Tyler MacPhee

**CNT 4104 Software Project Computer Networks - Assignment 3**

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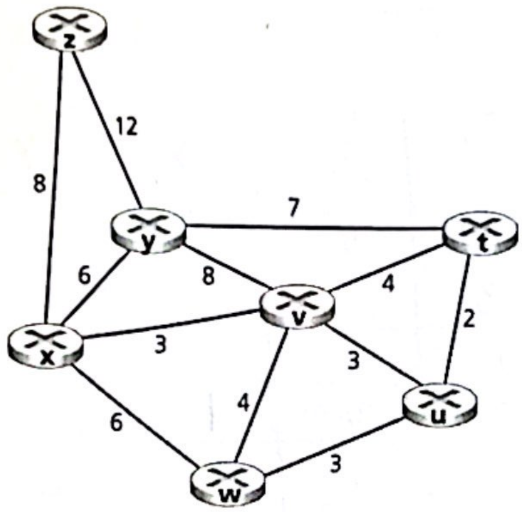
*This assignment encompasses material from in-lecture presentations, online resources, and the textbook. It encompasses topics covered in the initial three weeks. Kindly transcribe the answers and consolidate the content into* ***a single file****, which could be in either Word or PDF format. You can use typing, handwriting, or a writing pad for this purpose. Total: 100 points + 20 extra points*

**Question 1:** 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 the Dijkstra algorithm slides (20 points).




| Step | N | D(t), P(t) | D(u),P(u) | D(v),P(v) | D(w),P(w) | D(y) T(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 | Xvuwyz | 7,v | 6,v | 3,x | 6,x | 6,x | 8,x |
| 6 | Xvuwyz | 7,v | 6,v | 3,x | 6,x | 6,x | 8,x |

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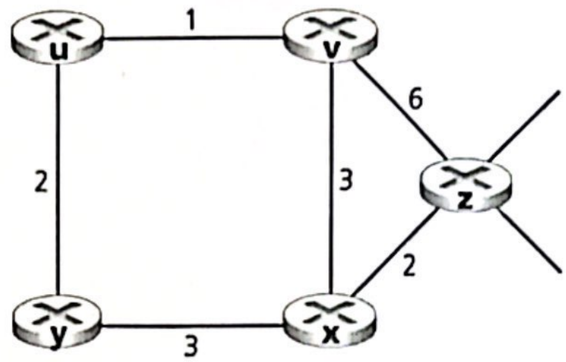
**Question 2**: Consider the network shown below, and assume that each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance table entries at node *z*. (t=0, t=1, t=2, t=3...) (20 points)




| t | destination | u | v | x | y | z |
|---|---|---|---|---|---|---|
| 0 | u | 0 | 3 | 1 | 2 | 0 |
| 0 | v | 3 | 0 | 2 | 2 | ∞ |
| 0 | x | 1 | 2 | 0 | 1 | 1 |
| 0 | y | 2 | 2 | ϕ | 0 | 2 |
| 0 | z | 0 | ∞ | 1 | 2 | 0 |
| 1 | u | 0 | ∞ | 0 | 1 | 0 |
| 1 | v | ∞ | 0 | ∞ | 1 | 0 |
| 1 | x | 0 | ∞ | 0 | 0 | 0 |
| 1 | y | 1 | ∞ | 1 | 0 | 0 |
| 1 | z | 0 | ∞ | 0 | 0 | 0 |
| 2 | u | 0 | ∞ | 0 | 1 | 0 |
| 2 | v | ∞ | 0 | ∞ | 1 | 0 |
| 2 | x | 0 | ∞ | 0 | 0 | 0 |
| 2 | y | 1 | ∞ | 1 | 0 | 0 |
| 2 | z | 0 | ∞ | 0 | 0 | 0 |
| 3 | u | 0 | ∞ | 0 | 1 | 0 |
| 3 | v | ∞ | 0 | ∞ | 1 | 0 |
| 3 | x | 0 | ∞ | 0 | 0 | 0 |
| 3 | y | 1 | ∞ | 1 | 0 | 0 |
| 3 | z | 0 | ∞ | 0 | 0 | 0 |

**Question 3:** If all the links in the Internet were to provide reliable delivery service, would the TCP reliable delivery service be redundant? Why or why not? (15 points)

NO, because this wouldn't address the higher-level problems that TCP does. for Example, data loss, End-to-End & out-of-order transmissions.

TCP is still needed to reorder out of sync Packets/data & IPs can have Equipment/routing failures

**Question 4:** List three differences between 4G and 5G cellular networks. (5 each, 15 points total)

1) Speed: 5G is much faster than 4G. Specifically, 5G can reach up to & beyond gigabit speeds, while 4G can typically reach several hundred megabits

2) Latency! 5G experiences lower latency than 4G, because it can transmit data more quickly over the network

