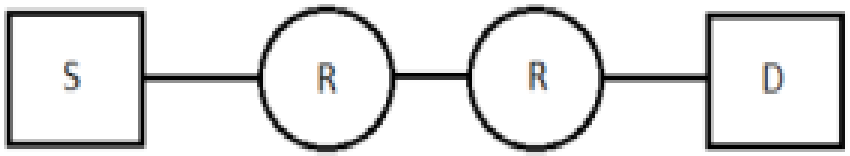
VANETs Problems and Solutions

Question 1

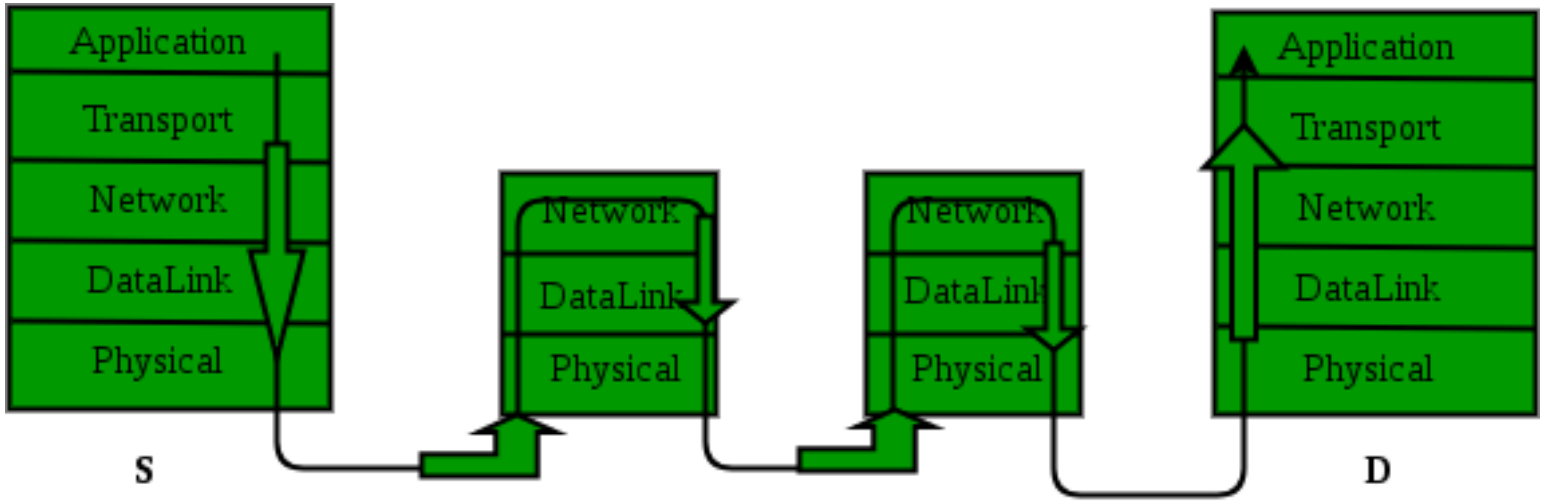
Assume that source S and destination D are connected through two intermediate routers labeled R. Determine how many times each packet has to visit the network layer and the data link layer during a transmission from S to D.



a. Network layer – 4 times and Data link layer – 4 times
b. Network layer – 4 times and Data link layer – 3 times
c. Network layer – 4 times and Data link layer – 6 times
d. Network layer – 2 times and Data link layer – 6 times

Solution

- **Answer: (C)**
  Explanation: Router is a network layer device.
  See the following diagram :



Question 2

- Think of vehicular-ad-hoc networks with fast moving nodes, e.g., cars in a city. What problems arise even for the routing algorithms adapted to ad-hoc networks? Explain your answer.
- **Solution:**
- For fast moving cars in cities **efficient routing** is very difficult as the topology changes very fast. Flooding with some optimisations may be the only way to go.

