Lab Exercise 6: Throughput, IP Fragmentation and Routing

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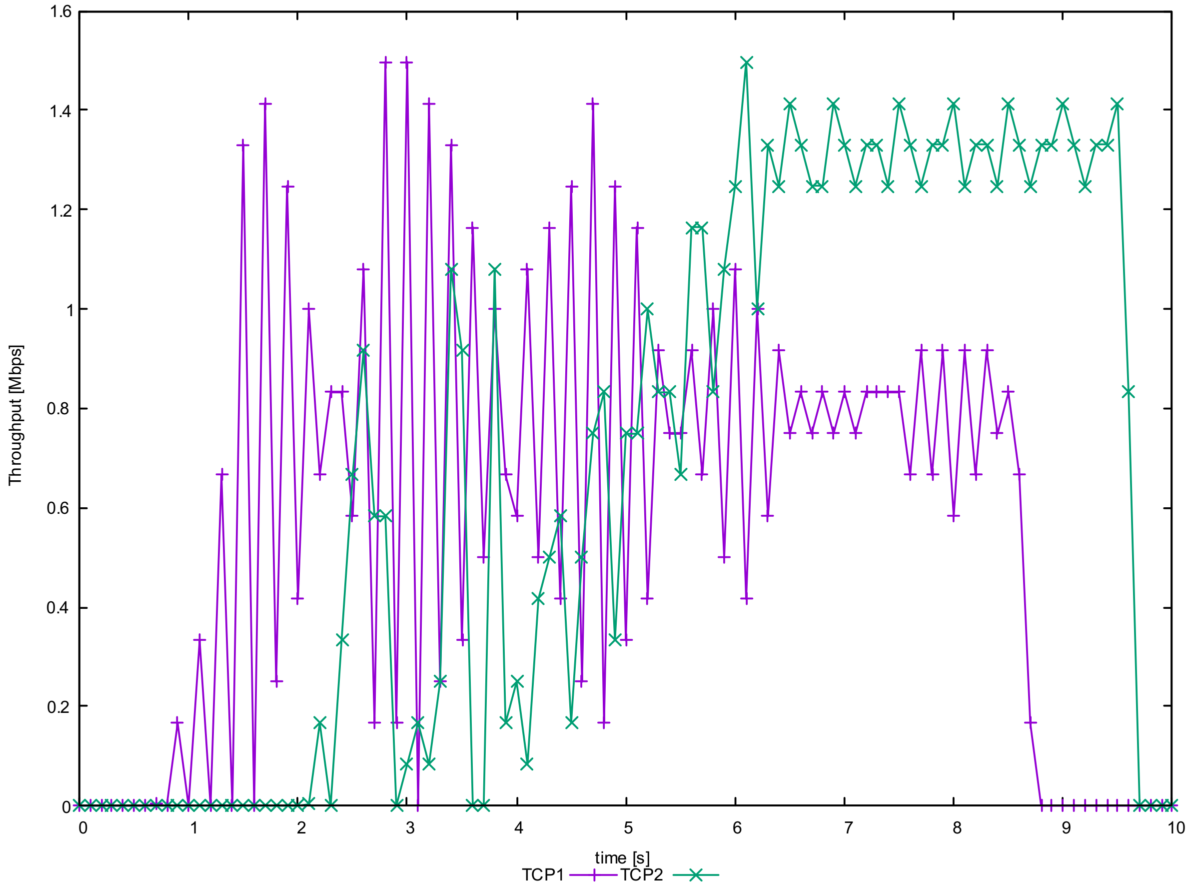
Exercise 1: Setting up NS2 simulation for measuring TCP throughput



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

TCP1 competes with TCP4 on n1-n2 link and completes with TCP2 on n2-n4 link. In addition, TCP2 has less RTT. Therefore, TCP2 gets more bandwidths share on n2-n4 link.

