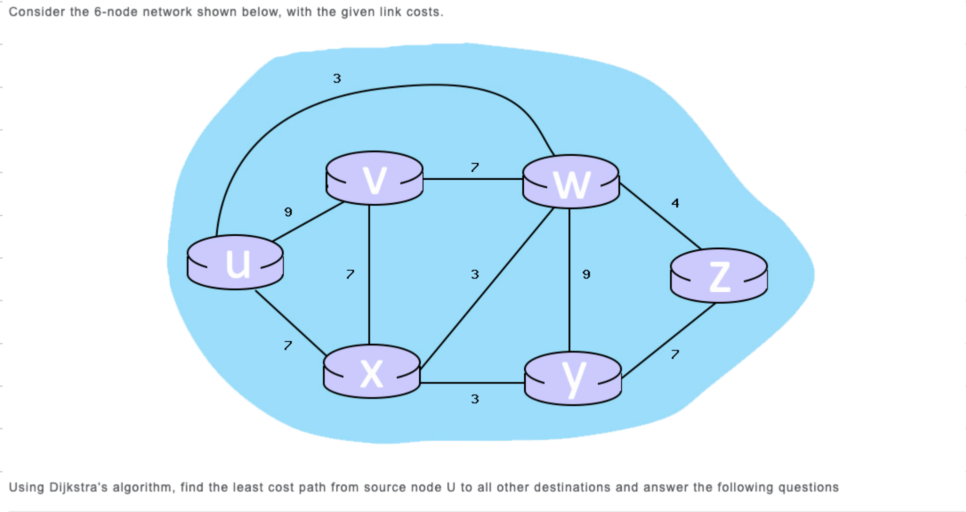
DIJKSTRA'S LINK STATE ALGO



Consider the 6-node network shown below, with the given link costs.

Using Dijkstra's algorithm, find the least cost path from source node U to all other destinations and answer the following questions

- $u \to x$:

u	v	w	x	y	z
0	9,u	3,u	7,u	+∞	+∞
∅	9,u	3,u	6,w	9,w	7,w
				9,x	

$N' = \{u\}$

$n = w$ $AdjL(w) = \{u, v, x, y, z\}$

$D(v) = \min\{9, 3+7\} = 9$

$D(x) = \min\{7, 3+3\} = 6$ ✓

$D(y) = \min\{+\infty, 3+9\} = 12$ ✓

$D(z) = \min\{+\infty, 3+4\} = 7$ ✓

$N' = \{u, w\}$

$n = x$ $AdjList(x) = \{u, v, w, y\}$

$D(v) = \min\{9, 6+7\} = 9$

$D(y) = \min\{12, 6+3\} = 9$ ✓

$N' = \{u, w, x\}$

$n = z$ $AdjL = \{w, y\}$

$D(y) = \min\{9, 7+7\} = 9$

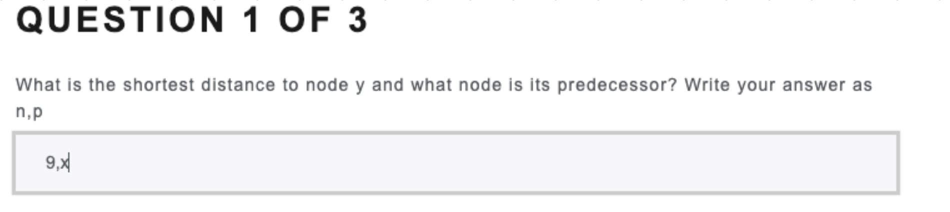
$N' = \{u, w, x, z\}$

$n = v$ $AdjL = \{u, w\}$

$N' = \{u, v, w, x, z\}$

$n = y$ $AdjL = \{x, w, z\}$

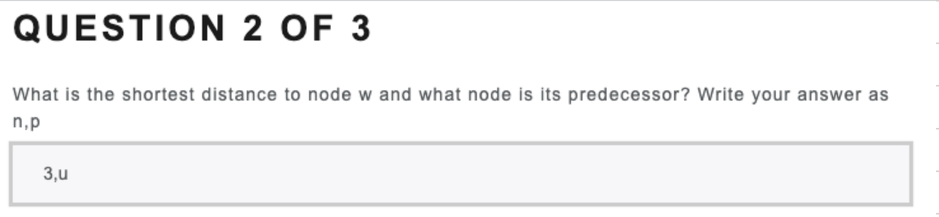
$N' = \{u, v, w, x, y, z\}$



QUESTION 1 OF 3

What is the shortest distance to node y and what node is its predecessor? Write your answer as n,p

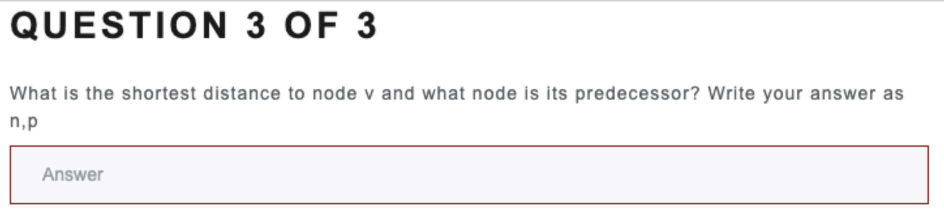
9,x



QUESTION 2 OF 3

What is the shortest distance to node w and what node is its predecessor? Write your answer as n,p

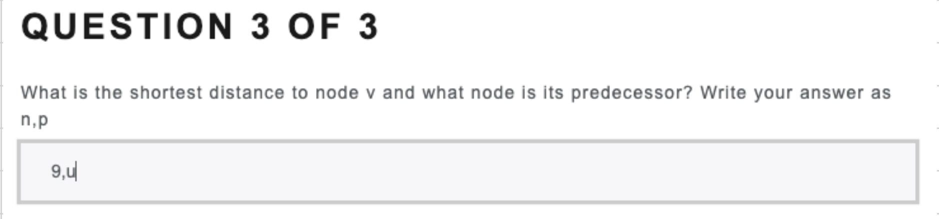
3,u



QUESTION 3 OF 3

What is the shortest distance to node v and what node is its predecessor? Write your answer as n,p