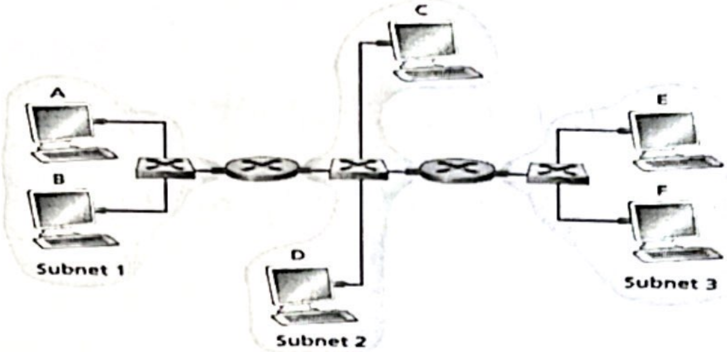
3) Capacity/Availability. 5G can support more devices simultaneously than 4G can, this improves things like IoT / Smart home devices

**Question 5**: Consider three LANs interconnected by two routers, as shown in the following figure:

a) Assign IP addresses to all of the interfaces. For Subnet 1 use addresses of the form 192.168.1.xxx; for Subnet 2 uses addresses of the form 192.168.2.xxx; and for Subnet 3 use addresses of the form 192.168.3.xxx. (10 points)

b) Assign MAC addresses to all of the adapters. (you can choose any MAC address you like) (5 points)

c) Consider sending an IP datagram from Host E to Host B. Suppose all of the ARP tables are up to date. Enumerate all the steps, as done in the slides. (15 points)




a) Router1 interface 1 = 192.168.1.1
router1 interface 2 = 192.168.2.1
router 2 interface1 = 192.168.2.2
router 2 interface 2 = 192.168.3.1
router 3 interface 1 = 192.168.3.2
router 3 interface 2 = 192.168.1.2

b) $R_1 I_1$ A1:B1:C1:D1:E1:F1
$R_1 I_2$ A2:B2:C2:D2:E2:F2

$R_2 I_1$ B1:B2:B3:B4:B5:B6
$R_2 I_2$ C1:C2:C3:C4:C5:C6

$R_3 I_1$ D1:D2:D3:D4:D5:D6
$R_3 I_2$ E1:E2:E3:E4:E5:E6

c)
1. host E checks routing table & finds subnet 2
2. Host E gets Mac from ARP table
3. Host E encapsulates IP source & IP destination
4. Host E sends ethernet frame to R1
5. R1 gets frame & checks Mac
6. R1 finds Mac & destination IP
7. R1 uses ARP table & updates the source & destination for next hop
8. R1 sends frame to R2
9. R2 gets frame & checks Mac
10. R2 finds Mac & destination IP
11. R2 updates source & destination IP for host B
12. R2 sends frame to Host B
13. Host B recieves frame, and delivers to the next layer

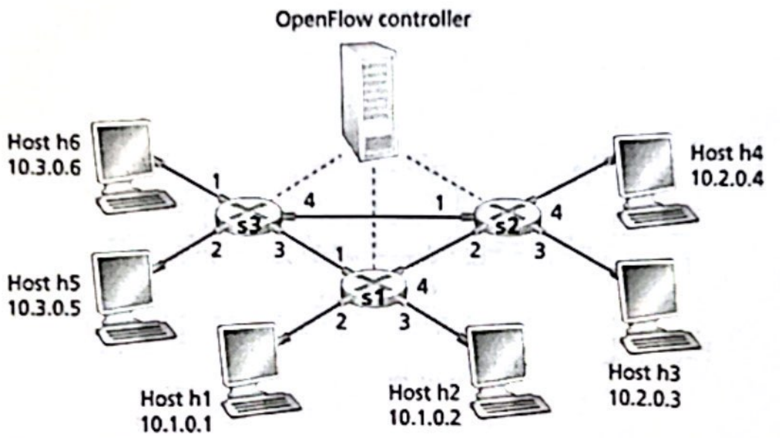
**Question 6 (extra credits)**: Consider the SDN OpenFlow network shown in the following figure. Suppose we want switch s2 to function as a firewall. Specify the ***flow table*** in s2 that implements the following firewall behaviors (specify a different flow table for each of the four firewalling behaviors below) for delivery of datagrams destined to h3 and h4. You do not need to specify the forwarding behavior in s2 that forwards traffic to other routers. (5 points for each flow table, 20 extra credits in total)

a) ***flow table*** on: Only traffic arriving from hosts h1 and h6 should be delivered to hosts h3 or h4 (i.e., that arriving traffic from hosts h2 and h5 is blocked).

b) ***flow table*** on: Only TCP traffic is allowed to be delivered to hosts h3 or h4 (i.e., that UDP traffic is blocked).

c) ***flow table*** on: Only traffic destined to h3 is to be delivered (i.e., all traffic to h4 is blocked).

d) ***flow table*** on: Only UDP traffic from h1 and destined to h3 is to be delivered. All other traffic is blocked.




a)

| Match | Forward |
|---|---|
| 10.1.01 → 10.2.0.3 | 3 |
| 10.1.0.1 → 10.2.0.4 | 4 |
| 10.3.0.6 → 10.2.0.3 | 3 |
| 10.3.0.6 → 10.2.0.4 | 4 |

b)

| Match (TCP) | Forward |
|---|---|
| Any → 10.2.0.3 | 3 |
| Any → 10.2.0.4 | 3 |

c)

| Match | forward |
|---|---|
| Any → 10.2.0.3 | 3 |

d)

| Match (UDP) | forward |
|---|---|
| 10.1.0.1 → 10.2.0.3 | 3 |