COMP3331

Lab 6

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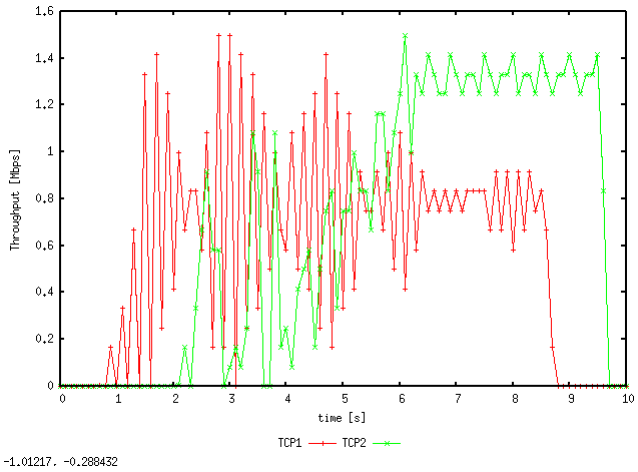
Exercise 1: Setting up NS2 simulation for measuring TCP throughput



1. *Why the throughput achieved by flow tcp2 is higher than tcp1 between time span 6 sec to 8 sec?*

All flows are active between 6 to 8 seconds. Tcp1 (flow1) has to compete with flow3 and flow4 and thus due to the fairness in TCP causes a lower throughput compared to flow2 which has less flows to compete with (and less bottlenecked links). Observing delay as well, and noting that throughput is inversely proportional to RTT, flow2 has a lower RTT than flow1 correlating to a higher throughput in flow2.

2. *Why the throughput for flow tcp1 is fluctuating between time span 0.5 sec to 2 sec?*

Flow1 is in the slow-start phase, a fluctuation in the throughput is thus observed.

3. *Why is the maximum throughput achieved by any one flow capped at around 1.5Mbps?*

The maximum throughput is defined by the bottleneck link. The links with 2.5 Mbps always compete with other flows simultaneously and due to TCP fairness, the link's bandwidth is shared and thus divided between the flows – causing a lower maximum throughput of 1.5 Mbps. The flow does not achieve 2.5 Mbps initially due to the slow-start phase.

Exercise 2: Understanding IP Fragmentation

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?*

Fragmentation is observed to data sizes 2000 and 3500 bytes as the sizes are larger than the default MTU (maximum transmission unit) of 1500 bytes. The initiating host fragments the original datagram. When the data is specified at 2000 2 fragments are formed.

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

The reply from the destination did also get fragmented into 3 fragments. The host/router that fragmented the packet is unknown because it could have happened anywhere in between.

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?*

ID	Length	Flag	Offset
7a7b	1514	0x2000	0
7a7b	1514	0x20b9	1480
7a7b	582	0x0172	2960

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

We can only be sure if fragmentation of fragments has occurred on incoming packets if they are smaller than the MTU however for outgoing packets we cannot be sure whether or not this has occurred (requires knowledge of network topology).

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

There is no transport layer protocol used. Thus, the fragments received would be incomplete and discarded. If a transport layer such as TCP were employed, all the fragments would be sent again (retransmission) as it is unknown which fragment was lost.

Exercise 3: Understanding the Impact of Network Dynamics on Routing

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

The nodes that communicate: 0 with 2, 0 with 5 through 1 and 4, 2 with 5 through 3. Node 0 goes from 0 to 1 to 4 to 5. Node 2 goes from 2 to 3 to 5. The route doesn't change over time.

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?*

At the time, link between node 1 and 4 goes down. The route did not change and thus caused package loss from node 0.

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?*

There is some additional traffic observed corresponding to the control packets which were exchanged to build the forwarding table. The network reroutes router 1 traffic from node 0 to node 2.

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

The change in link cost causes the routing to change as that link 1-4 because more "expensive" and thus the traffic chooses to follow path 1-2-3-5 (with a lower cost).

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

Now that multipath has been enabled, the traffic can take more than 1 path to the same destination. Load balancing will occur over paths of equal cost. Thus, 2-1-4-5 and 2-3-5 have the same cost (4) so the traffic followed both paths from node 2 to node 5.