Answer

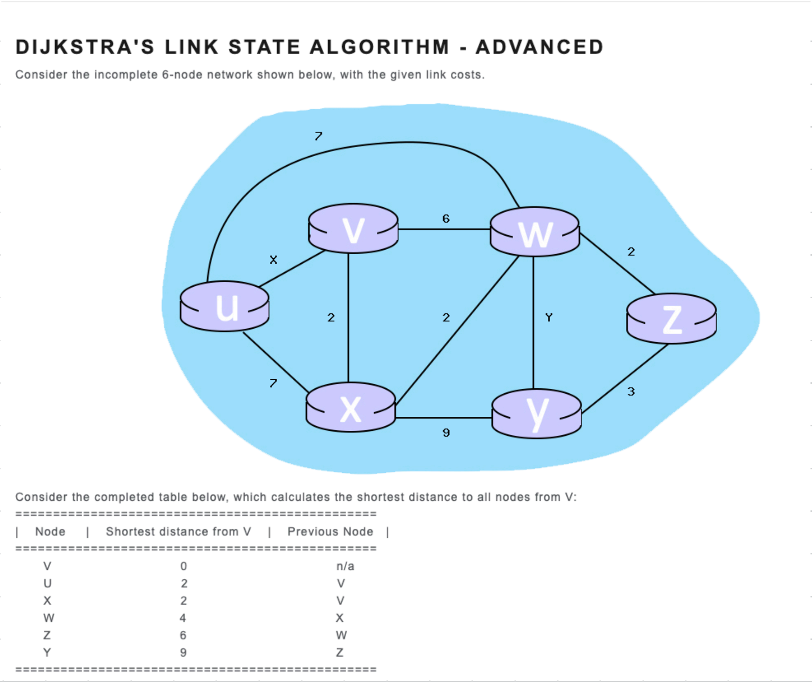


QUESTION 3 OF 3

What is the shortest distance to node v and what node is its predecessor? Write your answer as n,p

9,u

DIJKSTRA'S LS : ADVANCED

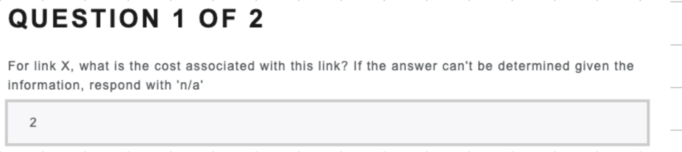


DIJKSTRA'S LINK STATE ALGORITHM - ADVANCED

Consider the incomplete 6-node network shown below, with the given link costs.

Consider the completed table below, which calculates the shortest distance to all nodes from V:

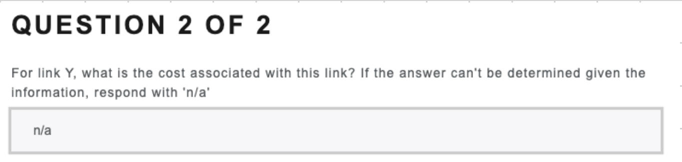
```
================================================
|   Node    |   Shortest distance from V   |   Previous Node   |
================================================
    V                   0                    n/a
    U                   2                    V
    X                   2                    V
    W                   4                    X
    Z                   6                    W
    Y                   9                    Z
================================================
```



QUESTION 1 OF 2

For link X, what is the cost associated with this link? If the answer can't be determined given the information, respond with 'n/a'

2

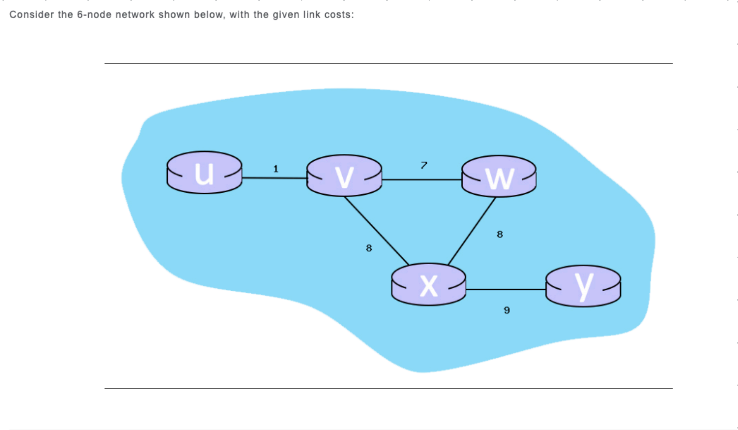


QUESTION 2 OF 2

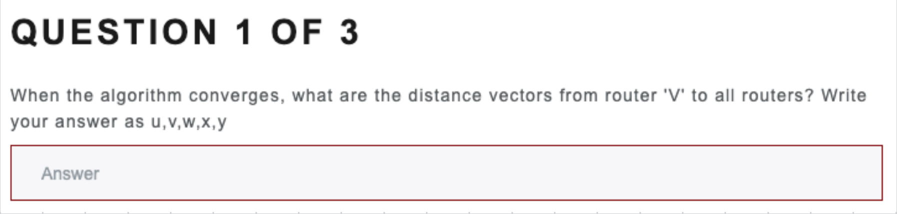
For link Y, what is the cost associated with this link? If the answer can't be determined given the information, respond with 'n/a'

n/a

BELLMAN FORD ALGO



Consider the 6-node network shown below, with the given link costs:



QUESTION 1 OF 3

When the algorithm converges, what are the distance vectors from router 'V' to all routers? Write your answer as u,v,w,x,y

$\downarrow t$

- v

$[D_v(u)=1\ ,\ D_v(w)=7,\ D_v(x)=8]$

- u

$[D_u(v)=1]$

- w

$[D_w(v)=7,\ D_w(x)=8]$

- x

$[D_x(v)=8,\ D_x(w)=8$
$D_x(y)=9]$

- y

$[D_y(x)=9]$

- u riceve lista da v → invia a v

$[\ D_u(v)=\min\{0+1\}=1,\ \underline{D_u(w)}_{ch}=\min\{\overbrace{7+1}^{v}\}=8,$
$\underline{D_w(x)}_{ch}=\min\{\overbrace{8+1}^{w}\}=9\ ]$

- w riceve lista da v → invia a {v,x}

$[\ D_w(v)=\min\{\overbrace{0+7}^{v}_{7},\}=7,\ \ D_w(x)=\min\{\overbrace{8+7}^{v},_{8}\}=8,\ \ \underline{D_w(u)}_{ch\ +\infty}=\{\overbrace{1+7}^{v},\}=8!$

- x riceve lista da v → invia a {v, w, y}

$[\ D_x(v)=\min\{0+8\}=8,\ \ D_x(u)=\{+\infty,\ \underline{\overbrace{1+8}^{v}}_{ch}\}=9,\ \ D_x(w)=\min\{8,\overbrace{7+8}^{v}\}=8\ ]$
$D_x(y)=\{9\}$

- v riceve lista da u : no change

→ v riceve lista da w: //

→ x // // // w //

-> v riceve lista da x: -> invia a u, w, ~~x~~

[... $D_v(y) = \min\{9+8\} = 17$]

