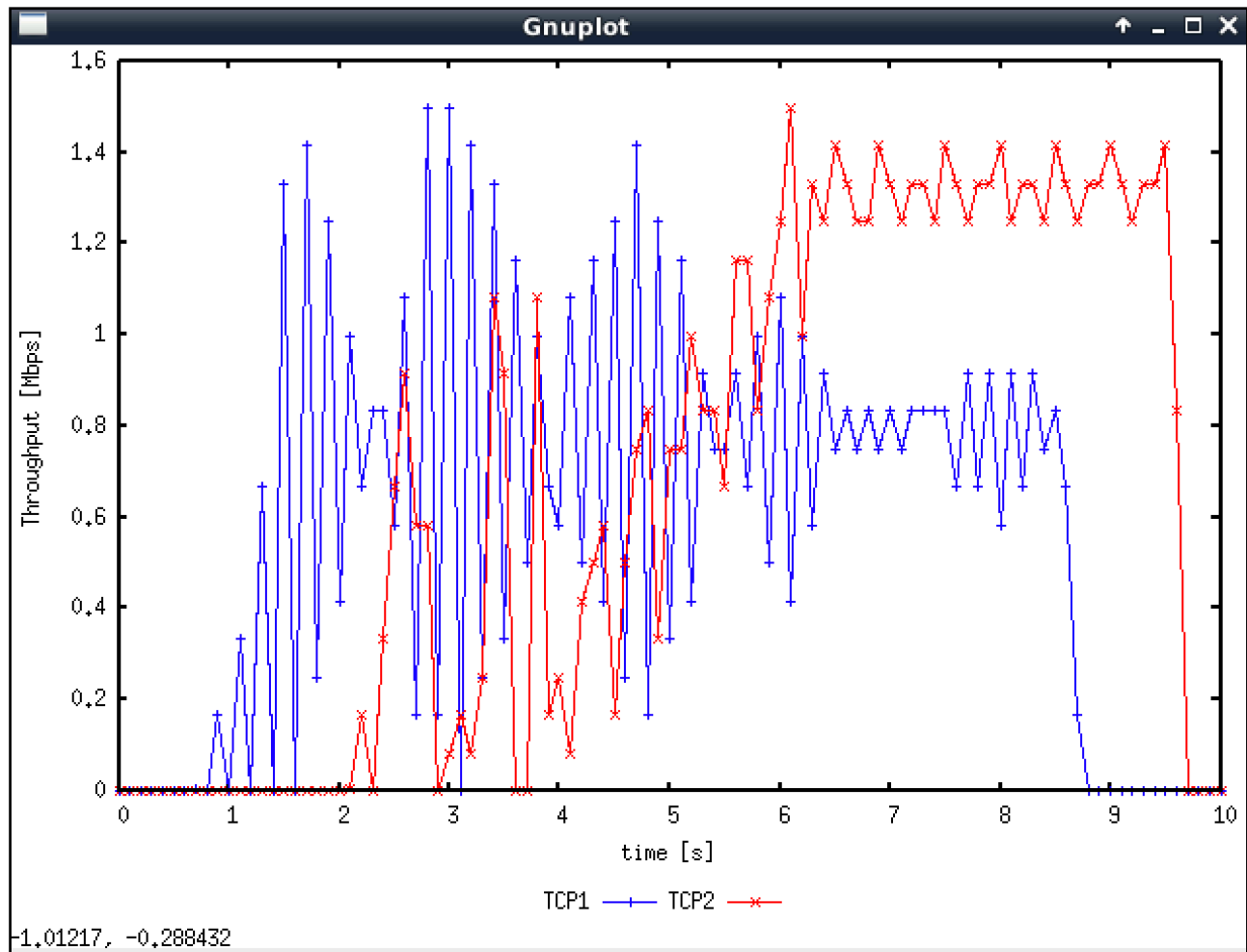


**E1:**

Q1:

The reason is that flow tcp 1 has to traverse more routers than flow tcp 2, which means it has a longer delay.

Q2:

Tcp 1 is using slow-start to detect available bandwidth.

Q3:

During time 0.5 - 2.0 sec, tcp 1 is the only flow active but it is still in the slow-start phase and have to compete with other flows starting at 2.0 sec before it can reach the maximum bandwidth.

**E2:**

Q1:

The data size **2000** and **3500** caused fragmentation because there is offset flag in frame, picture shows below:

```
Flags: 0x00
Fragment offset: 1480
Time to live: 64
Protocol: ICMP (1)
Header checksum: 0x04c4 [validation disabled]
Source: 192.168.1.103 (192.168.1.103)
Destination: 8.8.8.8 (8.8.8.8)
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
[2 IPv4 Fragments (2008 bytes): #16(1480), #17(528)]
  [Frame: 16, payload: 0-1479 (1480 bytes)]
  [Frame: 17, payload: 1480-2007 (528 bytes)]
[Fragment count: 2]
[Reassembled IPv4 length: 2008]
[Reassembled IPv4 data: 080008f5d90500005b51dd800009a51108090a0b0c0d0e0f...]
```

**192.168.1.103** fragmented the original datagram.

And in data size id specifies as 2000, there will be **2** fragments created.

