Homework 1

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Chapter 2

43 Let A and B be two stations attempting to transmit on an Ethernet. Each has a steady queue of frames ready to send; A's frames will be numbered A_1, A_2, and so on, and B's similarly. Let $T = 51.2s$ be the exponential backoff base unit. Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of $0 \times T$ and $1 \times T$, respectively, meaning A wins the race and transmits A_1 while B waits. At the end of this transmission, B will attempt to retransmit B_1 while A will attempt to transmit A_2. These first attempts will collide, but now A backs off for either $0 \times T$ or $1 \times T$, while B backs off for time equal to one of $0 \times T, ..., 3 \times T$.

(a) Give the probability that A wins this second backoff race immediately after this first collision; that is, A's first choice of backoff time $k \times 51.2$ is less than B's.
Answer: $P(k_A, kB) = (0, 1)(0, 2)(0, 3)(1, 2)(1, 3) = \frac{5}{8}$
$\therefore count(k_A) + count(k_B)/count(k_A) \times count(k_B) = \frac{5}{8}$

(b) Suppose A wins this second backoff race. A transmits A_3, and when it is finished, A and B collide again as A tries to transmit A_4 and B tries once more to transmit B_1. Give the probability that A wins this third backoff race immediately after the first collision.
Answer:

$$\begin{cases} k_B = 7of8 & \text{if } k_A = 0 \\ k_B = 6of8 & \text{if } k_A = 1 \end{cases}$$

$\therefore \frac{7+6}{count(k_A) \times count(k_B)} = \frac{13}{16}$

(c) Give a reasonable lower bound for the probability that A wins all the remaining backoff races.
Answer: Since the probabilities of A winning race 1 and 2 with $\frac{5}{8}$ and $\frac{13}{16}$ respectively, we can grab a lower bound for each of $\frac{1}{2}$ and $\frac{3}{4}$. A generalized equation to recreate this event would be $(1 - \frac{1}{2^{i-1}})$, where A wins all 3 of the initial races.

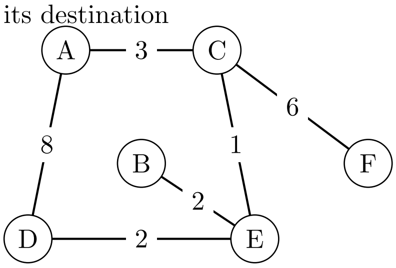
(d) What then happens to the frame B_1? This scenario is known as the Ethernet capture effect.
Answer: It just starts all over again but at B_2 this time.

53 How can a wireless node interfere with the communications of another node when the two nodes are separated by a distance greater than the transmission range of either node?
Answer: We have 2 communicaton connections: $A- > B$ and $C- > B$. Wireless interferance would occur when node C interferes with the $A- > B$ connection and where A interferes with the $C- > B$ connection.

55 How can hidden terminals be detected in 802.11 networks?
Answer: First you send off a RTS (Request to Send) packet. Then the receiver sends a reply as a CTS (Cleared to Send) packet. The second the initial transmitter gets the CTS from the receiver it send the data packets. There is a case though that if the transmitter never receives the encoded duration field that is within the CTS then the transmitter will enter a backoff mode.

Chapter 3

3 For the network given in Figure 3.45, give the datagram forwarding table for each node. The links are labeled with relative costs; yourtables should forward each packet via the lowest-cost path to its destination



Answer:

Node A:

Destination	Hop
B	C
C	C
D	C
E	C
F	C

Node B:

Destination	Hop
A	E
C	E
D	E
E	E
F	E

Node C:

Destination	Hop
A	A
B	E
D	E
E	E
F	F

Node D:

Destination	Hop
A	E
B	E
C	E
E	E
F	E

Node E:

Destination	Hop
A	C
B	B
C	C
D	D
F	C

Node F:

Destination	Hop
A	C
B	C
C	C
D	C
E	C

13 Given the extended LAN shown in Figure 3.48, indicate which ports are not selected by the spanning tree algorithm.

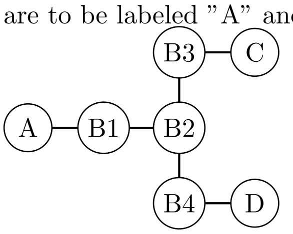
Answer:

B1:	(B1, B1, 0)	(B1, B1, 0)	(B1, B1, 0)
B2:	(B2, B2, 0)	(B2, B2, 0)	(B2, B1, 2)
B3:	(B3, B3, 0)	(B3, B1, 1)	(B3, B1, 1)
B4:	(B4, B4, 0)	(B4, B1, 2)	(B4, B1, 2)
B5:	(B5, B5, 0)	(B5, B2, 1)	(B5, B1, 2)
B6:	(B6, B6, 0)	(B6, B1, 2)	(B6, B1, 2)
B7:	(B7, B7, 0)	(B7, B1, 1)	(B7, B1, 1)

15 Consider the arrangement of learning bridges shown in Figure 3.49. Asusming all are initially empty, give the forwarding tables for each of the bridges B1 to B4 after the following transmissions:

- A sends to C.
- C sends to A.
- D sends to C.