-> w riceve da x: -> invia a ~~v~~, ~~x~~

[... $D_w(y) = \min\{9+8\} = 17$]

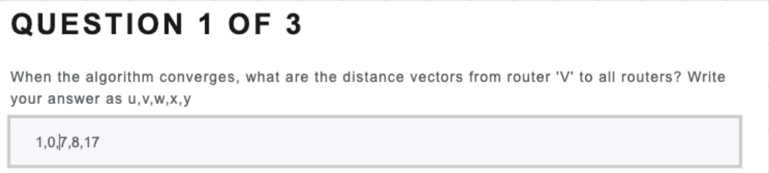
-> y riceve da x:

[..., $D_y(v) = \min\{8+9\} = 17$, $D_y(u) = \{9+9\} = 18$, $D_y(w) = \{17$

-> u riceve da v:

[... $D_u(y) = 18$]

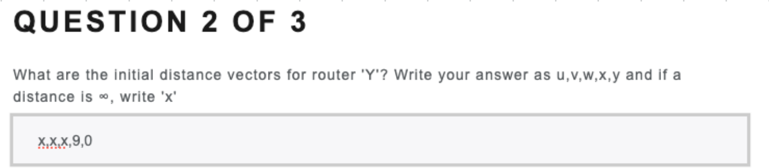
->



QUESTION 1 OF 3

When the algorithm converges, what are the distance vectors from router 'V' to all routers? Write your answer as u,v,w,x,y

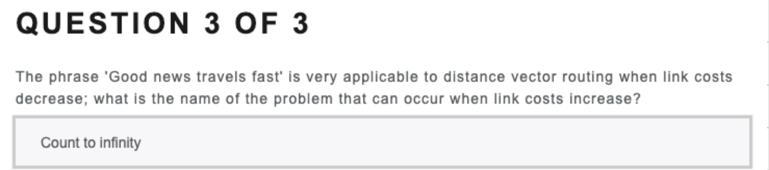
1,0,7,8,17



QUESTION 2 OF 3

What are the initial distance vectors for router 'Y'? Write your answer as u,v,w,x,y and if a distance is ∞, write 'x'

x,x,x,9,0

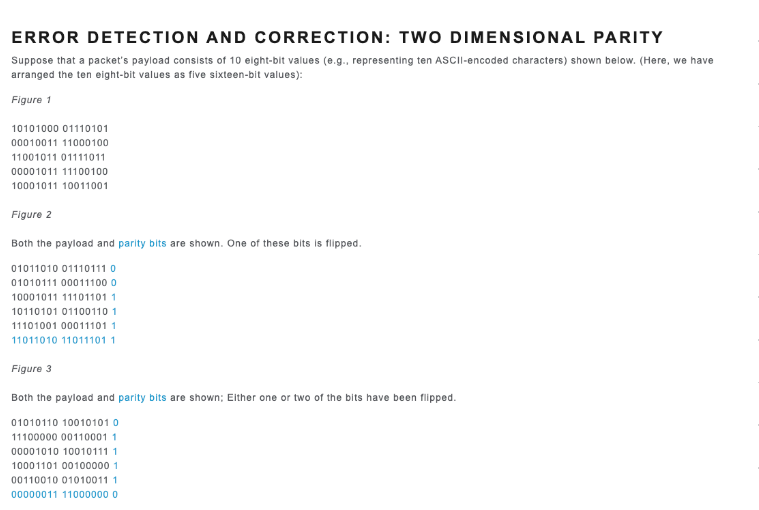


QUESTION 3 OF 3

The phrase 'Good news travels fast' is very applicable to distance vector routing when link costs decrease; what is the name of the problem that can occur when link costs increase?

Count to infinity

EDC: 2D PARITY CHECK



ERROR DETECTION AND CORRECTION: TWO DIMENSIONAL PARITY

Suppose that a packet's payload consists of 10 eight-bit values (e.g., representing ten ASCII-encoded characters) shown below. (Here, we have arranged the ten eight-bit values as five sixteen-bit values):

Figure 1

```
10101000 01110101
00010011 11000100
11001011 01111011
00001011 11100100
10001011 10011001
```

Figure 2

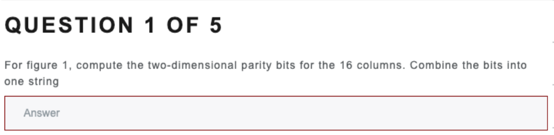
Both the payload and parity bits are shown. One of these bits is flipped.

```
01011010 01110111 0
01010111 00011100 0
10001011 11101101 1
10110101 01100110 1
11101001 00011101 1
11011010 11011101 1
```

Figure 3

Both the payload and parity bits are shown; Either one or two of the bits have been flipped.

```
01010110 10010101 0
11100000 00110001 1
00001010 10010111 1
10001101 00100000 1
00110010 01010011 1
00000011 11000000 0
```

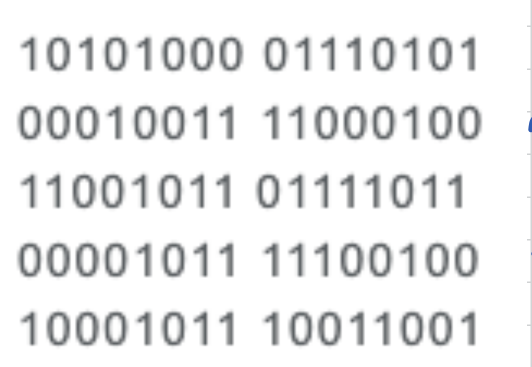


QUESTION 1 OF 5

For figure 1, compute the two-dimensional parity bits for the 16 columns. Combine the bits into one string

Answer

111100



```
10101000 01110101
00010011 11000100
11001011 01111011
00001011 11100100
10001011 10011001
```

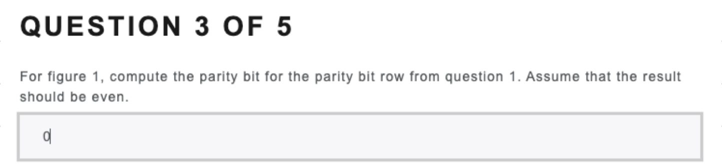
0
0
1
1
0

11110000 10110111

QUESTION 2 OF 5

For figure 1, compute the two-dimensional parity bits for the 5 rows (starting from the top). Combine the bits into one string

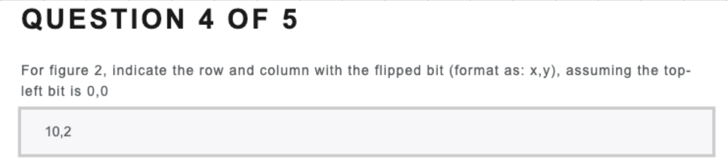
00110



QUESTION 3 OF 5

For figure 1, compute the parity bit for the parity bit row from question 1. Assume that the result should be even.

