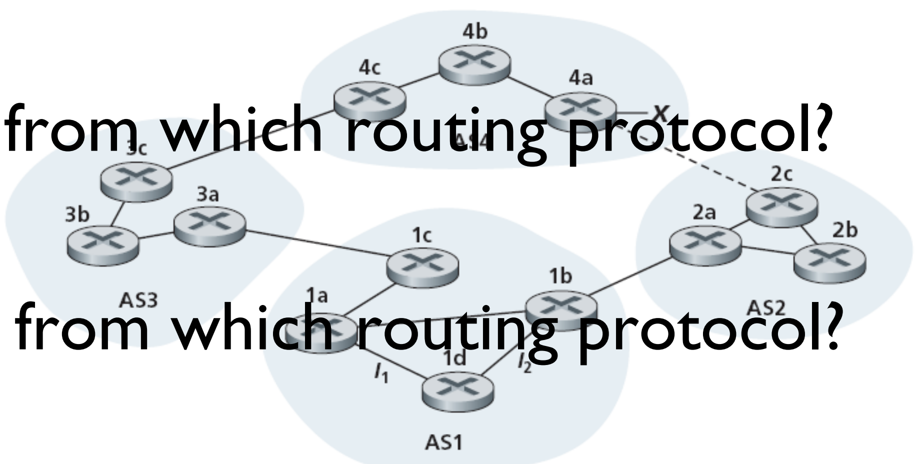
Answer: iBGP

c. Router 1c learns about *x* from which routing protocol?

Answer: eBGP

d. Router 1d learns about *x* from which routing protocol?

Answer: iBGP



Q&A