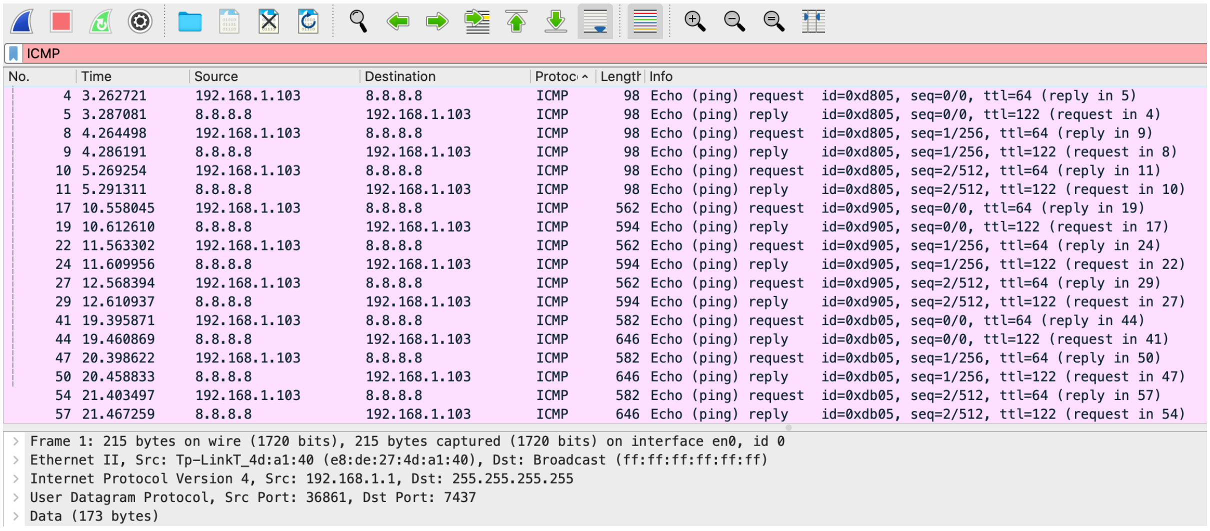
Question 2: Why the throughput for flow tcp1 is fluctuating between time span 0.5 sec to 2 sec?

Because TCP1 is in the slow-start stage.

Question 3: Why is the maximum throughput achieved by anyone flow capped at around 1.5Mbps?

About two seconds ago, TCP1 is the only flow but is in the slow-start stage. After two seconds, TCP2 adds and will share bandwidth with TCP1.

Exercise 2: Understanding IP Fragmentation


ICMP

No.	Time	Source	Destination	Protocol	Length	Info
4	3.262721	192.168.1.103	8.8.8.8	ICMP	98	Echo (ping) request id=0xd805, seq=0/0, ttl=64 (reply in 5)
5	3.287081	8.8.8.8	192.168.1.103	ICMP	98	Echo (ping) reply id=0xd805, seq=0/0, ttl=122 (request in 4)
8	4.264498	192.168.1.103	8.8.8.8	ICMP	98	Echo (ping) request id=0xd805, seq=1/256, ttl=64 (reply in 9)
9	4.286191	8.8.8.8	192.168.1.103	ICMP	98	Echo (ping) reply id=0xd805, seq=1/256, ttl=122 (request in 8)
10	5.269254	192.168.1.103	8.8.8.8	ICMP	98	Echo (ping) request id=0xd805, seq=2/512, ttl=64 (reply in 11)
11	5.291311	8.8.8.8	192.168.1.103	ICMP	98	Echo (ping) reply id=0xd805, seq=2/512, ttl=122 (request in 10)
17	10.558045	192.168.1.103	8.8.8.8	ICMP	562	Echo (ping) request id=0xd905, seq=0/0, ttl=64 (reply in 19)
19	10.612610	8.8.8.8	192.168.1.103	ICMP	594	Echo (ping) reply id=0xd905, seq=0/0, ttl=122 (request in 17)
22	11.563302	192.168.1.103	8.8.8.8	ICMP	562	Echo (ping) request id=0xd905, seq=1/256, ttl=64 (reply in 24)
24	11.609956	8.8.8.8	192.168.1.103	ICMP	594	Echo (ping) reply id=0xd905, seq=1/256, ttl=122 (request in 22)
27	12.568394	192.168.1.103	8.8.8.8	ICMP	562	Echo (ping) request id=0xd905, seq=2/512, ttl=64 (reply in 29)
29	12.610937	8.8.8.8	192.168.1.103	ICMP	594	Echo (ping) reply id=0xd905, seq=2/512, ttl=122 (request in 27)
41	19.395871	192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request id=0xdb05, seq=0/0, ttl=64 (reply in 44)
44	19.460869	8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply id=0xdb05, seq=0/0, ttl=122 (request in 41)
47	20.398622	192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request id=0xdb05, seq=1/256, ttl=64 (reply in 50)
50	20.458833	8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply id=0xdb05, seq=1/256, ttl=122 (request in 47)
54	21.403497	192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request id=0xdb05, seq=2/512, ttl=64 (reply in 57)
57	21.467259	8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply id=0xdb05, seq=2/512, ttl=122 (request in 54)