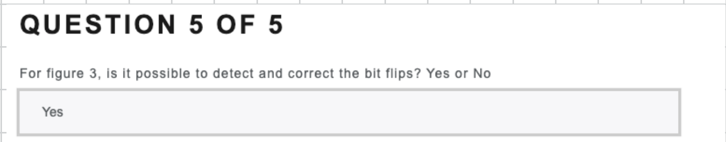
0



QUESTION 4 OF 5

For figure 2, indicate the row and column with the flipped bit (format as: x,y), assuming the top-left bit is 0,0

10,2

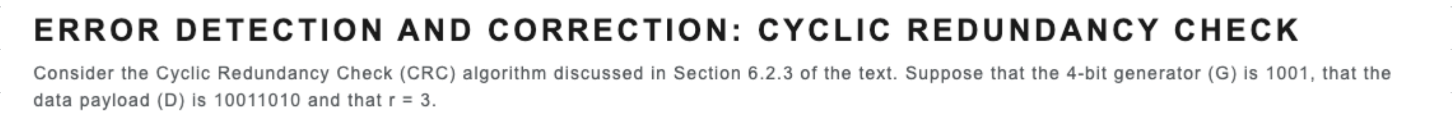


QUESTION 5 OF 5

For figure 3, is it possible to detect and correct the bit flips? Yes or No

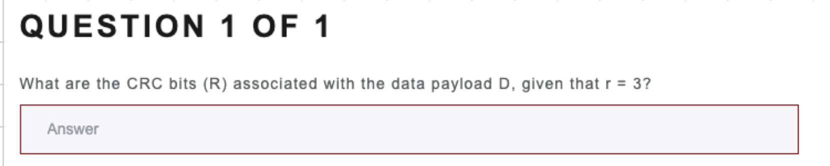
Yes

- CRC



ERROR DETECTION AND CORRECTION: CYCLIC REDUNDANCY CHECK

Consider the Cyclic Redundancy Check (CRC) algorithm discussed in Section 6.2.3 of the text. Suppose that the 4-bit generator (G) is 1001, that the data payload (D) is 10011010 and that r = 3.



QUESTION 1 OF 1

What are the CRC bits (R) associated with the data payload D, given that r = 3?

Answer

G = 1001

D = 10011010

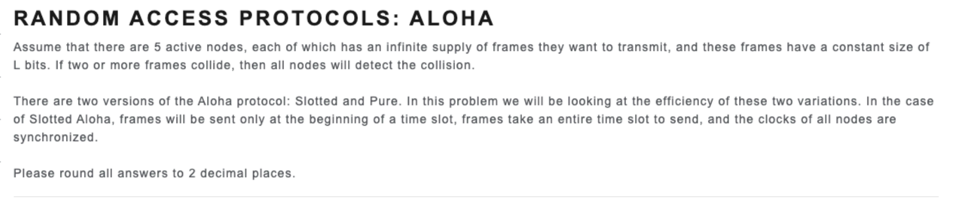
r = 3

- $R = \text{resto}\left(\frac{2^r \cdot D}{G}\right)$
- $2^r \cdot D = 10011010;000$
- $\frac{2^r \cdot D}{G} \rightarrow$ 10011010000 | 1001

Quotient: 1000100101

1001
01
0
10
00
101
000
1010
1001
11
00
110
000
1100
1001
1010
1001 = 0$\boxed{011}$

● ALOHA

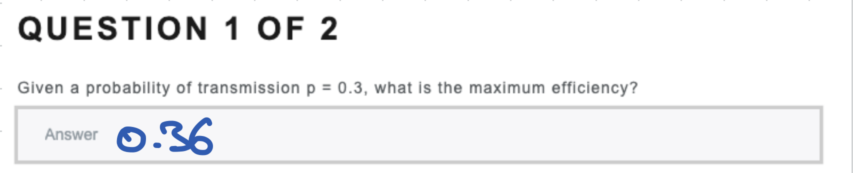


RANDOM ACCESS PROTOCOLS: ALOHA

Assume that there are 5 active nodes, each of which has an infinite supply of frames they want to transmit, and these frames have a constant size of L bits. If two or more frames collide, then all nodes will detect the collision.

There are two versions of the Aloha protocol: Slotted and Pure. In this problem we will be looking at the efficiency of these two variations. In the case of Slotted Aloha, frames will be sent only at the beginning of a time slot, frames take an entire time slot to send, and the clocks of all nodes are synchronized.

Please round all answers to 2 decimal places.

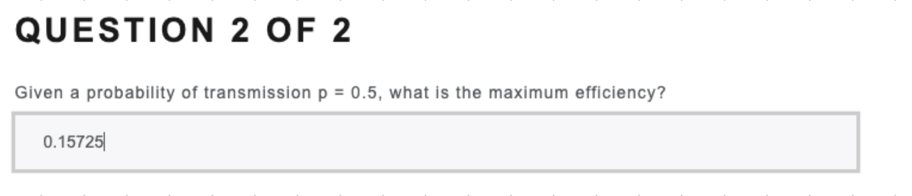


QUESTION 1 OF 2

Given a probability of transmission p = 0.3, what is the maximum efficiency?

Answer 0.36

$5 \cdot 0.3 \cdot 0.7^{4}$

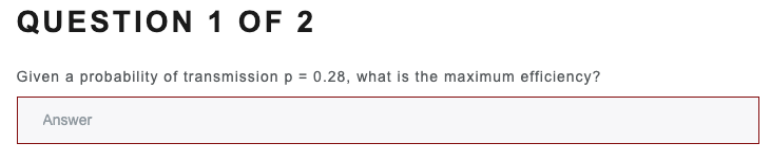


QUESTION 2 OF 2

Given a probability of transmission p = 0.5, what is the maximum efficiency?

0.15725

PURE:



QUESTION 1 OF 2

Given a probability of transmission p = 0.28, what is the maximum efficiency?

Answer

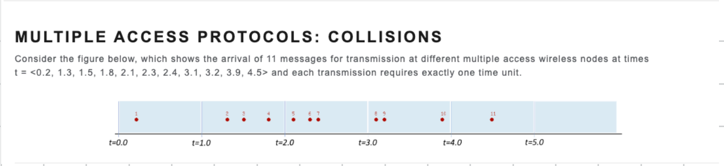
$N \cdot p \cdot (1-p)^{2(N-1)} = 0.157$ ✓

QUESTION 2 OF 2

Given a probability of transmission p = 0.62, what is the maximum efficiency?

