COMP9331 Lab Exercise 4: Throughput, IP Fragmentation and Routing

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Exercise 1: Setting up NS2 simulation for measuring TCP throughput

Question 1:
From time span 6s to 7s, all four FTP/TCP flows started. Flow tcp1 shares bandwidth with tcp4 from link n1 to n2. From time span 6s to 8s, flow tcp1 and tcp2 shares bandwitdth all the way from links n2 to n4 and n4 to n5. Since the total RTT of flow tcp1 is longer than flow tcp2, flow tcp2 gets more bandwidth from links n2 to n4 and n4 to n5. Therefore, flow tcp2 gets higher throughput.

Question 2:
The flow tcp1 has just started at 0.5s, all tcp connection start with the slow start stage. The fluctuation is because the flow tcp1 is detecting the highest available bandwidth.

Question 3:
The only flow that do not need to share bandwidth with other flows is tcp1 from 0.5s to 2s. However, the flow tcp1 is in slow start stage and it has not detected the highest available bandwidth 2.5Mbps. After 2s, all paths in the network has some other flows share bandwidth with them, so no flow can reach the highest available bandwidth 2.5Mbps.

Exercise 2: Understanding IP Fragmentation

Question 1:
Data size of 2000 bytes and 3500 bytes both cased fragmentation. The maximum transmission unit for ethernet is 1500 bytes, when transmitting packages larger than the MTU, it will be fragmented. The original host has fragmented the original datagram. As for 2000 bytes, from packet no. 16 in the given tracefile, we can found ‘Fragmented IP protocol’ in the info section, which means the fragmentation happens here. ‘Reassembled in #17’ means fragments 16 and 17 are together. The packet 16 and 17 are fragments caused by sending 2000 bytes data because they have data size 1500 and 548 respectively (20 bytes IP header for both packets and 8 bytes ICMP header). Therefore, two fragments have been created when data size is 2000.

Question 2:
Yes. From the trace, we can see that the reply is formed by packet no. 42,43,44, all three packets are fragments, they reassembled in #44. It is fragmented because the size transmitted has exceed the MTU.

Question 3:

Packet No.	ID	Length	Flag	Offset
39	0x7a7b	1500	0x2000	0
40	0x7a7b	1500	0x20b9	1480
41	0x7a7b	568	0x0172	2960

Question 4:
Fragmentation of fragments does not occur at 192.168.1.103 because we only received three fragments from 8.8.8.8. However, we don't know if fragmentation of fragments occurs when sending from 192.168.1.103 to 8.8.8.8. because we don't know how many fragments received by 8.8.8.8.

Question 5:
All of the fragments of the original datagram from 192.168.1.103 need to be retransmitted.

Exercise 3: Understanding the Impact of Network Dynamics on Routing

Question 1:
There are two routes: node 0 sending to node 5, node 2 sending to node 5.
Node 0 -> 1 -> 4 -> 5
Node 2 -> 3 -> 5
The routes does not change over time.

Question 2:
At time 1.0, the link between node 1 and node 4 is down, the route from node 0 to node 5 is not changed, the data can only transferred from node 0 to node 1 and cannot proceed further because the link from 1 to 4 is down. The route from node 2 to node 5 is working fine.

At time 1.2, the link between node 1 and node 4 is up, the route from node 0 to node 5 is not changed, the data from node 0 can be successfully transmitted to node 5. The route from node 2 to node 5 is working fine.

Question 3:
Yes, the additional traffic is observed because Distance-Vector routing protocol is constructing its forwarding table by exchanging information.

At time 1.0, the link between node 1 and node 4 is down, the route from node 0 to node 5 is changed, the data transmitted follow the new route:
Node 0 -> 1 -> 2 -> 3 -> 5
This new route is found by Distance-Vector routing protocol.
The route from node 2 to node 5 is same but need to share bandwidth with the route from node 0.

At time 1.2, the link between node 1 and node 4 is up, the route is changed back to the original route:
Node 0 -> 1 -> 4 -> 5
This is because the original route costs one node less than the new route.

Question 4:
The routing from Node 0 to node 5 changes
from: Node 0 -> 1 -> 4 -> 5
to: Node 0 -> 1 -> 2 -> 3 -> 5
This is because the cost from 1 to 4 has changed to 3 and the costs of other links are all 1. This makes the original route costs 5, while the new route only costs 4 in total.

Question 5:

The route from node 0 to node 5 is not changed, whereas the route from node 2 to 5 is affected by the new rules. There are two routes from node 2 to 5 and the load is equally distributed to each route. The two routes are:

original: Node 2 -> 3 -> 5

new: Node 2 -> 1 -> 4 -> 5.

Since the cost of link 1 to 4 is set to 2, and the cost of link 3 to 5 is set to 3, this makes the cost of original route (Node 2 -> 3 -> 5) equals to 4, while the cost of new route (Node 2 -> 1 -> 4 -> 5) is also 4. Because the multipath is allowed, the traffic load is equally distributed to each route.

As to the route from node 0 to node 5, the other route (Node 0 -> 1 -> 2 -> 3 -> 5)'s cost is 6, while the original route (Node 0 -> 1 -> 4 -> 5) still has the lowest cost of 4. The route is not changed.