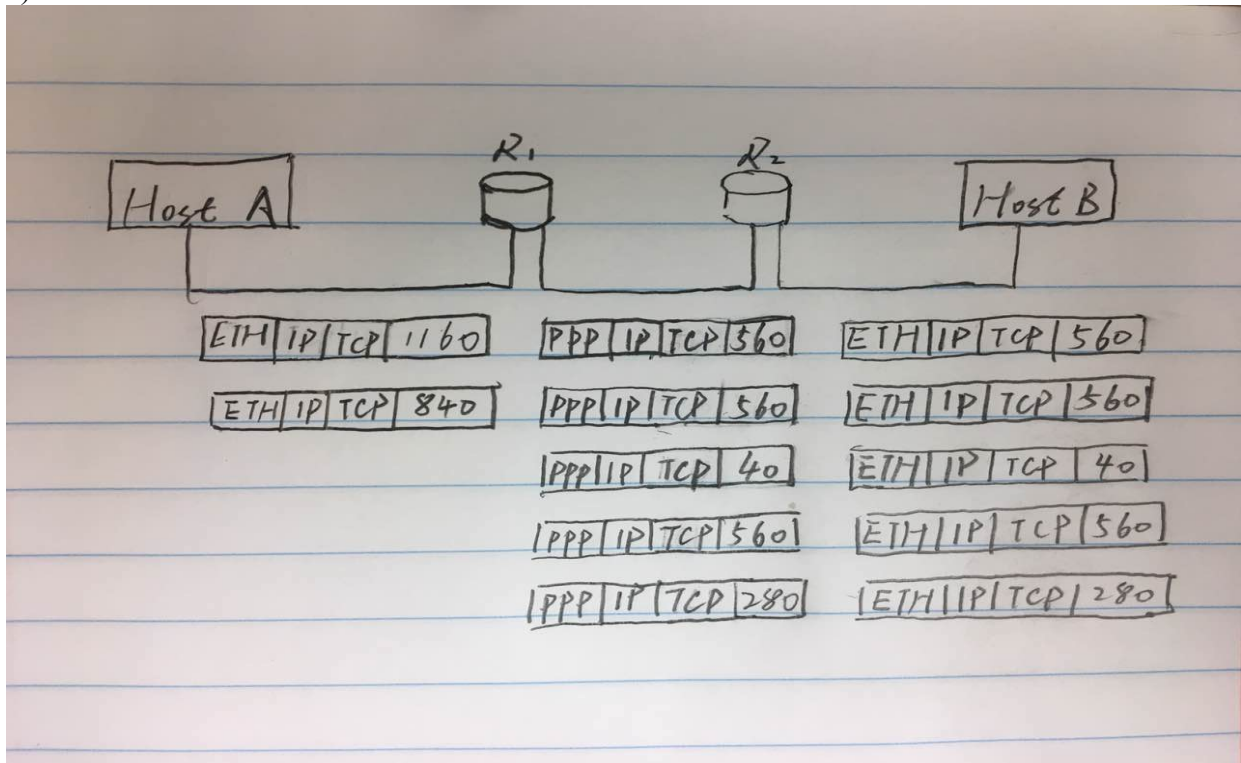


## 1. IP Fragmentation

a)



Since IP is in network layer and TCP is in transport, there are  $(560+40) + (560+40) + (40+40) + (560+40) + (280+40) = 2200 \text{ bytes} = 2200 \times 8 = \underline{17600 \text{ bits}}$  delivered to network layer protocol at host B.

b)  $A \rightarrow R1: p^2$

$R1 \rightarrow R2: p^5$

$R2 \rightarrow B: p^5$

Thus,  $A \rightarrow B: p^2 * p^5 * p^5 = \underline{p^{12}}$

c)  $(2000+40) / (9/10)^{12} = \underline{7223 \text{ bytes}}$

d) It will be discarded.