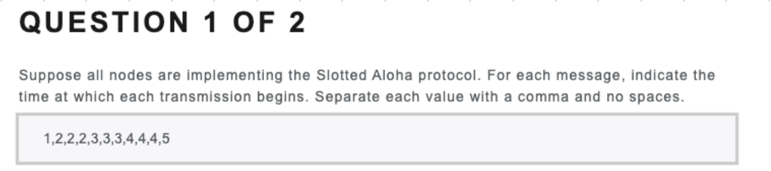
0.01

COLLISIONS:



MULTIPLE ACCESS PROTOCOLS: COLLISIONS

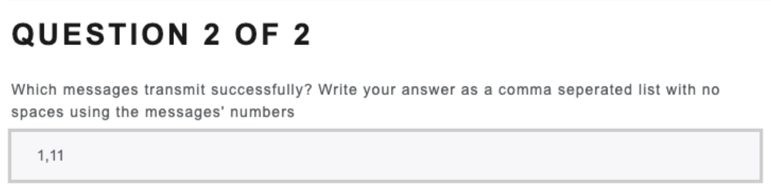
Consider the figure below, which shows the arrival of 11 messages for transmission at different multiple access wireless nodes at times t = <0.2, 1.3, 1.5, 1.8, 2.1, 2.3, 2.4, 3.1, 3.2, 3.9, 4.5> and each transmission requires exactly one time unit.



QUESTION 1 OF 2

Suppose all nodes are implementing the Slotted Aloha protocol. For each message, indicate the time at which each transmission begins. Separate each value with a comma and no spaces.

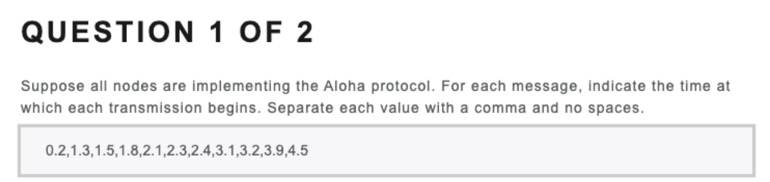
1,2,2,2,3,3,3,4,4,4,5



QUESTION 2 OF 2

Which messages transmit successfully? Write your answer as a comma seperated list with no spaces using the messages' numbers

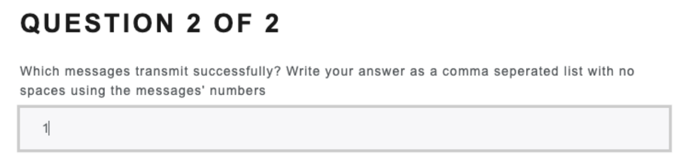
1,11



QUESTION 1 OF 2

Suppose all nodes are implementing the Aloha protocol. For each message, indicate the time at which each transmission begins. Separate each value with a comma and no spaces.

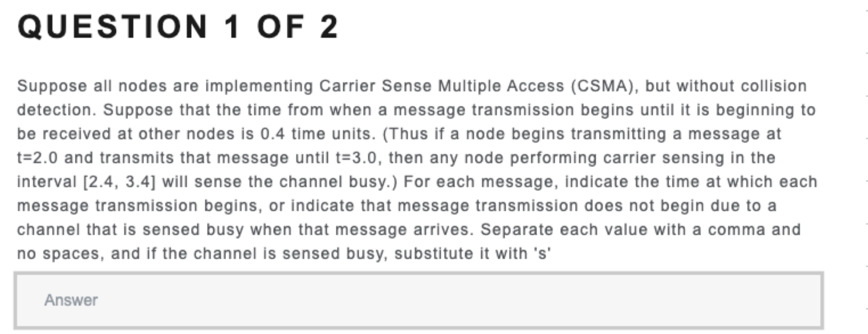
0.2,1.3,1.5,1.8,2.1,2.3,2.4,3.1,3.2,3.9,4.5



QUESTION 2 OF 2

Which messages transmit successfully? Write your answer as a comma seperated list with no spaces using the messages' numbers

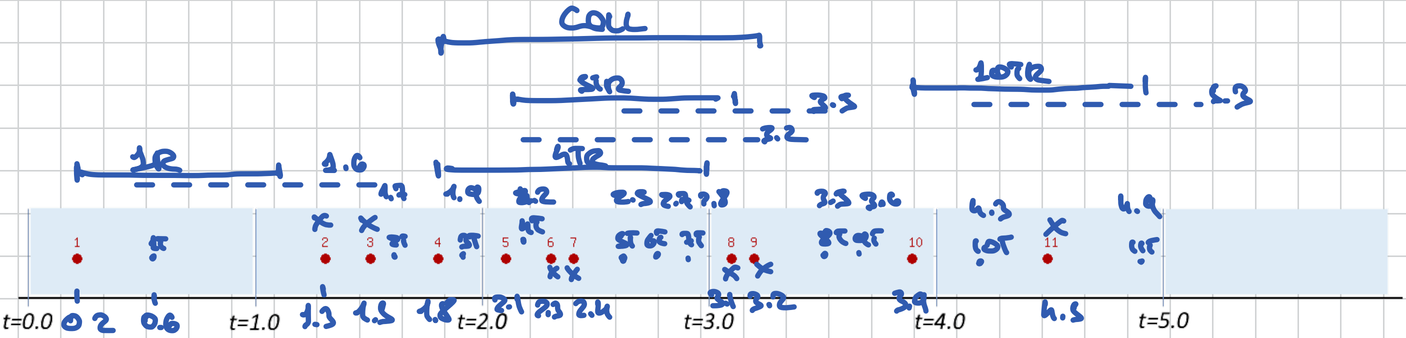
1



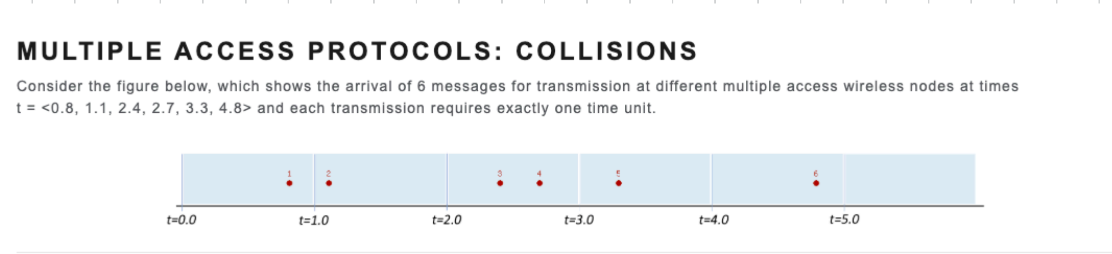
QUESTION 1 OF 2

Suppose all nodes are implementing Carrier Sense Multiple Access (CSMA), but without collision detection. Suppose that the time from when a message transmission begins until it is beginning to be received at other nodes is 0.4 time units. (Thus if a node begins transmitting a message at t=2.0 and transmits that message until t=3.0, then any node performing carrier sensing in the interval [2.4, 3.4] will sense the channel busy.) For each message, indicate the time at which each message transmission begins, or indicate that message transmission does not begin due to a channel that is sensed busy when that message arrives. Separate each value with a comma and no spaces, and if the channel is sensed busy, substitute it with 's'