Identify ports with the unique neighbor reached directly from that port; that is, the ports for B1 are to be labeled "A" and "B2".



Answer:

B1:	(A, A)	(B2, C)	
B2:	(B1, A)	(B3, C)	(B4, D)
B3:	(B2, A and D)	(C, C)	
B4:	(B2, A)	(D, D)	

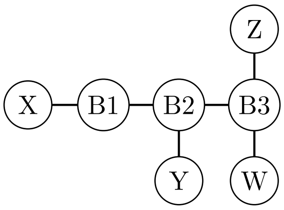
17 Consider hosts X, Y, Z, W and learning bridges B1, B2, B3, with initially empty forwarding tables, as in Figure 3.50.

(a) Suppose X sends to W. Which Bridges learn where X is? Does Y's network interface see this packet?
Answer: Because the path from X to W passes through all bridges each node in the network knows of the location of X.

(b) Suppose Z now sends to X. Which bridges learn where Z is? Does Y's network interface see this packet?
Answer: Because X's location is already known the packet is sent directly to X from Z and Y is never reached because B2 immediately sends to B1

(c) Suppose Y now sends to X. Which bridges learn where Y is? Does Z's network interface see this packet?
Answer: Because the only connection to Y is B2 and B2 knows that to the left is B1 and then X it just sends straight from Y to B2 to B1 to X. Never informing B3 or Z

(d) Finally, suppose W sends to Y. Which bridges learn where W is? Does Z's network interface see this packet?
Answer: Because B3 never interacted with Y it has to push the packet to Z instead, luckily Z knows where Y is but once it gets there, B1 was never informed of the packet, meaning that B1 does not know where Y is.



33 What aspect of IP address makes it necessary to have one address per network interface, rather than just one per host? In light of your answer, why does IP tolerate point-to-point interfaces that have nonunique addresses or no addresses?
Answer: The subnet, because point-to-point allows duplicate addresses

36 Suppose a TCP message that contains 1024 bytes of data and 20 bytes of TCP header is passed to IP for delivery across two networks interconnected by a router (i.e., it travels from the source host to a router to the destination host). The first network has an MTU of 1024 bytes; the second has an MTU of 576 bytes. Each network's MTU gives the size of the largest IP datagram that can be carried in a link-layer frame. Give the sizes and offsets of the sequence of fragments delivered to the network layer at the destination host. Assume all IP headers are 20 bytes.
Answer:

$$\begin{array}{rcl} \text{First MTU} & & \\ 1024 - 20 & = & 1004 \\ 8 \times \lfloor \frac{1004}{8} \rfloor & = & 1000 \\ 1024 + 20 & = & 1044 \\ \text{Second MTU} & & \\ 576 - 20 & = & 556 \\ 8 \times \lfloor \frac{556}{8} \rfloor & = & 552 \end{array}$$

46 For the network shown in Figure 3.53, give global distance-vector tables like those of Tables 3.10 and 3.13 when

(a) Each node knows only the distances to its immediate neighbors.
Answer:

	A	B	C	D	E	F
A	0		3	8		
B		0			2	
C	3		0		1	6
D	8			0	2	
E		2	1	2	0	
F			6			0

(b) Each node has reported the information it had in the preceding step to its immediate neighbors.

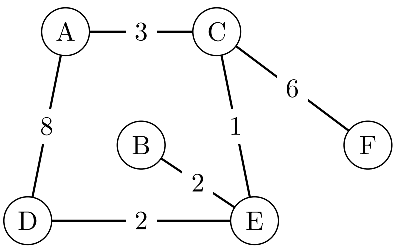
Answer:

	A	B	C	D	E	F
A	0		3	8	4	9
B		0	3	4	2	
C	3	3	0	3	1	6
D	8	4	3	0	2	
E	4	2	1	2	0	7
F	9		6		7	0

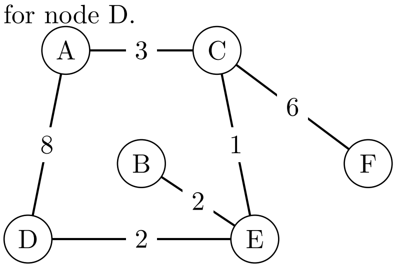
(c) Step (b) happens a second time.

