**Introduction to Computer Networks**

**Homework 4 - Solutions**

[1] What are the two most important network-layer functions in a datagram network? What are the three most important network-layer functions in a virtual circuit network?

Answer: Datagram-based network layer: forwarding; routing. Additional function of VC-based network layer: call setup.

[2] **(2 points)** Do the routers in both datagram networks and virtual-circuit networks use forwarding tables? If so, what the forwarding tables for both classes of network include?

**Answer: Yes, both use forwarding tables.**

**-The forwarding table in datagram networks includes two fields: destination prefix and interface.**

**-The forwarding table in VC-networks includes four fields: incoming interface, incoming VC number, outgoing interface, and outgoing VC number.**

[3] Routers.

a. Describe how packet loss can occur at input ports.

**Answer: Packet loss occurs if the queue size at the input port grows large because of the slow switching fabric speed and thus exhausts the router’s buffer space.**

b. **(1 point)** Describe how packet loss at input ports can be eliminated (without using infinite buffers)

**Answer: It can be eliminated if the switching fabric speed is at least n times as fast as the input line speed, where n is the number of input ports.**

[4] **(2 points)** Consider a datagram network using 8-bit host addresses. Suppose a routers uses longest prefix matching and has the following forwarding table

|  |  |
| --- | --- |
| **Prefix Match** | **Interface** |
| 1 | 0 |
| 11 | 1 |
| 111 | 2 |
| Otherwise | 3 |

For each of the four interfaces, what are the associated range of destination host addresses and the number of address in the range?

**Answer:**

**Destination Address Range Link Interface**

10000000

through (64 addresses) 0

10111111

11000000

through(32 addresses) 1

11011111

11100000

through (32 addresses) 2

11111111

00000000

through (128 addresses) 3

01111111

[5]. Consider sending a 3,000-byte datagram into a link that has an MTU of 1500 bytes, and then into a link that has an MTU of 500 bytes. Suppose the original datagram is stamped with the identification number 466.

(a) **(1 point)** How many fragments are generated?

**A: 9**

(b) **(4 points)** What is the identification number, size, flag, and offset for each? Fill in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **fragment** | **Identification number** | ***length*** | ***Frag flag*** | ***Offset*** |
| 1 | 466 | 500 | 1 | 0 |
| 2 | 466 | 500 | 1 | 60 |
| 3 | 466 | 500 | 1 | 120 |
| 4 | 466 | 60 | 1 | 180 |
| 5 | 466 | 500 | 1 | 185 |
| 6 | 466 | 500 | 1 | 245 |
| 7 | 466 | 500 | 1 | 305 |
| 8 | 466 | 60 | 1 | 365 |
| 9 | 466 | 40 | 0 | 370 |

**[6]**. Consider the following network. With the indicated link costs, use Dijkstra’s shortest-path algorithm to compute the shortest path from z to all network nodes. Show how the algorithm works step by step by filling in the following table. D(y) is the current value of path cost from z to y; p(t) is the predecessor node along path from z to y; N’ is the set of notes whose least path cost has been determined.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Step** | **N’** | ***D(y),p(y)*** | | ***D(x),p(x)*** | ***D(u),p(u)*** | ***D(v),p(v)*** | ***D(w),p(w)*** |
| **1** | **z** | **3,z** | **5,z** | | **3,z,** | **1,z** | **5,z** |
| **2** | **z, v** | **3,z** | **5,z** | | **2,v** | **1,z** | **3,v** |
| **3** | **z, v, u** | **3,z** | **3,u** | | **2,v** | **1,z** | **3,v** |
| **4** | **z, v, u, y** | **3,z** | **3,u** | | **2,v** | **1,z** | **3,v** |
| **5** | **z, v, u, y, x** | **3,z** | **3,u** | | **2,v** | **1,z** | **3,v** |
| **6** | **z, v, u, y, x, w** | **3,z** | **3,u** | | **2,v** | **1,z** | **3,v** |