Answer

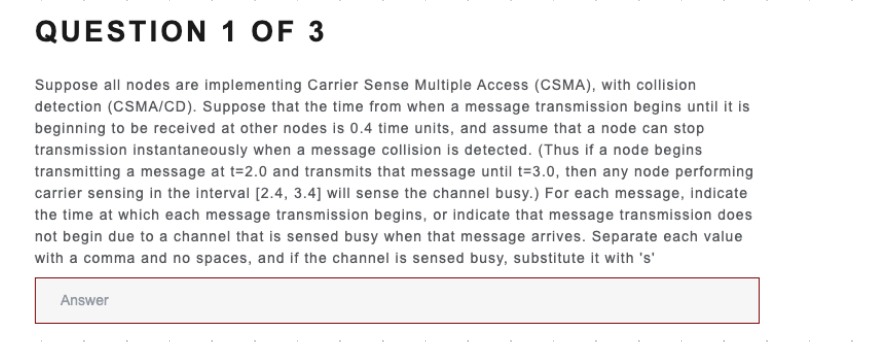


COLLISIONS: CSMA/CD



MULTIPLE ACCESS PROTOCOLS: COLLISIONS

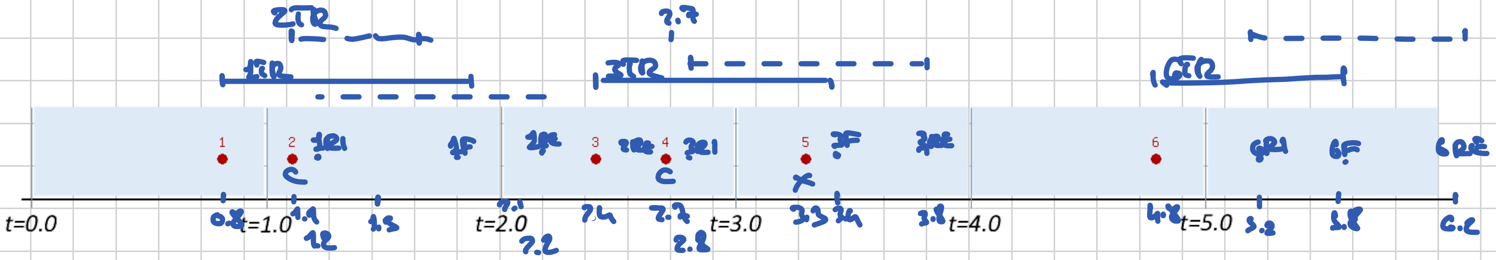
Consider the figure below, which shows the arrival of 6 messages for transmission at different multiple access wireless nodes at times t = <0.8, 1.1, 2.4, 2.7, 3.3, 4.8> and each transmission requires exactly one time unit.



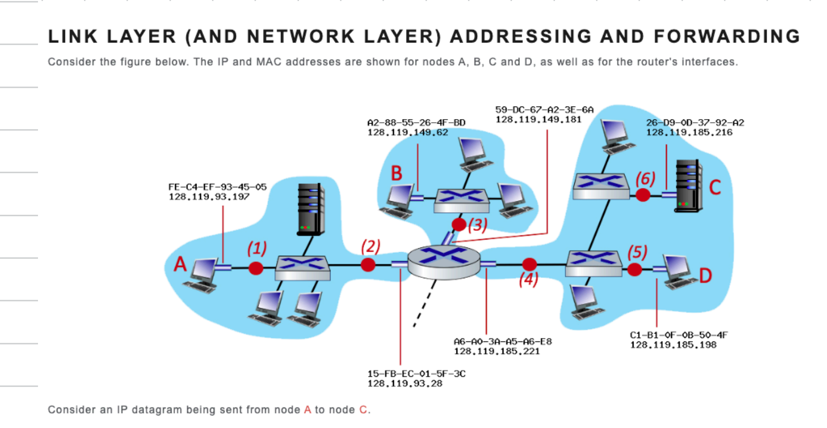
QUESTION 1 OF 3

Suppose all nodes are implementing Carrier Sense Multiple Access (CSMA), with collision detection (CSMA/CD). Suppose that the time from when a message transmission begins until it is beginning to be received at other nodes is 0.4 time units, and assume that a node can stop transmission instantaneously when a message collision is detected. (Thus if a node begins transmitting a message at t=2.0 and transmits that message until t=3.0, then any node performing carrier sensing in the interval [2.4, 3.4] will sense the channel busy.) For each message, indicate the time at which each message transmission begins, or indicate that message transmission does not begin due to a channel that is sensed busy when that message arrives. Separate each value with a comma and no spaces, and if the channel is sensed busy, substitute it with 's'

Answer



- ADDRESSING & FORWARDING



LINK LAYER (AND NETWORK LAYER) ADDRESSING AND FORWARDING

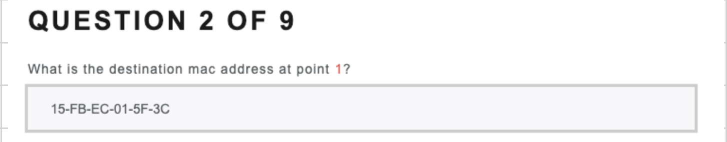
Consider the figure below. The IP and MAC addresses are shown for nodes A, B, C and D, as well as for the router's interfaces.

Consider an IP datagram being sent from node A to node C.

QUESTION 1 OF 9

What is the source mac address at point 1?

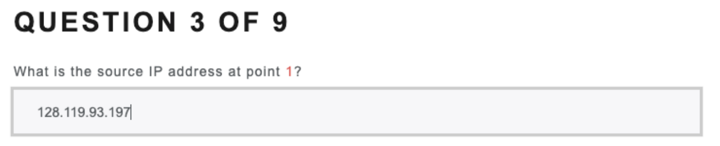
FE-C4-EF-93-45-05



QUESTION 2 OF 9

What is the destination mac address at point 1?