## 2. IP Fragmentation

a)  $1 - \text{success} = 1 - (1 - 1.5\%)^{15} = 0.2 = \underline{20\%}$

b) Since all fragments received must have been part of the same transmission, these two transmissions are independent. We just to calculate the probability they both fail.

$$0.2 * 0.2 = 0.04 = \underline{4\%}$$

c)  $1 - \text{success} = 1 - (1 - (1.5\%)(1.5\%))^{15} = 0.0034 = \underline{0.34\%}$

d) Since all fragments from the same packet have same ID, we can treat two transmissions which send same information as one transmission. Which means we can use Ident field to change the situation from question (b) to (c). It will reduce the probability of loss. Which we already proved above.

### 3. Forwarding and Classless Inter-domain Routing (CIDR)

a)  $120 < 128 = 2^7$  thus,  $32 - 7 = 25$

$61 < 62 = 2^6$  thus,  $32 - 6 = 26$

A: 233.1.15.0/25

B: 233.1.15.128/26

C: 233.1.15.192/26

b)

128.174.240.0/20:  $2^{(32-20)} = 2^{12} = \underline{4096}$

128.174.240.128/25:  $2^{(32-25)} = 2^7 = \underline{128}$

128.174.240.17: (masklen=32)  $2^{(32-32)} = 2^0 = \underline{1}$

128.174.252.0/22:  $2^{(32-22)} = 2^{10} = \underline{1024}$

c)

R1: 1111

R2: 111110

R3: 111111

Interface 1: 11110000 1

Interface 2: 11110000 00010001

Interface 3: 11110000 00010

i: Interface 2; All match

ii: R1;  $245 \rightarrow 11110101$

iii: R2;  $250 \rightarrow 11111010$

iv: R3;  $254 \rightarrow 11111110$

v: R4;  $225 \rightarrow 11100001$

vi: Interface 3;  $240.18 \rightarrow 11110000 00010010$

## 4. Networking Utilities

### ifconfig:

```
[[haow4@linux-a2 ~]$ ifconfig
em2: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
    ether d4:ae:52:aa:db:e7 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
    device interrupt 58

em3: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
    ether d4:ae:52:aa:db:e8 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
    device interrupt 59

em4: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
    ether d4:ae:52:aa:db:e9 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
    device interrupt 60

eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 128.174.11.96 netmask 255.255.255.192 broadcast 128.174.11.127
    inet6 fe80::d6ae:52ff:feaa:db:e6 prefixlen 64 scopeid 0x20<link>
    ether d4:ae:52:aa:db:e6 txqueuelen 1000 (Ethernet)
    RX packets 1026459175 bytes 665971426252 (620.2 GiB)
    RX errors 0 dropped 18 overruns 0 frame 0
    TX packets 1401193477 bytes 1489561035534 (1.3 TiB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
    device interrupt 56

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1 (Local Loopback)
    RX packets 401562638 bytes 1186725191462 (1.0 TiB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 401562638 bytes 1186725191462 (1.0 TiB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

I use ifconfig command to show all information. According to above picture, it is 128.174.11.127

### arp:

After I use ping -b 128.174.11.127, I get

```
[[haow4@linux-a2 ~]$ arp
Address                  HWtype  HWaddress           Flags Mask            Iface
cse-blade-ilom1.engr.il ether    00:14:4f:e6:51:63   C                    eth0
linux-a3.ews.illinois.e ether    d4:ae:52:aa:b8:71   C                    eth0
0017-engwrkstn1-net.gw. ether    a8:d0:e5:bf:6b:81   C                    eth0
ccgl-serv-01-mgmt.bioen ether    f8:bc:12:32:ee:f4   C                    eth0
linux-a1.ews.illinois.e ether    d4:ae:52:aa:aa:c0   C                    eth0
cs-vmhome-309.ews.illin ether    b0:83:fe:d5:ad:44   C                    eth0
cs-vmhost-310.ews.illin ether    b0:83:fe:d5:c1:48   C                    eth0
```