Answer:

	A	B	C	D	E	F
A	0	6	3	6	4	9
B	6	0	3	4	2	9
C	3	3	0	3	1	6
D	6	4	3	0	2	9
E	4	2	1	2	0	7
F	9	9	6	9	7	0



48 For the network given in Figure 3.53, show how the link-state algorithm builds the routing table for node D.



Answer:

	Confirmed	Tentative
1	(D, 0, -)	
2	(D, 0, -)	(A, 8, A) (E, 2, E)
3	(D, 0, -) (E, 2, E)	(A, 8, A) (B, 4, E) (C, 3, E)
4	(D, 0, -) (E, 2, E) (C, 3, E)	(A, 6, E) (B, 4, E) (F, 9, E)
5	(D, 0, -) (E, 2, E) (C, 3, E) (B, 4, E)	(A, 6, E) (F, 9, E)
6	(D, 0, -) (E, 2, E) (C, 3, E) (B, 4, E) (A, 6, E)	
7	(D, 0, -) (E, 2, E) (C, 3, E) (B, 4, E) (A, 6, E) (F, 9, E)	

54 For the network in Figure 3.53, suppose the forwarding tables are all established as in Exercise 46 and then the C-E link fails. Give:

(a) The tables of A, B, D, and F after C and E have reported the news.
Answer:

Node A:

destination	cost	hop
B		-
C	3	C
D		-
E		-
F	9	C

Node B:

destination	cost	hop
A		-
C		-
D	4	E
E	3	E
F		-

Node D:

destination	cost	hop
A		-
B	4	E
C		-
E	2	E
F		-

Node F:

destination	cost	hop
A	9	C
B		-
C	6	C
D		-
E		-

(b) The tables of A and D after their next mutual exchange.
Answer:

Node A:

destination	cost	hop
B	12	D
C	3	C
D	8	D
E	10	D
F	9	C

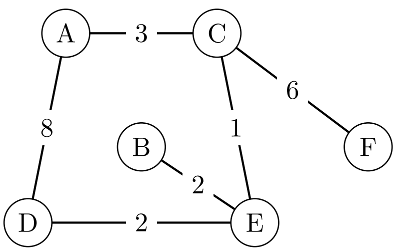
Node D:

destination	cost	hop
A	8	A
B	4	E
C	11	A
E	2	E
F	17	A

(c) The table of C after A exchanges with it.
Answer:

Node C:

destination	cost	hop
A	3	A
B	15	A
D	11	A
E	13	A
F	6	F



Playing with ping:

Use the ping command to measure and report the average round trip time between a Linux desktop on the SE1 Linux lab and the following machines:

(a) mars.ucmerced.edu

```
$ ping mars.ucmerced.edu

Pinging mars.ucmerced.edu [169.236.151.100] with 32 bytes of data:
Reply from 169.236.151.100: bytes=32 time=24ms TTL=61
Reply from 169.236.151.100: bytes=32 time=28ms TTL=61
Reply from 169.236.151.100: bytes=32 time=24ms TTL=61
Reply from 169.236.151.100: bytes=32 time=30ms TTL=61

Ping statistics for 169.236.151.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 24ms, Maximum = 30ms, Average = 26ms
```

(b) www.berkeley.edu

```
$ ping www.berkeley.edu

Pinging www-production-1113102805.us-west-2.elb.amazonaws.com [52.88.59.144] with 32 bytes of data:
Reply from 52.88.59.144: bytes=32 time=39ms TTL=229
Reply from 52.88.59.144: bytes=32 time=47ms TTL=229
Reply from 52.88.59.144: bytes=32 time=39ms TTL=229
Reply from 52.88.59.144: bytes=32 time=38ms TTL=229

Ping statistics for 52.88.59.144:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 38ms, Maximum = 47ms, Average = 40ms
```

(c) www.columbia.edu

```
$ ping www.columbia.edu

Pinging www.wwwr53.cc.columbia.edu [128.59.105.24] with 32 bytes of data:
Reply from 128.59.105.24: bytes=32 time=86ms TTL=226
Reply from 128.59.105.24: bytes=32 time=87ms TTL=226
Reply from 128.59.105.24: bytes=32 time=83ms TTL=226
Reply from 128.59.105.24: bytes=32 time=87ms TTL=226

Ping statistics for 128.59.105.24:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 83ms, Maximum = 87ms, Average = 85ms
```

(d) www.uba.ar

```
$ ping www.uba.ar

Pinging webubapr.uba.AR [157.92.5.15] with 32 bytes of data:
Reply from 157.92.5.15: bytes=32 time=212ms TTL=49
Reply from 157.92.5.15: bytes=32 time=209ms TTL=49
Reply from 157.92.5.15: bytes=32 time=210ms TTL=49
Reply from 157.92.5.15: bytes=32 time=206ms TTL=49

Ping statistics for 157.92.5.15:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 206ms, Maximum = 212ms, Average = 209ms
```

