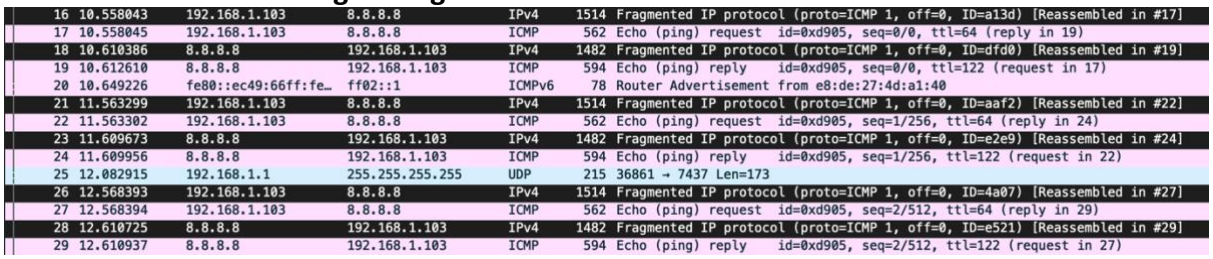
Lab06

Exercise 1: Setting up NS2 simulation for measuring TCP throughput

1. The throughput achieved by flow tcp2 is higher than tcp1 between 6-8 seconds because tcp2 has more packages during this time due to the bandwidth of n0-n1-n2 being smaller than that of n3-n2, respectively being 2.5Mbps and 10 Mbps.
2. The throughput for flow tcp1 is fluctuating between 0.5-2 seconds because tcp1 is initiating at a slow start phase and having its window size readjusted.
3. The maximum throughput achieved by any one flow is capped at around 1.5Mbps because there are multiple flows going through a link which means that the flows are bottlenecked at the links with low bandwidth (2.5mbps). Multiple flows limit the bandwidth to 1.5Mbs

Exercise 2: Understanding IP Fragmentation

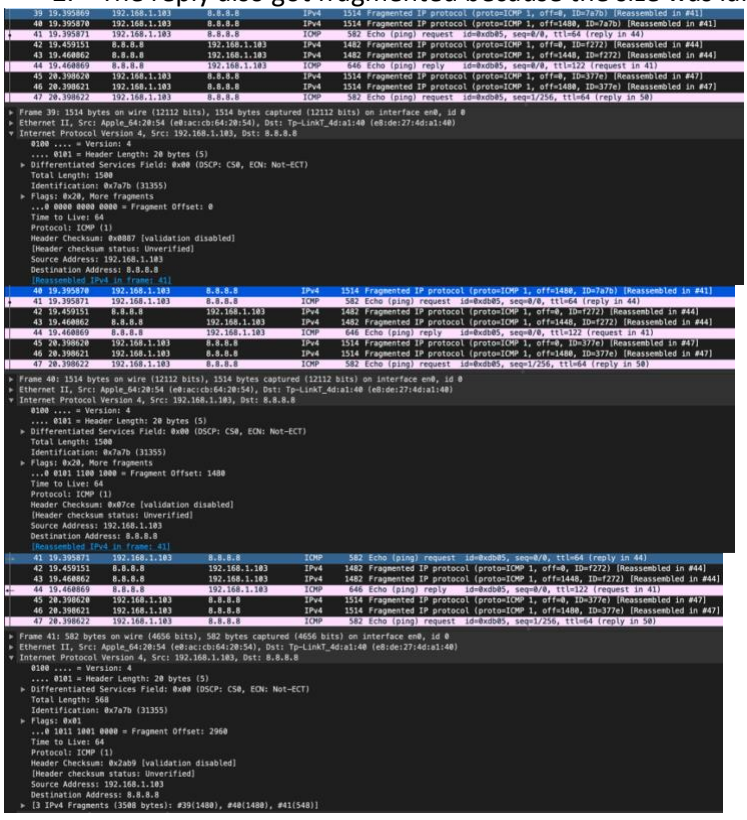


16	10.558043	192.168.1.103	8.8.8.8	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=a13d) [Reassembled in #17]
17	10.558045	192.168.1.103	8.8.8.8	ICMP	562	Echo (ping) request id=0xd905, seq=0/0, ttl=64 (reply in 19)
18	10.610386	8.8.8.8	192.168.1.103	IPv4	1482	Fragmented IP protocol (proto=ICMP 1, off=0, ID=dfd0) [Reassembled 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)
20	10.649226	fe80::ec49:66ff:fe…	ff02::1	ICMPv6	78	Router Advertisement from e8:de:27:4d:a1:40
21	11.563299	192.168.1.103	8.8.8.8	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=aaf2) [Reassembled in #22]
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)
23	11.609673	8.8.8.8	192.168.1.103	IPv4	1482	Fragmented IP protocol (proto=ICMP 1, off=0, ID=e2e9) [Reassembled 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)
25	12.082915	192.168.1.1	255.255.255.255	UDP	215	36861 → 7437 Len=173
26	12.568393	192.168.1.103	8.8.8.8	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=4a07) [Reassembled in #27]
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)
28	12.610725	8.8.8.8	192.168.1.103	IPv4	1482	Fragmented IP protocol (proto=ICMP 1, off=0, ID=e521) [Reassembled 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)

1. The data sizes that caused fragmentation are 2000 bytes pings as fragmentation of a packet occurs when the ping is over 1500 bytes.
   192.168.1.103 fragmented the original datagram.
   Two fragments were created when specified at 2000 bytes.

42	19.459151	8.8.8.8	192.168.1.103	IPv4	1482	Fragmented IP protocol (proto=ICMP 1, off=0, ID=f272) [Reassembled in #44]
43	19.460862	8.8.8.8	192.168.1.103	IPv4	1482	Fragmented IP protocol (proto=ICMP 1, off=1448, ID=f272) [Reassembled 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)
45	20.398620	192.168.1.103	8.8.8.8	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=377e) [Reassembled in #47]

2. The reply also got fragmented because the size was larger than 1500 bytes.



3. First: ID: 31355, length: 1500, flags: 0x01, offset values: set, offset 0
   Second: ID: 31355, length: 1500, flags: 0x01, offset values: set, offset 1480
   Third: ID: 31355, length: 568, flags: 0x00, offset values: Not set, offset 2960

4. No fragmentation has occurred when data of size 3500 bytes was used as all 3500 byte datagrams arrived in three fragments.
5. If one fragment is lost, the whole packet will have to be retransmitted and fragmented again.

Exercise 3: Understanding the Impact of Network Dynamics on Routing

1. Node 0 communicates with node 5. The route is 0-1-4-5
   Node 2 communicates with node 5. The route is 2-3-5.
   It does not change over time.
2. Between 1.0-1.2, the link between node 1 and node 4 goes down. The link between node 0 to node 5 is broken and the packets are dropped at node 1.
3. Yes, there is a small packet being transmitted in the network before time 1.0. The network finds a new path to node 5 which is 0-1-2-3-5.
4. Now that the new path has been found, the network no longer transmits information between node 1 and node 4 but rather through nodes 0-1-2-3-5. After uncommenting "ns cost $n1 $n4 3", the network after using the Distance-Vector routing protocol avoids link between node 1 and node 4.
5. Now, packets from node 0 travel 0-1-4-5 but packets from node 2 have two different routes: 2-1-4-5 and 2-3-5. Therefore, the packets are able to simultaneously travel through two different paths rather than just one restrictive single path before.