Lab 6 : Routing, Throughput and IP Fragmentation

Exercise 1: Understanding the Impact of Network Dynamics on Routing

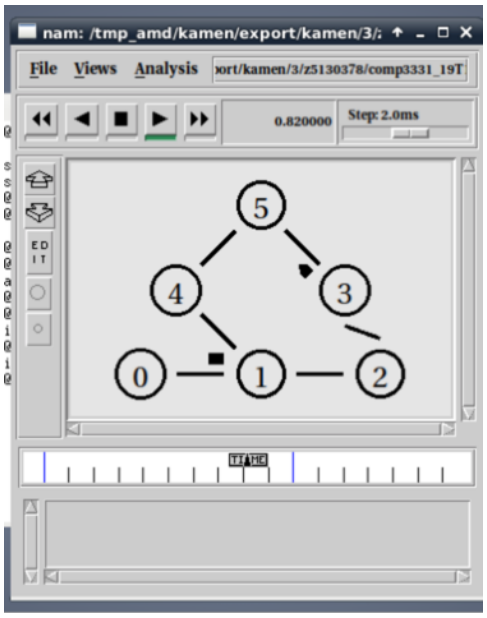
Question 1 : Which nodes communicate with which other nodes? Which route do the packets follow? Does it change over time?

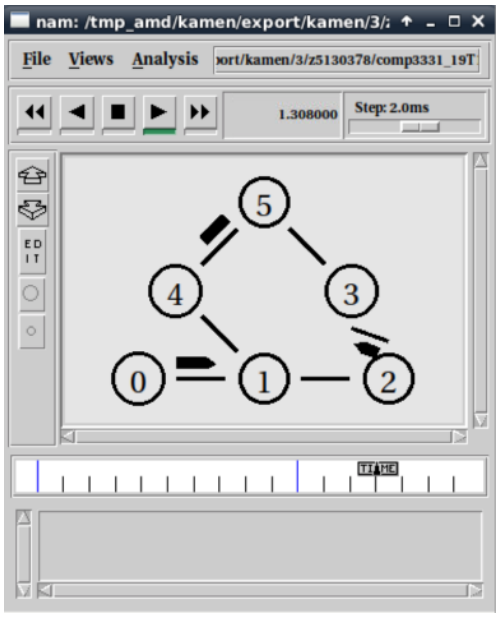
Solution 1 :

As observed in the below attachment, the nodes communicating are 0,1,4,5 and the route is are 0 -> 1 -> 4 -> 5

The network is sending packets via UDP via the route 0 -> 1 -> 4 -> 5

There is one more path following 2->3->5



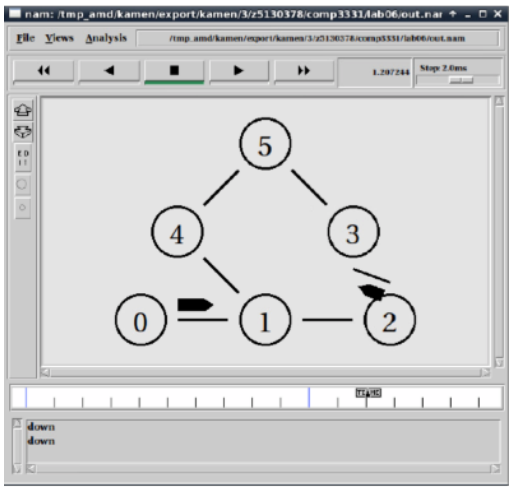


Also, after observing the output for the time period we can deduce that he route does not change after time.

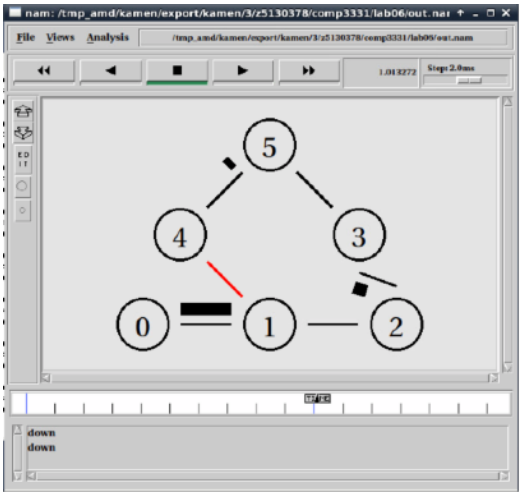
Question 2 : What happens at time 1.0 and at time 1.2? Does the route between the communicating nodes change as a result of that?

