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Chapter 12

**12.1)** Consider a packet-switching network of *N* nodes, connected by the following topologies:

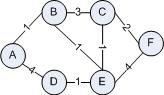
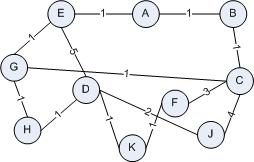
1. Star: one central node with no attached station; all other nodes attach to the central node.
2. Loop: each node connects to two other nodes to form a closed loop.
3. Fully connected: each node is directly connected to all other nodes.

For each case, give the average number of hops between stations.

Ans: The number of hops will be one less than the number of nodes visited for any given network.

1. The fixed number of hops would be 2.
2. In a loop the farthest distance for any given station would be half-way around the loop. On average, a station will send data half this distance. For an N-node network, the average number of hops is (
3. If it is fully connected where each node is connected with every other node than only 1 hop is required.

**12.9)** Apply Dijkstra’s routing algorithm to the network below. Provide a table similar to table 12.2a and a figure similar to Figure 12.9.

1. Node 1 of network a where A = 1, B = 2, C = 3, D = 4, E = 5 and F = 6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **M** | **L (2) Path** | **L (3) Path** | **L (4) Path** | **L (5) Path** | **L (6) Path** |
| 1 {1} | 1 1-2 | ∞ ─ | 4 1-4 | ∞ ─ | ∞ ─ |
| 2 {1,2} | 1 1-2 | 4 1-2-3 | 4 1-4 | 2 1-2-5 | ∞ ─ |
| 3 {1,2,5} | 1 1-2 | 3 1-2-5-3 | 3 1-2-5-4 | 2 1-2-5 | 6 1-2-5-6 |
| 4 {1,2,5,3} | 1 1-2 | 3 1-2-5-3 | 3 1-2-5-4 | 2 1-2-5 | 5 1-2-5-3-6 |
| 5 {1,2,5,3,4} | 1 1-2 | 3 1-2-5-3 | 3 1-2-5-4 | 2 1-2-5 | 5 1-2-5-3-6 |
| 6 {1,2,5,3,4,6} | 1 1-2 | 3 1-2-5-3 | 3 1-2-5-4 | 2 1-2-5 | 5 1-2-5-3-6 |

1. Node 1 of network b where A = 1, B = 2, C = 3, D = 4, E = 5, F = 6, G = 7, H = 8, I = 9, J = 10, and K = 11. Essentially the table for network b is similar in construction by much larger. The results for node A are listed below

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A to B | A to C | A to D | A to E | A to F | A to G | A to H | A to J | A to K |
| A-B | A-B-C | A-E-G-H-D | A-E | A-B-C-F | A-E-G | A-E-G-H | A-B-C-J | A-E-G-H-D-K |

**12.10)** Repeat Problem 12.9 using Bellman-Ford algorithm.

1. Node 1 of network a where A = 1, B = 2, C = 3, D = 4, E = 5 and F = 6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **h** | Lh(2) Path | Lh(3) Path | Lh(4) Path | Lh(5) Path | Lh(6) Path |
| 0 | ∞ ─ | ∞ ─ | ∞ ─ | ∞ ─ | ∞ ─ |
| 1 | 1 1-2 | ∞ ─ | 4 1-4 | ∞ ─ | ∞ ─ |
| 2 | 1 1-2 | 4 1-2-3 | 4 1-4 | 2 1-2-5 | ∞ ─ |
| 3 | 1 1-2 | 3 1-2-5-3 | 3 1-2-5-4 | 2 1-2-5 | 6 1-2-3-6 |
| 4 | 1 1-2 | 3 1-2-5-3 | 3 1-2-5-4 | 2 1-2-5 | 5 1-2-5-3-6 |

1. Node 1 of network b where A = 1, B = 2, C = 3, D = 4, E = 5, F = 6, G = 7, H = 8, I = 9, J = 10, and K = 11.

**12.11)** Will Dijkstra’s algorithm and the Bellman-Ford algorithm always yield the same solution? Why or Why not?

Ans: If at any point there is a unique least-cost path, the two algorithms will yield the same result because they are both guaranteed to find the least-cost path. If there are two or more equal least-cost paths, the two algorithms may result in different least-cost paths, depending on the order in which they are explored.