(e) sydney.edu.au

```
$ ping sydney.edu.au

Pinging sydney.edu.au [129.78.5.8] with 32 bytes of data:
Reply from 129.78.5.8: bytes=32 time=181ms TTL=239
Reply from 129.78.5.8: bytes=32 time=181ms TTL=239
Reply from 129.78.5.8: bytes=32 time=172ms TTL=239
Reply from 129.78.5.8: bytes=32 time=178ms TTL=239

Ping statistics for 129.78.5.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 172ms, Maximum = 181ms, Average = 178ms
```

For each, estimate the physical distance between engineering lab and the destination. Calculate the speed-of-light round-trip delay given this distance. At what fraction of the speed of light did your ping packets travel, for each?

(Bonus extra credit) traceroute problem:

Use "traceroute" to determine the path taken between a machine in the SE1 lab and

(a) www.uba.ar

```
$ tracert www.uba.ar

Tracing route to webubapr.uba.AR [157.92.5.15]
over a maximum of 30 hops:

  1     3 ms     5 ms     5 ms  10.0.0.1
  2    17 ms    16 ms    11 ms  96.120.14.81
  3    15 ms    14 ms    14 ms  ae-251-1203-rur01.merced.ca.ccal.comcast.net [68.87.200.22
  4    15 ms    16 ms    17 ms  ae-12-ar01.sacramento.ca.ccal.comcast.net [162.151.40.21]
  5    21 ms    19 ms    22 ms  be-36411-cs01.sunnyvale.ca.ibone.comcast.net [96.110.41.97
  6    21 ms    26 ms    21 ms  be-3102-pe02.529bryant.ca.ibone.comcast.net [96.110.41.210
  7    19 ms    37 ms    21 ms  66.208.229.78
  8   212 ms   207 ms   207 ms  ae12.baires3.bai.seabone.net [195.22.220.123]
  9   216 ms   213 ms   214 ms  claro-argentina.baires3.bai.seabone.net [185.70.203.7]
 10   206 ms   204 ms   205 ms  be4-1-cf223-igw-01-bsas.claro.com.ar [131.100.186.97]
 11     *        *        *     Request timed out.
 12     *        *        *     Request timed out.
 13     *        *        *     Request timed out.
 14   210 ms   208 ms   205 ms  157.92.5.15

Trace complete.
```

(b) sydney.edu.au

```
$ tracert sydney.edu.au

Tracing route to sydney.edu.au [129.78.5.8]
over a maximum of 30 hops:

  1     4 ms     5 ms     6 ms  10.0.0.1
  2    17 ms    14 ms    16 ms  96.120.14.81
  3    27 ms    21 ms    13 ms  ae-251-1203-rur01.merced.ca.ccal.comcast.net [68.87.200.22
  4    16 ms    22 ms    21 ms  ae-12-ar01.sacramento.ca.ccal.comcast.net [162.151.40.21]
  5    20 ms    22 ms    26 ms  be-36431-cs03.sunnyvale.ca.ibone.comcast.net [96.110.41.10
  6    26 ms    27 ms    19 ms  be-1312-cr12.sunnyvale.ca.ibone.comcast.net [96.110.46.30]
  7    30 ms    24 ms    24 ms  be-303-cr01.9greatoaks.ca.ibone.comcast.net [96.110.37.178
  8    18 ms    19 ms    20 ms  be-2312-pe12.9greatoaks.ca.ibone.comcast.net [96.110.33.42
  9    20 ms    23 ms    19 ms  50.208.234.10
 10    25 ms    19 ms    18 ms  ae-11.r25.snjsca04.us.bb.gin.ntt.net [129.250.6.118]
 11    19 ms    19 ms    19 ms  ae-0.a01.snjsca04.us.bb.gin.ntt.net [129.250.3.163]
 12    27 ms    20 ms    24 ms  xe-0-0-54-0.a01.snjsca04.us.ce.gin.ntt.net [129.250.192.25
 13   174 ms   172 ms   173 ms  xe-1-0-1.pe1.msct.nsw.aarnet.net.au [202.158.194.161]
 14   175 ms   175 ms   193 ms  et-8-1-0.pe1.brwy.nsw.aarnet.net.au [113.197.15.152]
 15   180 ms   176 ms   176 ms  gw1.vl216.ae11.pe1.brwy-pe1.aarnet.net.au [138.44.5.47]
 16     *        *        *     Request timed out.
 17     *        *        *     Request timed out.
 18   179 ms   181 ms   178 ms  uat-scilearn.sydney.edu.au [129.78.5.8]

Trace complete.
```

From its output, using your powers of sleuthing, google, and best guesses, describe the geographical path the packets take – cities and countries at each hop.