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**CS 528 – 01**
**Homework 3**

**1. Why does the Offset field in the IP header measure the offset in 8-byte units? (Hint: Recall that the Offset field is 13 bits long.)**

The Offset field is 13 bits long and maximum IP packet size is 2^16 bytes length. So, offset field can be measured in 2 ^ (16 – 13) => 8 byte units.

**2. Suppose a TCP message that contains 1024 bytes of data and 20 bytes of TCP header is passed to IP for delivery across two networks interconnected by a router (i.e., it travels from the source host to a router to the destination host). The first network has an MTU of 1020 bytes; the second has an MTU of 572 bytes. Each network's MTU gives the size of the largest IP datagram that can be carried in a link-layer frame. Give the sizes and offsets of the sequence of fragments delivered to the network layer at the destination host. Assume all IP headers are 20 bytes.**

In the first router, the IP payload is 1024 + 20 = 1044 bytes. Maximum size of data allowed in first router is 1020 – 20 = 1000 bytes. The TCP payload can be fragmented as 1000, 48 bytes.

1st fragment: 20 bytes header – 1000 bytes of payload – offset 0
2nd fragment: 20 bytes header – 44 bytes of payload – offset 1000/8 = 125

In the second router, the maximum size of data allowed is 572 – 20 = 552 bytes. The second fragment from first router will not fragmented and will be delivered as such. The first fragment will be fragmented as 552, 448.

3rd fragment: 20 bytes header – 552 bytes of payload – offset 0
4th fragment: 20 bytes header – 448 bytes of payload – offset 552/8 = 6

So at the destination host, the 2nd, 3rd and 4th fragment will reach.

3. **(a) Consider a subnet with prefix 128.226.40.128/26. Give an example of one IP address (of form a.b.c.d) that can be assigned in this network.**

Address: 128.226.40.128 10000000.11100010.00101000.10 000000
Netmask: 255.255.255.192 = 26 11111111.11111111.11111111.11 000000
Required IP address = 128.226.40.129 10000000.11100010.00101000.10 000001

**(b) Suppose an ISP owns the block of addresses of the form 128.226.40.64/26. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?**

Address: 128.226.40.64 10000000.11100010.00101000.01 000000
Netmask: 255.255.255.192 = 26 11111111.11111111.11111111.11 000000

To create 4 subnets, we can add extra two bits to the netmask as

11111111.11111111.11111111.1111 0000 = 28

The prefix of four subnets are
1) 128.226.40.64/28
2) 128.226.40.80/28
3) 128.226.40.96/28
4) 128.226.40.112/28

(c) How many hosts are allowed in each subnet created in (b)? (You do not need to consider hosts that are behind NATs.)

Number of hosts allowed in each subnet is 2 ^4 – 2 = 14

4.

**(a) Why is an ARP query sent within a broadcast frame?**

The ARP query is sent within a broadcast frame because the querying host does not know the destination adapter corresponding to the destination IP address.

**(b) Why is an ARP response sent within a frame with a specific destination MAC address?**

The responding node knows the source adapter address to which the response to be sent, so there is no need to send a broadcast frame.

**5) For the network below, show how Dijkstra's algorithm builds the routing table for router 3**

| From 3 | 0 | 1 | 2 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 3 | 1.3,3 | 0.9,3 | ∞ | 9.1,3 | ∞ | 1.6,3 | ∞ |
| 3,1 | 1.3,3 | | ∞ | 9.1,3 | ∞ | 1.6,3 | 10.6,1 |
| 3,1,0 | | | 1.9,0 | 9.1,3 | ∞ | 1.6,3 | 2.3,0 |
| 3,1,0,6 | | | 1.9,0 | 4.3,6 | ∞ | | 2.3,0 |
| 3,1,0,6,2 | | | | 4.3,6 | 4.4,2 | | 2.3,0 |
| 3,1,0,6,2,7 | | | | 4.3,6 | 4.4,2 | | |
| 3,1,0,6,2,7,4 | | | | | 4.4,2 | | |

Routing Table for 3

| Destination | Link | Next Hop |
|---|---|---|
| 0 | (3,0) | 0 |
| 1 | (3,1) | 1 |
| 2 | (3,0,2) | 0 |
| 4 | (3,6,4) | 6 |

| | | |
|---|---|---|
| 5 | (3,0,2,5) | 0 |
| 6 | (3,6) | 6 |
| 7 | (3,0,7) | 0 |

**6) The distance vector of a router X is given below ((A,3,7), (B,2,4), (C,1,1), (D,2,2), (E,0,1), (W,3,8), (X,-1,0), (Y,3,1), (Z,2,5)) where an entry (Y,p,c) indicates X reaches Y through port p in c hops. X receives via port 2 a vector ((A,3,4),(B,2,3),(C,4,4),(D,1,10),(E,0,1),(F,3,3), (Y,3,1),(Z,-1,0)) Answer the following questions.**

**(a) Give the vector of X after processing the incoming vector in the alphabetic order of routers.**

((A,2,5)
(B,2,4)
(C,1,1)
(D,2,2)
(E,0,1)
(F,2,4)
(W,3,8)
(X,-1,0)
(Y,3,1)
(Z,2,1))

**(b) Apparently, the input vector is advertised by Z. The communication link between X and Z is: X2 → Z1. That is, the link connecting X and Z is called port 2 at X and port 1 at Z. Point out a routing loop between X and Z**

Routing loop can happen between X and Z while the link between Z and A is broken and Z does not inform the link failure to X. If X sends data to A through node Z, Z sends back to X, knowing the failure between Z and A. The loop continues.