Q2:

The reply from the destination 8.8.8.8 for 3500-byte data size also get fragmented, as picture shows below:

```
[Destination GeoIP: Unknown]
[3 IPv4 Fragments (3508 bytes): #55(1448), #56(1448), #57(612)]
  [Frame: 55, payload: 0-1447 (1448 bytes)]
  [Frame: 56, payload: 1448-2895 (1448 bytes)]
  [Frame: 57, payload: 2896-3507 (612 bytes)]
[Fragment count: 3]
[Reassembled IPv4 length: 3508]
[Reassembled IPv4 data: 0000407edb0500025b51dd8b0007496808090a0b0c0d0e0f...]
```

The reason is that data size is too large to transmit, and must be fragmented.

Q3:

Like the picture shows below:

41	19.39587100( 192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request	id=0xdb05
44	19.46086900( 8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply	id=0xdb05
47	20.39862200( 192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request	id=0xdb05
50	20.45883300( 8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply	id=0xdb05
54	21.40349700( 192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request	id=0xdb05
57	21.46725900( 8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply	id=0xdb05

Protocol: ICMP (1)						
▼ Header checksum: 0x2ab9 [validation disabled]						
[Good: False]						
[Bad: False]						
Source: 192.168.1.103 (192.168.1.103)						
Destination: 8.8.8.8 (8.8.8.8)						
[Source GeoIP: Unknown]						
[Destination GeoIP: Unknown]						
▼ [3 IPv4 Fragments (3508 bytes): #39(1480), #40(1480), #41(548)]						
[Frame: 39, payload: 0-1479 (1480 bytes)]						
[Frame: 40, payload: 1480-2959 (1480 bytes)]						
[Frame: 41, payload: 2960-3507 (548 bytes)]						
[Fragment count: 3]						
[Reassembled IPv4 length: 3508]						
[Reassembled IPv4 data: 0800565cdb0500005b51dd8900072b8e08090a0b0c0d0e0f...]						

41	19.39587100( 192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request	id=0xdb05
44	19.46086900( 8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply	id=0xdb05
47	20.39862200( 192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request	id=0xdb05
50	20.45883300( 8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply	id=0xdb05
54	21.40349700( 192.168.1.103	8.8.8.8	ICMP	582	Echo (ping) request	id=0xdb05
57	21.46725900( 8.8.8.8	192.168.1.103	ICMP	646	Echo (ping) reply	id=0xdb05

▼ Internet Control Message Protocol						
Type: 8 (Echo (ping) request)						
Code: 0						
Checksum: 0x565c [correct]						
Identifier (BE): 56069 (0xdb05)						
Identifier (LE): 1499 (0x05db)						
Sequence number (BE): 0 (0x0000)						
Sequence number (LE): 0 (0x0000)						
[Response frame: 44]						

ID: 0Xdb05, length = 1500, flag = 1, offset = 0

ID: 0Xdb05, length = 1500, flag = 1, offset = 185

ID: 0Xdb05, length = 568, flag = 0, offset = 370

Q4:

This is not sure, I can only sure about that there is no further fragmentation occur in the last packet of the fragment. But in the former two fragments, I can not sure whether there is fragmentation occur only we can found the offset value is between 0 and 185 or 185 and 370.

Q5:

If one fragment is lost, the whole packet should be retransmitted, and the packet with one fragment missing will be discarded.

**E3:**

Q1:

Node 0 sends packets to Node 5, follow the route 0 - 1 - 4 - 5.

Node 2 sends packets to Node 5, follow the route 2 - 3 - 5.

Both the routes do not change over time.

Q2:

At time 1.0 the link between Node 1 and Node 4 goes down, the route between Node 1 and Node 5 does not change, but Node 0 cannot reach Node 5.

At time 1.2 the link between Node 1 and Node 4 goes up, and the packets can be forwarded again, and Node 0 can reach Node 5 again.

Q3:

When the link between Node 1 and Node 4 goes down, the route changes to 0 - 1 - 2 - 3 - 5.

However, when link between Node 1 and Node 4 goes up, the route back to 0 - 1 - 4 - 5.

The reason is that the original route has lower cost than 0 - 1 - 2 - 3 - 5.

Q4:

This changes the cost of the link between Node 1 to Node 4 to Node3.

The route changes to 0 - 1 - 2 - 3 - 5 since the cost of route 0 - 1 - 2 - 3 - 5 is 4 which is lower than the cost of route 0 - 1 - 4 - 5 is 5.

Q5:

Node 2 can transmit data use route 2 - 1 - 4 - 5 or route 2 - 3 - 5.

Since the network is now using multi path routing, Node 2 will split traffic equally on both these paths.