> Frame 1: 215 bytes on wire (1720 bits), 215 bytes captured (1720 bits) on interface en0, id 0
> Ethernet II, Src: Tp-LinkT_4d:a1:40 (e8:de:27:4d:a1:40), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Internet Protocol Version 4, Src: 192.168.1.1, Dst: 255.255.255.255
> User Datagram Protocol, Src Port: 36861, Dst Port: 7437
> Data (173 bytes)

Question 1: Which data size has caused fragmentation and why?

2000 and 3500 size of data has caused fragmentation, because the max maximum transmission unit (MTU) is 1500bytes.

Which host/router has fragmented the original datagram?

192.168.1.103

How many fragments have been created when the data size is specified as 2000?

2 fragments have been created when data size is specified as 2000.

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

It will pass through the last link to the sender and the MTU of the last link is 1500 bytes, so it must be fragmented.

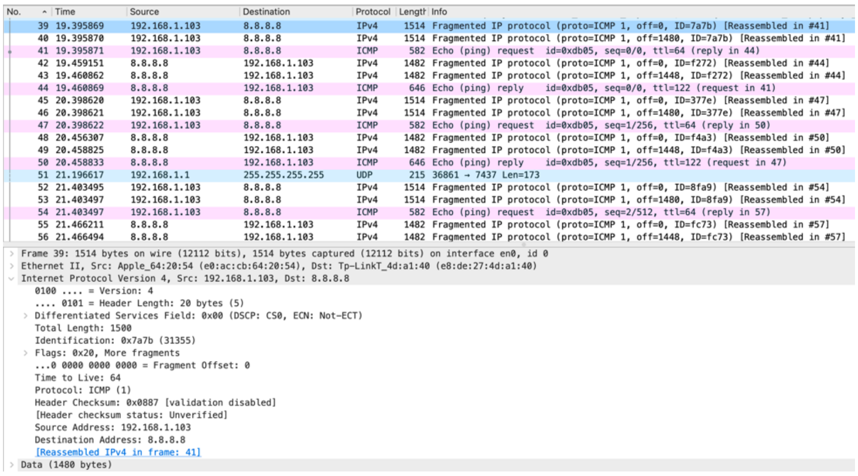
Question 3: Give the ID, length, flag and offset values for all the fragments of the first packet sent by 192.168.1.103 with a data size of 3500 bytes?