Solution 2 :

By running the script provided, the following output was produced :



At time = 1.2s



At time = 1.1

Yes, at time 0.1 the route changes and it becomes 0 -> 1 and the route 0 -> 4 is dropped.

Whereas, at time 1.2 the route gets back to normal I.e. 0 -> 1 -> 4.

Question 3 : Did you observe any additional traffic as compared to Step 3 above? How does the network react to the changes that take place at time 1.0 and time 1.2 now?

Solution 3 :

After modifying the script and running the simulation again, we do observe additional traffic.

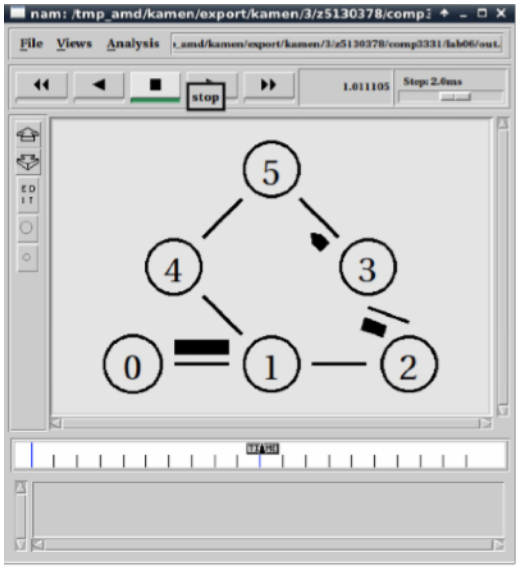
At t = 1.0 the route is the same but there is a little bit additional traffic. Similarly, at t = 1.2 the route is same but the re is lot more additional traffic along the route. Also, when route 1 -> 4 is down then the network uses the other route.

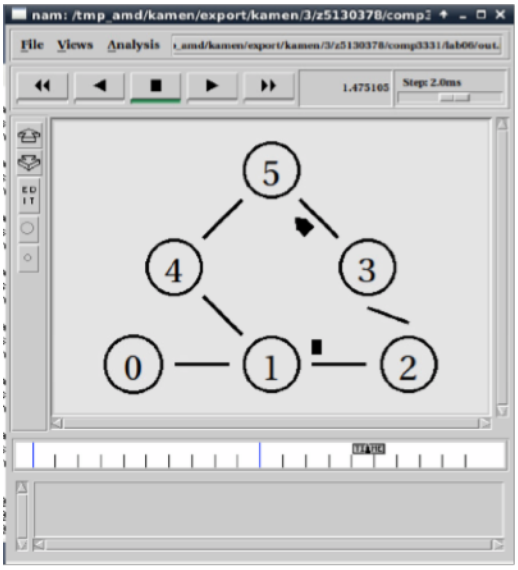
Question 4 : How does this change affect the routing? Explain why.

Solution 4 :

After modifying the script as stated, the route changes and becomes,0 -> 1 -> 2 -> 3 -> 5.

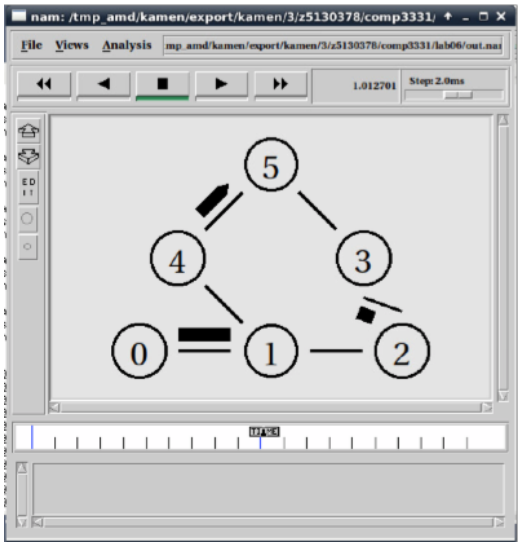
The cost of the route is changed to 3 which is lower than the cost if the route 0 -> 1 -> 4 -> 5.