Question 3

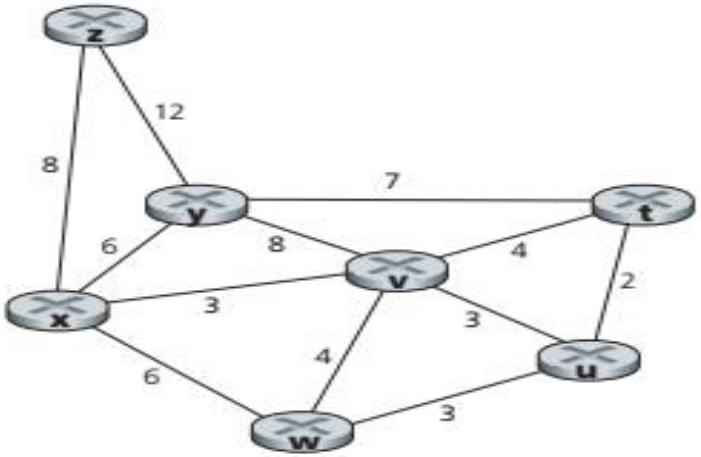
- How is the situation changed on highways? Justify.
- ***Solution:***
- However, if the cars are on a highway, it is simpler: cars typically form clusters per direction. On car of the cluster could be the cluster head, all other cars route via this car. Routing can go along the lanes of the highway.

Question 4

- *What are the benefits of location information for routing in ad-hoc networks, and which problems do arise? Explain your answer.*
- Location information may help routing (geo routing) by optimising the route. If one already knows the location it is simpler to choose the right router towards the destination. However, again privacy problems may arise. Not too many people want to reveal their location to everyone.

Question 5

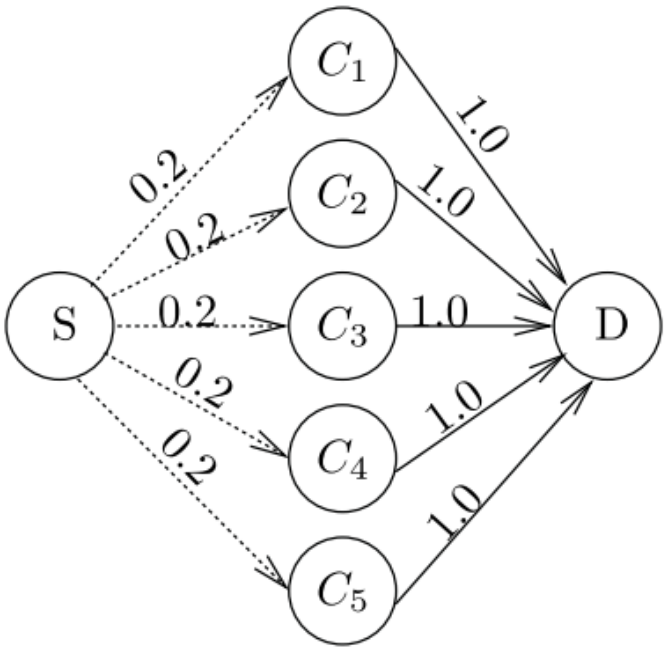
Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by computing a table similar to Routing Table. **[5]**



Solution

Step	*N'*	*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	∞	∞	3,x	6,x	6,x	8,x
1	xv	7,v	6,v	3,x	6,x	6,x	8,x
2	xvu	7,v	6,v	3,x	6,x	6,x	8,x
3	xvuw	7,v	6,v	3,x	6,x	6,x	8,x
4	xvuwy	7,v	6,v	3,x	6,x	6,x	8,x
5	xvuwyt	7,v	6,v	3,x	6,x	6,x	8,x
6	xvuwytz	7,v	6,v	3,x	6,x	6,x	8,x

- Figure 1 presents the meaning of OR and calculate the difference between traditional routing and OR protocols in the EXNT. We consider nodes S and D as the source and the destination, respectively.



Traditional routing protocol

- Therefore, the traditional routing protocol requires five transmissions, on average, to deliver the packet from *s* to one of the intermediate nodes (next-hop).
- Note that one other transmission is needed from the next-hop to the destination (in total 6 transmissions).

Opportunistic Routing

- In comparison with OR, we can select all five intermediate nodes as the CS.
- The combined link has a delivery ratio equal to $(1 - (1 - 20\%)^5) \approx 67\%$.
- As a result, when delivering a packet to any of the five candidates, the ExNT is only $1/0.67 = 1.48$, and,
- like the previous case, one additional transmission is necessary to deliver the packet from the selected candidate to the destination.
- Therefore, on average, it takes only 2.48 transmissions.