# Homework 3

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## Questions

1. What are the two most important network-layer functions in a computer network? What is the difference between them? (15 Points)

   **(a) Forwarding: The router-local action of transferring a packet from an input link interface to the appropriate output link interface. It typically takes place at very short timescales (typically a few nanoseconds), and is often implemented in hardware.**

   **(b) Routing: The network-wide process that determines the end-to-end paths that packets take from source to destination. It typically takes place on much longer timescales (typically seconds), and is often implemented in software.**

   **Aside from differences in scale, timescale, and implementation, the key distinction between the two functions is that routing determines the path a packet should take through the network, while forwarding carries out that path by directing the packet to its next hop at each router.**

2. Find all subnets in the following network. Write the IP address of those subnets in the subnet notation (i.e., a.b.c.d/x notation) (15 Points)

| **Subnet Location** | **IP address of the subnets** |
|---|---|
| Upper LAN (3 hosts) | 223.1.1.0/24 |
| Link b/w top and left router | 223.1.9.0/24 |
| Link b/w top and right router | 223.1.7.0/24 |
| Link b/w left and right router | 223.1.8.0/24 |
| Lower Left LAN (2 hosts) | 223.1.2.0/24 |
| Lower Right LAN (2 hosts) | 223.1.3.0/24 |

Table 1: IP address of the subnets in the network diagram

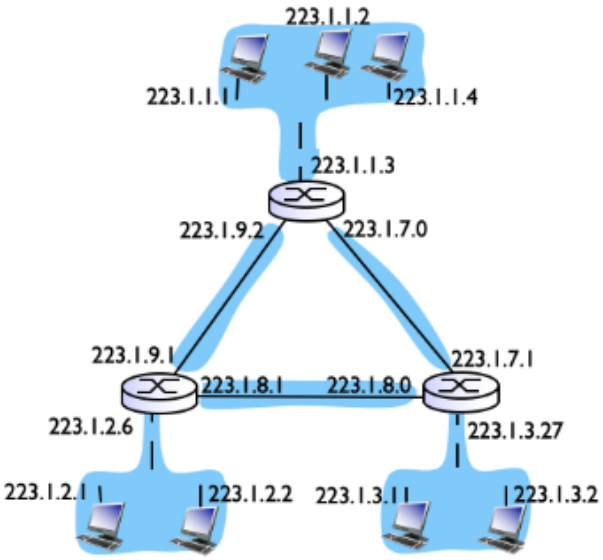


Figure 1: Provided network diagram

3. 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 what we use in the lecture note. Also draw the resulting shortest-path tree from x to all nodes and the resulting forwarding table in x. (40 Points)

| **Step** | **N'** | **D(y), p(y)** | **D(v), p(v)** | **D(w), p(w)** | **D(t), p(t)** | **D(u), p(u)** | **D(z), p(z)** |
|---|---|---|---|---|---|---|---|
| 0 | x | 6,x | 3,x | 6,x | $\infty$ | $\infty$ | 8,x |
| 1 | x,v | 6,x | - | 6,x | 7,v | 6,v | 8,x |
| 2 | x,v,y | - | - | 6,x | 7,v | 6,v | 8,x |
| 3 | x,v,y,w | - | - | - | 7,v | 6,v | 8,x |
| 4 | x,v,y,w,u | - | - | - | 7,v | - | 8,x |
| 5 | x,v,y,w,u,t | - | - | - | - | - | 8,x |
| 6 | x,v,y,w,u,t,z | - | - | - | - | - | - |

Table 2: Dijkstra's Algorithm Table

| Destination | Outgoing link |
|---|---|
| z | (x,z) |
| y | (x,y) |
| w | (x,w) |
| v | (x,v) |
| t | (x,v) |
| u | (x,v) |

Table 3: Forwarding Table

**z, y, w are directly connected to x.**
**v, t, u are connected to x via v.**

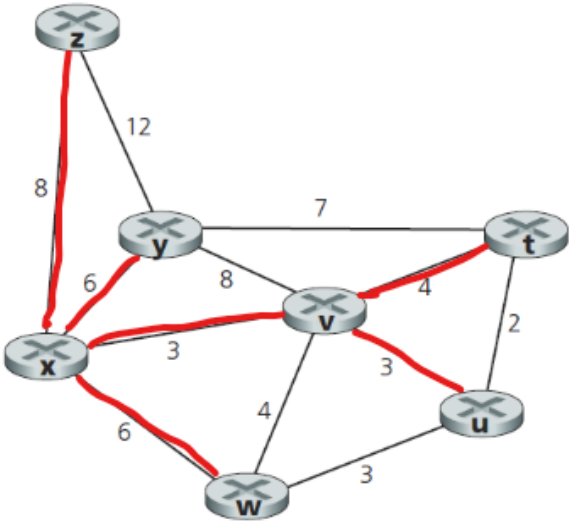


Figure 2: Shortest-path tree from x to all nodes

4. Consider the network of Figure. Distance vector routing is used, and the following vectors have just come in to router C:
from B: (5, 0, 8, 3, 6, 2);
from D: (6, 7, 6, 0, 9, 10);
from E: (7, 6, 3, 2, 0, 4).
The cost of the links from C to B, D, and E, are 6, 3, and 5, respectively. What is C's new routing table? Give both the outgoing line to use and the cost. (30 Points)

**List of IP addresses of the subnets:**

1. **Add the cost from C to B to the distance vector from B:**

$$(5+6, 0+6, 8+6, 3+6, 6+6, 2+6) = (11, 6, 14, 9, 12, 8)$$

2. **Add the cost from C to D to the distance vector from D:**

$$(6+3, 7+3, 6+3, 0+3, 9+3, 10+3) = (9, 10, 9, 3, 12, 13)$$

3. **Add the cost from C to E to the distance vector from E:**

$$(7+5, 6+5, 3+5, 2+5, 0+5, 4+5) = (12, 11, 8, 7, 5, 9)$$

4. **Finding the distance among the paths via B, D, and E:**
   - **To A: min(11, 9, 12) = 9 (via D)**
   - **To B: min(6, 10, 11) = 6 (via B)**
   - **To C = 0**
   - **To D: min(9, 3, 7) = 3 (via D)**
   - **To E: min(12, 12, 5) = 5 (via E)**
   - **To F: min(8, 13, 9) = 8 (via B)**
5. **C's new routing table is: (9, 6, 0, 3, 5, 8)**

| Destination | Outgoing line | Cost |
|---|---|---|
| A | via D | 9 |
| B | via B | 6 |
| C | - (self) | 0 |
| D | via D | 3 |
| E | via E | 5 |
| F | via B | 8 |

Table 4: Consolidated routing table

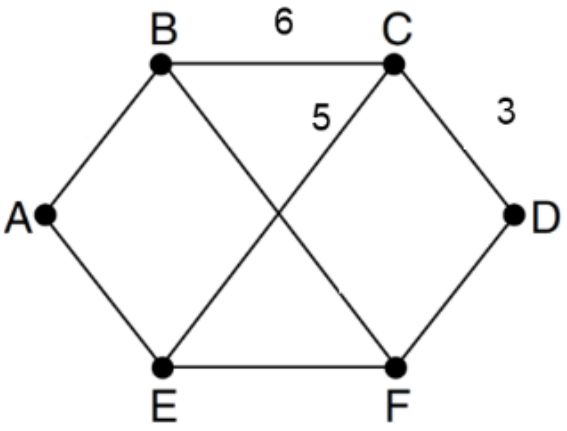


Figure 3: Provided distance vector diagram