ID: 0x7a7b

length: 1500

flag: 0x20, More fragments

offset: 0

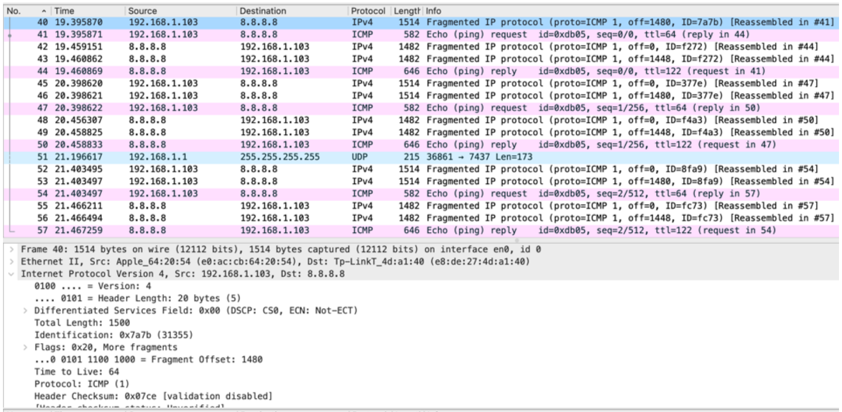


ID: 0x7a7b

length: 1500

flag: 0x20, More fragments

offset: 1480

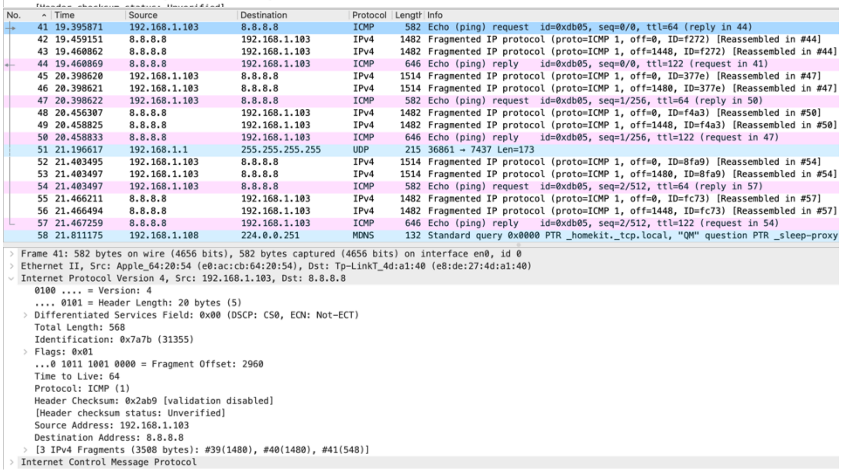


ID: 0x7a7b

length: 568

flag: 0x01

offset: 2960



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

No.

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

Because of using the Reliable Transport Protocol, the reciver checks that the fragment is incomplete and will discard it.

Exercise 3: Understanding the Impact of Network Dynamics on Routing

Question 1: Which nodes communicate with which other nodes?

Node 0 communicate with Node 5

Node 2 communicate with Node 5

Which route do the packets follow?

Node 0 - Node 1 - Node 4 - Node 5

Node 2 - Node 3 - Node 5

Does it change over time?

No, the routes do not change over 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?

When time t = 1.0, link Node 1 – Node 4 goes down. Node 0 cannot reach Node 5 and the packets are waiting at Node 1.

When time t = 1.2, link Node 1 – Node 4 goes up. The packets can reach Node 4 from Node 1.

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?

Yes. When link Node 1- Node 4 goes down, Node 0 – Node 5 will change to another path (Node 0 – Node 1 – Node 2 – Node 3 – Node 5).

If the link Node 1 – Node goes up, it will revert to original path.

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

After increasing the cost to 3 between Node 1 and Node 4, the original path (Node 0 -(1)- Node 1 -(3)- Node 4 -(1)- Node 5) cost is 5. Another path (Node 0 -(1)- Node 1 -(1)- Node 2 -(1)- Node 3 -(1)- Node 5) cost is 4. Because it prefers the lower cost, therefore, Node 0 – Node 5 will use route Node 0 – Node 1 – Node 2 – Node 3 – Node 5.

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

After changing, the Node 0 to Node 5 (Node 0 -(1)- Node 1 -(2)- Node 4 -(1)- Node 5) cost is 4. The Node 2 to Node 5 (Node 2 -(1)- Node 3 -(3)- Node 5) cost is also equal to 4. Therefore, it will split equally on each routes.