**12.14)** It was shown that flooding can be used to determine the minimum-hop route. Can it be used to determine the minimum delay route?

Ans: No, this delay was experienced under a condition of network flooding, and cannot be considered valid for other network conditions, even though it is true that the first packet to reach node 6 has experienced the minimum delay.

**12.15)** With random routing, only one copy of the packet is in existence at a time. Nevertheless, it would be wise to utilize a hop count field. Why?

Ans: Because there can be a scenario where a destination node may be unreachable.

**12.16)** Another adaptive routing scheme is known as backward learning. As a packet is routed through the network, it carries not only the destination address, but the source address plus a running hop count that is incremented from each hop. Each node builds a routing table that gives the next node and hop count for each destination. How is the packet information used to build that table? What are the advantages and disadvantages of this technique?

Ans: If a node sees a packet arriving on a particular line say link *p* from node *Q* with hop count of 6, we can determine that it knows that *Q* is at most six hops away via line *p*. So if the current best route to *Q* is estimated at more than six hops, it marks line *p* as the choice for traffic to *Q* and records the estimated distance as six hops.

The advantage of this algorithm is that, since it is an isolated technique, minimal node-to-node cooperation is needed. The disadvantage occurs if a line goes down or is overloaded. The algorithm improvements, does not change from the worse.

**12.18)** Consider a system using flooding with a hop counter. Suppose that the hop counter is originally set to the “diameter” of the network. When the hop count reaches zero. The packet is discarded except at its destination. Does this always ensure that a packet will reach its destination id there exist at least one operable path? Why or why not?

Ans: Yes. With flooding, all possible paths are used. So at least one path that is the minimum-hop path to the destination will be used.

**Chapter 18**

**18.2)** In the discussion of IP, it was mentioned that the *identifier, don’t fragment identifier* and *time to live* parameters are present in the Send primitive but not in the Deliver primitive because they are only of concern to IP. For each of these parameters indicate whether it is of concern to the IP entity in the source, the IP entities in any intermediate routers, and the IP entity in the destination end systems. Justify you answer.

Ans: While the intermediate systems clearly need to examine the TTL parameter and will need to examine the ID and don't-fragment parameters if fragmentation is desired. The destination IP entity needs to examine the ID parameter if reassembly is to be done and, also the TTL parameter if that is used to place a time limit on reassembly. The destination IP entity should not need to look at the don't-fragment parameter. As it is known that the IP entity in the source may need the ID and don't-fragment parameters. If the IP source entity needs to fragment, these two parameters are essential. Ideally, the IP source entity should not need to bother looking at the TTL parameter, since it should have been set to some positive value by the source IP user. It can be examined as a reality check.

**18.3)** What is the header overhead in the IP protocol?

Ans: The header overhead in the IP protocil is a minimum of 20 octets.

**18.4)** Describe some circumstances where it might be desirable to use source routing rather than let the routers make the routing decision.

Ans:

Possible reasons for strict source routing:

1. To test some characteristics of a particular path, such as transit delay or whether or not the path even exists;
2. The source wishes to avoid certain unprotected networks for security reasons;
3. The source does not trust that the routers are routing properly.

Possible reasons for loose source routing:

1. Allows the source to control some aspects of the route, similar to choosing a long-distance carrier in the telephone network;
2. It may be that not all of the routers recognize all addresses and that for a particular remote destination, the datagram needs to be routed through a "smart" router.

**18.6)** A 4480-octet datagram is to be transmitted and need to be fragmented because it will pass through an Ethernet with a maximum payload of 1500 octets. Show the Total Length, More Flag and Fragment Offset value in each of the resulting fragments.

Ans: The original datagram includes a 20-octet header and a data field of 4460 octets. It is known that the Ethernet frame can take a payload of 1500 octets, so each frame can carry an IP datagram with a 20-octet header and 1480 data octets. We can deduce that 1480 is divisible by 8, so we can use the maximum size frame for each fragment except the last. To fit 4460 data octets into frames that carry 1480 data octets we need:

3 datagrams × 1480 octets = 4440 octets, plus

1 datagram that carries 20 data octets (plus 20 IP header octets)

The relevant fields in each IP fragment listed below:

Total Length = 1500

More Flag = 1

Offset = 0

Total Length = 1500

More Flag = 1

Offset = 185

Total Length = 1500

More Flag = 1

Offset = 370

Total Length = 40

More Flag = 0

Offset = 555

**18.10)** A transport layer message consisting of 1500 bits of data and 160 bits of header is sent to an internet layer, which appends another 160 bits of header. This is then transmitted through two networks, each of which uses a 24-bit packet header. The destination network has a maximum packet size of 800 bits. How many bits, including header, are delivered to the network-layer protocol at the destination?

