Computer Networks

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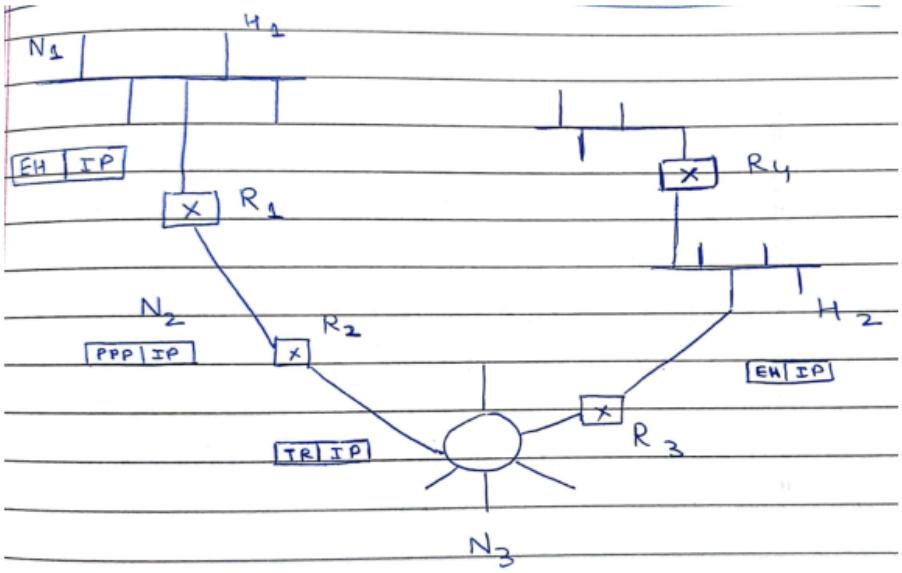
Hetergenous Network Connection



Maximum Transmission Unit(MTU) - Maximum data/payload a frame can contain.

We will arbitrarily assign MTUs for the four networks in the above diagram and send a message from H_1 to H_2 to understand how internet works.

Network	MTU
N_1	1500
N_2	400
N_3	300
N_4	1500

Let's say that H_1 has a 1000 byte message that it wants to send to H_2. We will assume that H_1 knows the IP address of H_2. H_1 will make an IP packet, whose rough structure is described below.

Note that:

1. **id** is the identifier of the packet. If the given packet is split into multiple packets due to different MTUs of different networks, **id** is what will help us identify which packet the data is part of.

Partial Header		
id=212	flags	offset
RH		
Payload (1000 bytes)		

Table 1: IP Packet

2. The **'falgs'** section is of 3 bits. We use one of the 3 bits to signify if there are more fragments to follow. If the bit is set to 0, it signifies that there are no more fragments to follow. If the bit is set to 1, it signifies that that there are more fragments to follow. By fragments, we refer to the multiple IP packets that were created due to the fact that MTU of network is lesser than the data an IP packet can hold.

3. **Offset** - If our data is split into multiple packets, we need to know the starting position of data in any given frame from the start of the original sequence of data. We need to know this to reassemble the frame in correct order. Let's say that our frame had 1000 bytes of data. And that got split into four frames of 250 bytes each. We need to know which frame contains data 0-250 bytes, which frame contains data 251-500 bytes and so on. This is what offset is meant for. In the above IP packet, offset is 0 as there is only one packet to be sent.

   Let's say that a given frame begins with the 480th byte of the given message. Hence, the value of the offset field would be $480/8 = 60$. Why the division by 8? Because the designers of IP decided that fragmentation should always happen on 8-byte boundaries, which means that the Offset field counts 8-byte chunks.

Now, H_1 will put the above IP packet into an ethernet frame as H_1 is part of an ethernet network. This ethernet frame will be sent to the R_1 router. R_1 will extract the IP pakcet from the frame received and create new packets as MTU for network $N_2 = 400$ bytes.

The following three IP packets will be created by R_1:

Partial Header		
id=212	flag=1	offset = 0
RH		
Payload (376 bytes)		

Partial Header		
id = 212	flag=1	offset = 47
RH		
Payload (376 bytes)		

Partial Header		
id = 212	flag=0	offset = 94
RH		
Payload (248 bytes)		

1. The above three IP packets formed by R_1 contain data that belonged to a single IP packet in N_1. Hence all the three IP packets will share the same id as that of the packet in N_1.

2. Flags for the first two packets are set to 1 as there are more fragments to follow and the flag of the last packet is set to 0 as there are no more fragments after it.

3. Since MTU for the the network = 400 bytes and the minimum header information = 20 bytes, the maximum payload that the IP packets can have is 380 bytes. But as already noted above, the offset field counts 8-byte chunks. This causes the payload to be a multiple of 8. Hence, the effective maximum payload = 376 bytes.

Hence, the 1000 byte message is split into three packets containing 376, 376 and 248 bytes respectively.

4. The first packet contains bytes 0 to 375 and hence the offset is set to 0. The second packet contains bytes 376 to 751 and hence the offset is set to $376/8 = 47$. Finally, the thrird packet contains bytes 752 to 999 and hence the offset is set to $752/8 = 94$.

R_1 will take these three IP packets and make three link layer frames and these three frames will be sent to R_2. R_2 will **not** reassemble the three IP packets after extracting them. Rather, it will split the IP packets according to N_3's MTU.

Hence the following IP packets will be made by R_2:

Partial Header		
id=212	flag=1	offset = 0
RH		
Payload (280 bytes)		

Partial Header		
id = 212	flag=1	offset = 35
RH		
Payload (96 bytes)		

Partial Header		
id = 212	flag=1	offset = 47
RH		
Payload (280 bytes)		

Partial Header		
id=212	flag=1	offset = 82
RH		
Payload (96 bytes)		

Partial Header		
id = 212	flag=0	offset = 94
RH		
Payload (248 bytes)		

1. The id of all the packets remains 212.
2. All packets expect the last one has flag = 1. The last packet has flag set to 0, to signify the end of the message.
3. MTU for the network = 300 bytes.

   Header data = 20 bytes

   Hence, maximum payload = 300 - 20 = 280 bytes.

   The first two frames that R_2 receives will contain IP packets will payload = 376 bytes. Each of these packets will be split into two packets, one containing 280 bytes (MTU) and the other containing 96 bytes.

   The final packet that R_2 receives has 248 bytes of payload, which is lesser than the MTU of N_3 and hence that frame will remain unchanged except the offset.

   The offset for the packets will be calculated in the same way as described above.

IP Address Structure

a. The structure of the IP address is as follows:

   In decimal: $a : b : c : d$

In binary: $(a)_2 : (b)_2 : (c)_2 : (d)_2$, where $(a)_2 = (b)_2 = (c)_2 = (d)_2 =$ 8 bits

b. Example of an IP address is 129:62:34:105

c. IP addresses are unique globally.

d. If a node changes its network, its IP address might change too as the IP address contains information about the network it is connected to.

e. Networks within an internetwork are controlled by a single admin. Every node in the entire internetwork will have the same starting address signifying that they are in the same internetwork. For ex - 192.135.c.d can be the representation of all addresses within an internetwork.

f. Having the same starting addresses of every node in the internetwork helps to identify which node is in the network. This is helpful because if we want to send a packet to a node in the same network, the sender node will know that the receiver node is nearby and hence search for a short path.