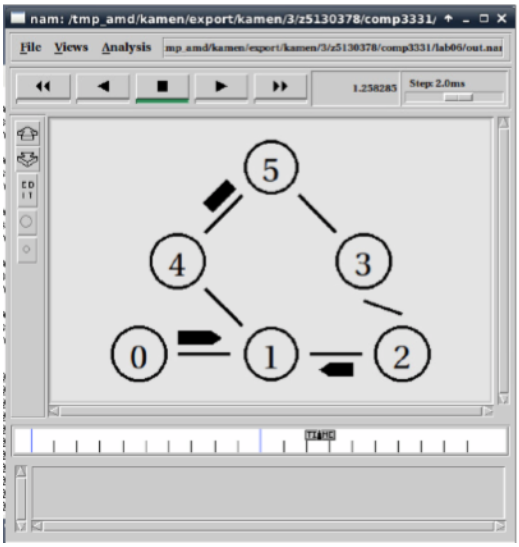




Question 5: Describe what happens and deduce the effect of the line you just uncommented.

Solution 5 :

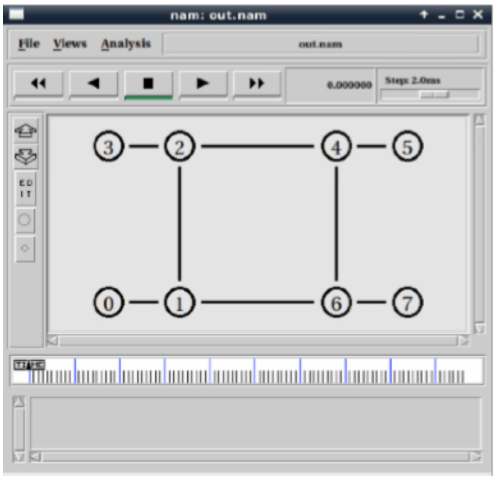


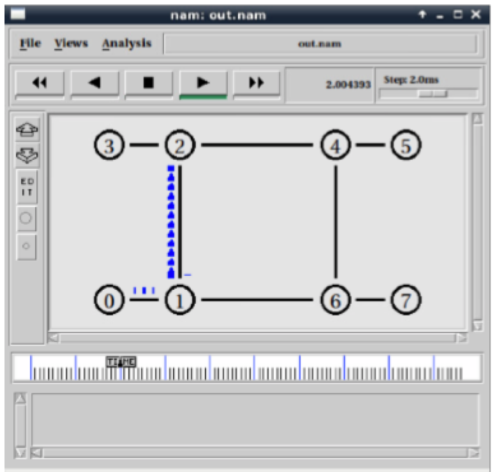


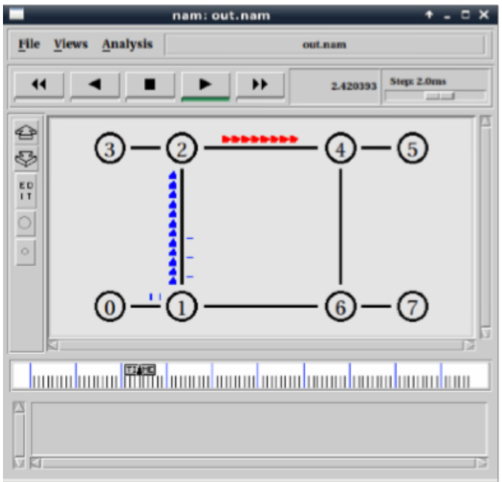
Both routes now have equal cost to the destination. Since, we are using multi path, node 1 will split traffic equally on the shortest paths.Uncommenting " `Node set multiPath_ 1` ", means that path 2 rather than following a single one of these equidistant paths now passes packets through both paths.