Ans: Data plus transport header plus internet header equals (1500 + 160 +160) 1820 bits. We know that this data is delivered in a sequence of packets, each with 24 bits of network header and up to 776 (800 bits – 24-bit) bits of higher-layer headers and/or data. Three network packets are needed. Total bits delivered = 1820 + 3 × 24 = 1892 bits.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Header (160 + 160 + 24 + 24) | 368 | 368 | 368 | 368 |
| Segment (1500) | 432 | 432 | 432 | 204 |
| Packet Size Received (800) | 800 | 800 | 800 | 572 |

Therefore, total delivered: 800 + 800 + 800 + 572 = 2972bits

**18.13)** Provide the following parameter values for each of the network classes A, B, and C. Be sure to consider any special or reserved addresses in your calculations

1. Number of bits in network portion of address
2. Number of bits in host portion of address
3. Number of distinct network allowed
4. Number of distinct hosts per network allowed
5. Integer range of first octet

Ans:

**Class A:**

1. 8 bits
2. 24 bits
3. First bit of the first octet in a class A address is 0 (leaving 7 bits), so 27 = 128 – 2 (0 and 127 are disallowed) = 126 networks
4. 224 = 16,777,216 – 2 (host address cannot be all 0’s or all 1’s) = 16,777,214 hosts
5. range: 1 through 126

**Class B:** (a)

1. 16 bits
2. 16 bits
3. first two bits of the first octet in a class B address are 10 (leaving 14 bits), so 214 = 16,384 networks
4. 216 = 65,536 – 2 (host address cannot be all 0’s or all 1’s) = 65,534 hosts
5. range: 128 through 191

**Class C:**

1. 24 bits
2. 8 bits
3. first three bits in the first octet in a class C address are 110 (leaving 21 bits), so 221 = 2,097,152 networks
4. 28 = 256 – 2 (host address cannot be all 0’s or all 1’s) = 254 hosts
5. range: 192 through 223

**18.14)** What percentage of the total IP address space does each of the network classes represent?

Ans: Class A controls 50 percentage of total IP address space with a maximum of 232 (4,294,967,296) addresses. Class B controls 25 percentage with a maximum of 230 (1,107,741,824) and Class C 12.5 percent with a maximum of 229 (536,870,912).

**18.15)** What is the difference between the subnet mask for a Class A address with 16 bits for the subnet ID and a Class B address with 8 buts for the subnet ID?

Ans: There is no difference: both have a subnet mask of 255.255.255.0, as does a class C address that is not subnetted.

18.16) Is the subnet mask 255.255.0.255 valid for a Class A address?

Ans: It's valid and it's called a noncontiguous subnet mask since the 16 bits for the subnet mask are not contiguous.

**18.17)** Given a network address of 192.168.100.0and a subnet mask of 255.255.255.192,

1. How many subnets are created?
2. How many hosts are there per subnet?

Ans:

1. If 192 = 11000001, 110 = 6 subnets
2. 31 hosts per subnet: xxx11111

**18.18)** Given a company with six individual departments and each department having ten computers or networked devices, what mask could be applied to the company network to provide the subnetting necessary to divide up the network equally?

Ans: 110-0-1010 (1010 = 10)

192.168.100.202

**18.19)** In contemporary routing and addressing, the notation commonly used is called classless interdomain routing or CIDR. With CIDR, the number of bits in the mask is indicated in the following fashion: 192.168.100.0/24. This corresponds to a mask of 255.255.255.0. If this example would provide for 256 host addresses on the network, how many addresses are provided with the following?

1. 192.168.100.0/23
2. 192.168.100.0/25

Ans:

1. Netmask: 255.255.254.0, shorthand: /23 [9-bit], number of addresses: 29 = 512
2. Netmask: 255.255.255.128, shorthand: /25 [7-bit], number of addresses: 27 = 128 = 126 hosts + 1 bcast + 1 net base