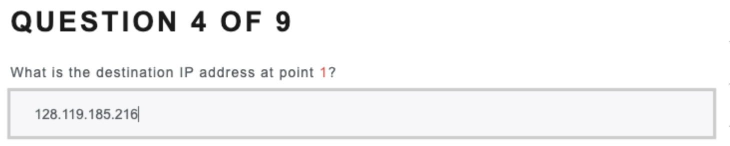
15-FB-EC-01-5F-3C



QUESTION 3 OF 9

What is the source IP address at point 1?

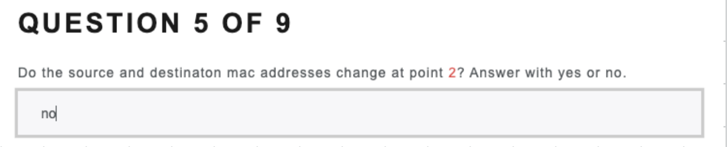
128.119.93.197



QUESTION 4 OF 9

What is the destination IP address at point 1?

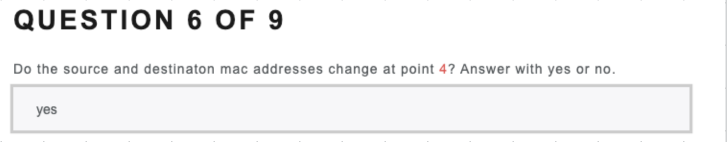
128.119.185.216



QUESTION 5 OF 9

Do the source and destinaton mac addresses change at point 2? Answer with yes or no.

no



QUESTION 6 OF 9

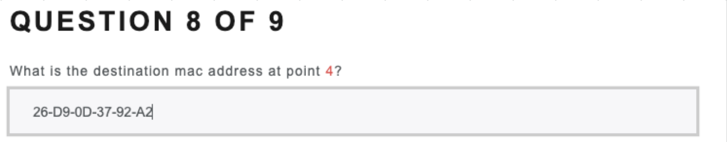
Do the source and destinaton mac addresses change at point 4? Answer with yes or no.

yes

QUESTION 7 OF 9

What is the source mac address at point 4?

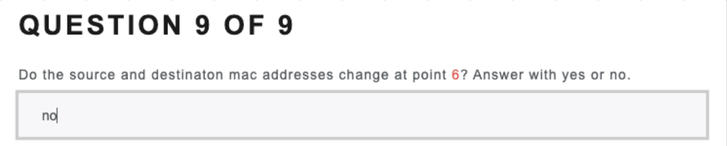
A6-A0-3A-A5-A6-E8



QUESTION 8 OF 9

What is the destination mac address at point 4?

26-D9-0D-37-92-A2

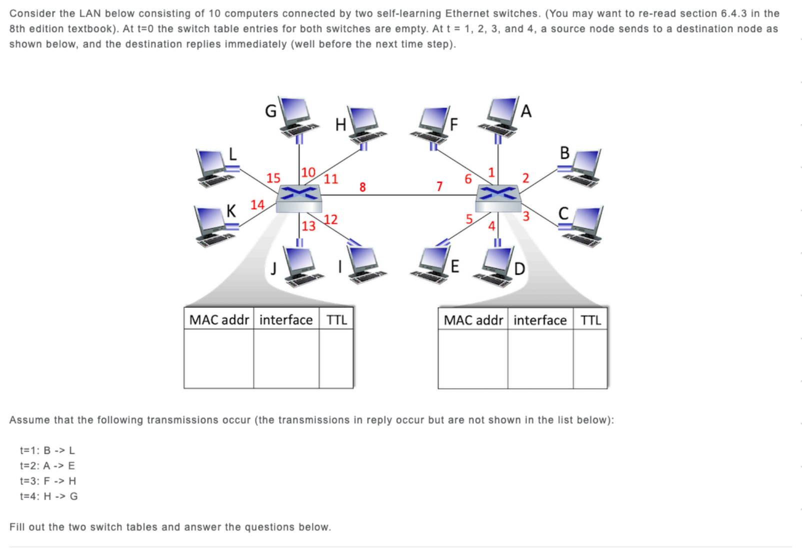


QUESTION 9 OF 9

Do the source and destinaton mac addresses change at point 6? Answer with yes or no.

no

SWITCHING

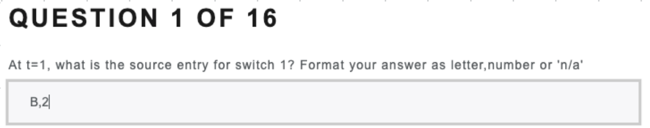


Consider the LAN below consisting of 10 computers connected by two self-learning Ethernet switches. (You may want to re-read section 6.4.3 in the 8th edition textbook). At t=0 the switch table entries for both switches are empty. At t = 1, 2, 3, and 4, a source node sends to a destination node as shown below, and the destination replies immediately (well before the next time step).

Assume that the following transmissions occur (the transmissions in reply occur but are not shown in the list below):

t=1: B -> L
t=2: A -> E
t=3: F -> H
t=4: H -> G

Fill out the two switch tables and answer the questions below.



QUESTION 1 OF 16

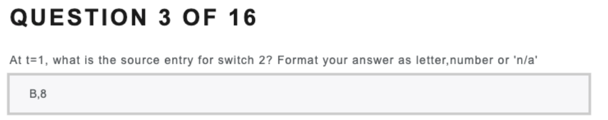
At t=1, what is the source entry for switch 1? Format your answer as letter,number or 'n/a'

B,2

QUESTION 2 OF 16

At t=1, what is the destination entry for switch 1? Format your answer as letter,number or 'n/a'

L,7



QUESTION 3 OF 16

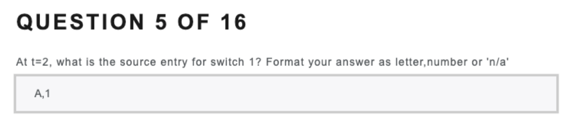
At t=1, what is the source entry for switch 2? Format your answer as letter,number or 'n/a'

B,8

QUESTION 4 OF 16

At t=1, what is the destination entry for switch 2? Format your answer as letter,number or 'n/a'

L,15



QUESTION 5 OF 16

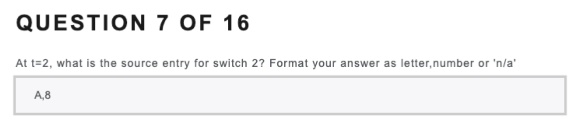
At t=2, what is the source entry for switch 1? Format your answer as letter,number or 'n/a'