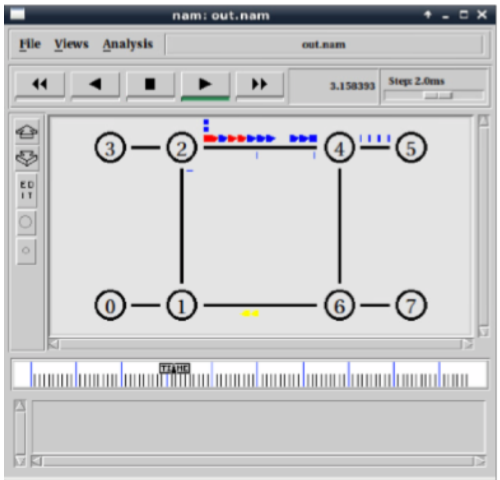
Exercise 2: Setting up NS2 simulation for measuring TCP throughput

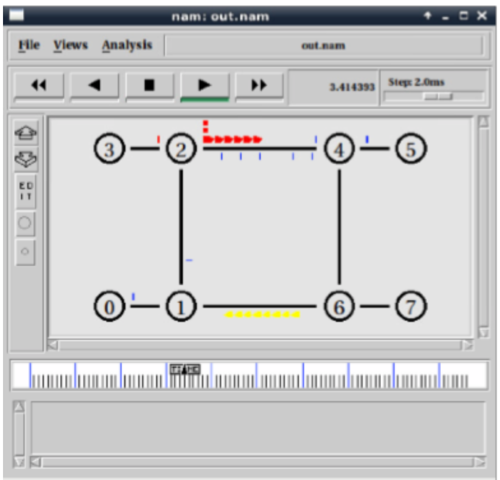
After completing the exercise2.tcl, the animation for the simulation using nam.out file comes out to be and running the nam window gives the following outputs at different times,