A,1

QUESTION 6 OF 16

At t=2, what is the destination entry for switch 1? Format your answer as letter,number or 'n/a'

E,5



QUESTION 7 OF 16

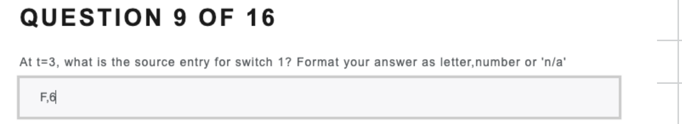
At t=2, what is the source entry for switch 2? Format your answer as letter,number or 'n/a'

A,8

QUESTION 8 OF 16

At t=2, what is the destination entry for switch 2? Format your answer as letter,number or 'n/a'

n/a



QUESTION 9 OF 16

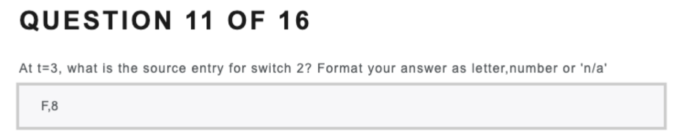
At t=3, what is the source entry for switch 1? Format your answer as letter,number or 'n/a'

F,6

QUESTION 10 OF 16

At t=3, what is the destination entry for switch 1? Format your answer as letter,number or 'n/a'

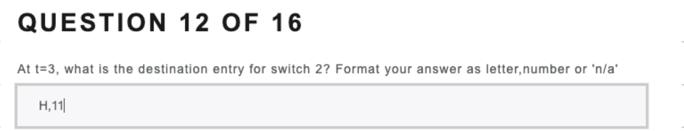
H,7



QUESTION 11 OF 16

At t=3, what is the source entry for switch 2? Format your answer as letter,number or 'n/a'

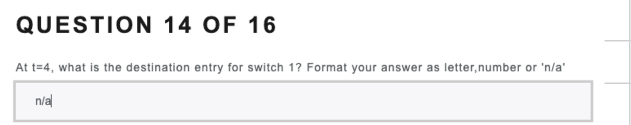
F,8



QUESTION 12 OF 16

At t=3, what is the destination entry for switch 2? Format your answer as letter,number or 'n/a'

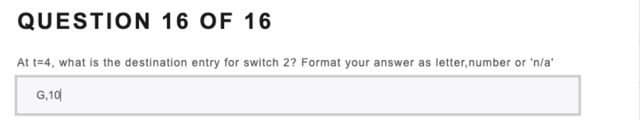
H,11



QUESTION 14 OF 16

At t=4, what is the destination entry for switch 1? Format your answer as letter,number or 'n/a'

n/a

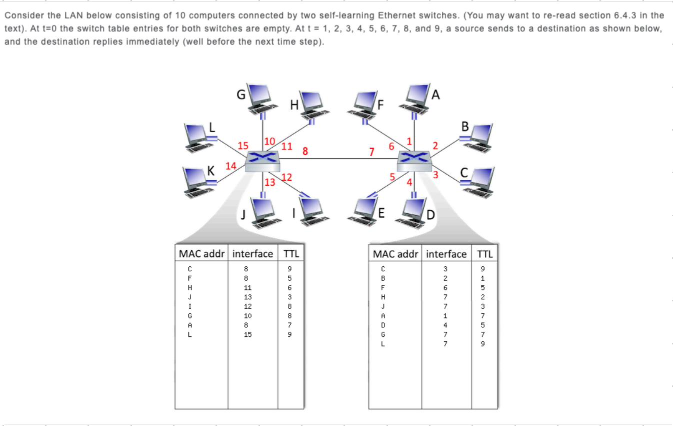


QUESTION 16 OF 16

At t=4, what is the destination entry for switch 2? Format your answer as letter,number or 'n/a'

G,10

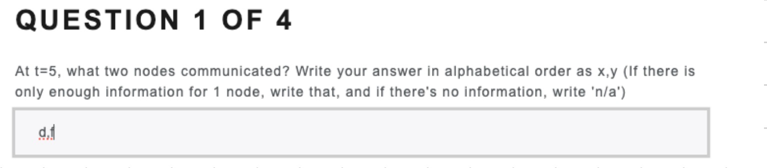
SWITCH: ADVANCED



Consider the LAN below consisting of 10 computers connected by two self-learning Ethernet switches. (You may want to re-read section 6.4.3 in the text). At t=0 the switch table entries for both switches are empty. At t = 1, 2, 3, 4, 5, 6, 7, 8, and 9, a source sends to a destination as shown below, and the destination replies immediately (well before the next time step).

MAC addr	interface	TTL
C	8	9
F	8	5
H	11	6
J	13	3
I	12	8
G	10	8
A	8	7
L	15	9

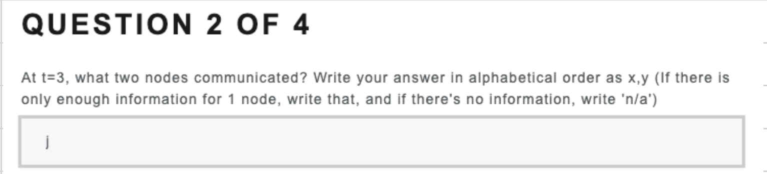
MAC addr	interface	TTL
C	3	9
B	2	1
F	6	5
H	7	2
J	7	3
A	1	7
D	4	5
G	7	7
L	7	9



QUESTION 1 OF 4

At t=5, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a')

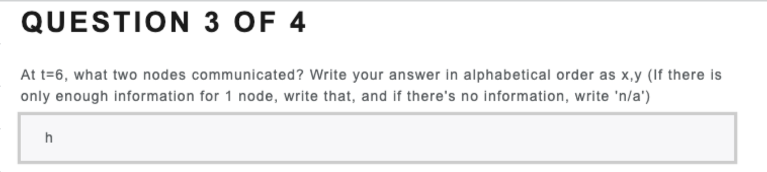
d,f



QUESTION 2 OF 4

At t=3, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a')

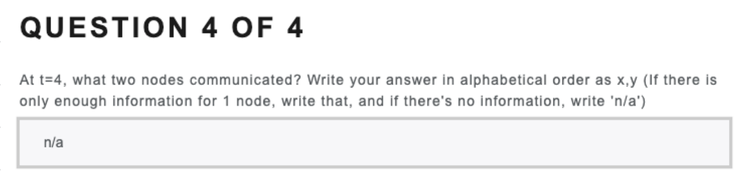
j



QUESTION 3 OF 4

At t=6, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a')

h



QUESTION 4 OF 4

At t=4, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a')

n/a