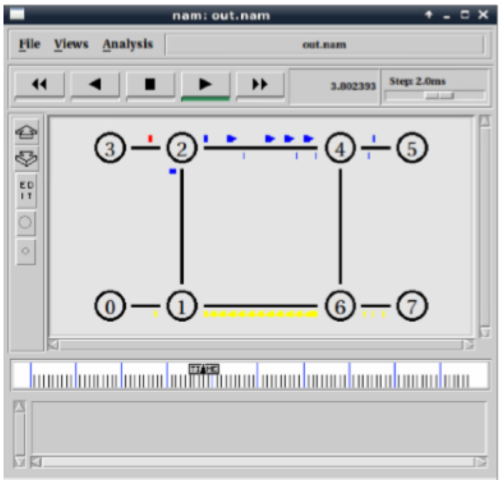




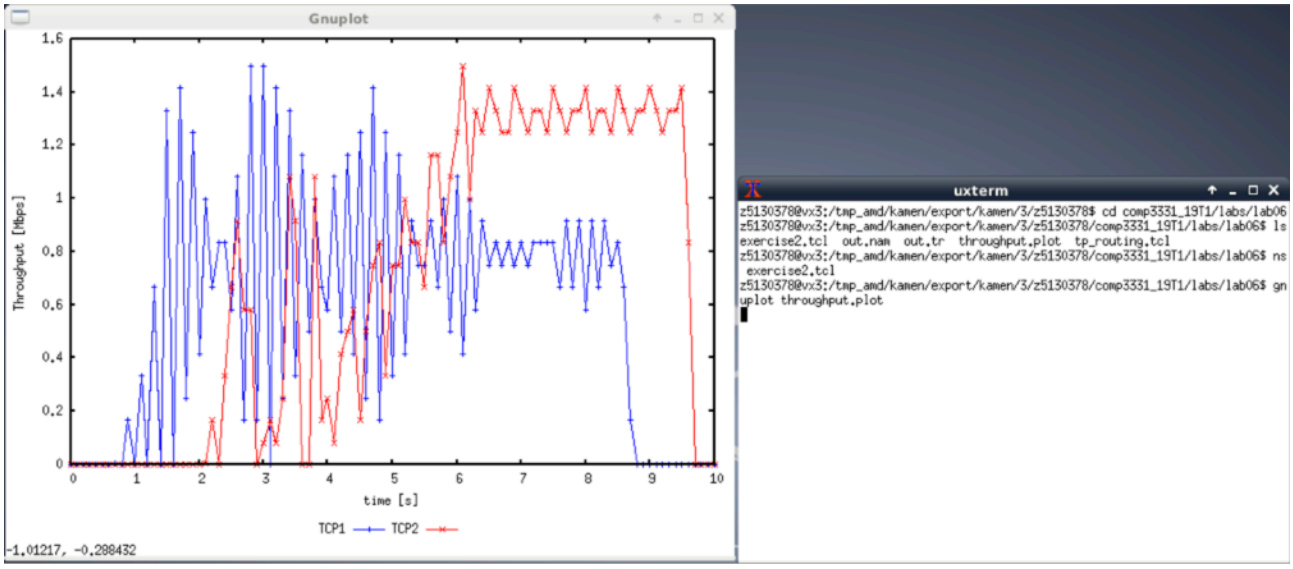






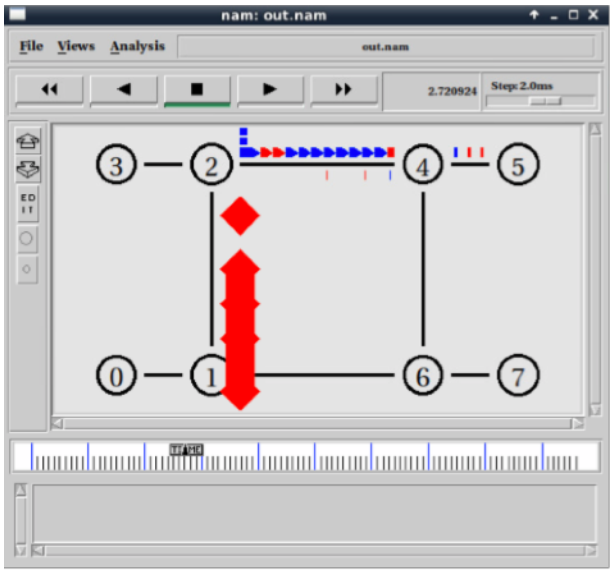


The command gnuplot throughput.plot gives,



The packets are moving from 0 -> 1 -> 2 -> 4 -> 5 for TCP1 at time 1.0. At time 1.2 packets via TCP2 starts moving along the network following the route 3 -> 2 -> 4 -> 5.

Also, as observed below in the screenshot,



The packets are being dropped (the big red chunk) and there is also queueing happening between node 2 and 4. TCP2 has higher throughput than TCP1 as observed form the plot.

Exercise 3: Understanding IP Fragmentation

Question 1: Which data size has caused fragmentation and why? Which host/ router has fragmented the original datagram? How many fragments have been created when data size is specified as 2000?

Solution 1 :

Fragmentation occurs when an IP datagram traverses a network which has a maximum transmission unit (MTU) that is smaller than the size of the datagram. The data sizes of 2000 and 3000 were fragmented, this was probably due to the sizes being larger than the smallest MTU of the connection. Also, the initialising and the receiving host(when replying) fragment the packets along the connection. The fragmentation splits the packet into two when the data size is 2000 and 3 when the data size is 3500.

Question 2: Did the reply from the destination 8.8.8.8. for 3500-byte data size also get fragmented? Why and why not?

Solution 2 :

Yes, the reply also got fragmented and this is due to the fact that the reply followed the same path as the initial ping, this means that they would have experienced the same MTU that would require fragmentation.

Question 3: Give the ID, length, flag and offset values for all the fragments of the first packet sent by 192.168.1.103 with data size of 3500 bytes?

Solution 3 :

Fragment 1 has ID:0x7a7b (31355) and Length:1514 with Flag:0x01 and Offset Values:0
Fragment 2 has ID:0x7a7b (31355) and Length:1514 with Flag:0x01 and Offset Values:1480
Fragment 3: has ID:0xdb05 (56069) and Length:582 with Flag:0x01 and Offset Values:2960

Question 4: Has fragmentation of fragments occurred when data of size 3500 bytes has been used? Why and why not?

Solution 4 :

It seems that fragmentation has not occurred when data of size 3500 bytes has been used. This is due to the two initial fragments having the same size and having the same id. If there was a second fragmentation I would expect some differences in the offset delta unless the smaller MTU was exactly half the size of the previous

MTU. i.e. there was a 2960 (1480*2) sized packet followed by the remaining 540 in a second packet where the initial packet was split exactly in half due to the second MTU being exactly half the size. Otherwise this would imply that fragmentation has not occurred.

Question 5: What will happen if for our example one fragment of the original datagram from 192.168.1.103 is lost?

Solution 5 :

If the first fragment is not lost, then after the waiting time for the fragment times out, the whole packet is dropped and follows the traditional avenues for what occurs during packet loss .There is one difference in the ICMP response from the router, that would be a ICMP message of type 8 with status 1. Rather than a status of type 0 which would refer to a whole packet. If the first fragment was dropped then there would likely not be a return message.