**Part 1**

Initially, on all ports, there was a get request GET HTTP/1.1

**Port 4000**

On this port, I did find some faulty packets and to describe some, there were “TCP Dup ACK” i.e a gap between the packets I received from the server, “Previous segment not captured”, “TCP Retransmission”, “TCP DUP ACK”. There was a three-way handshake in the start and also the connection ended with the standard termination sequence. There was a loss of packets and the server had to retransmit them.

**Port 4001**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4000. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

**Port 4002**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4001. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

**Port 4003**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4002. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

**Port 4004**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4003. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

**Port 4005**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4004. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

**Port 4006**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4005. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

**Port 4007**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4006. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

Connection closed without completion.

**Port 4008**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4007. There was a three-way handshake in the start and also the connection ended with the standard termination sequence. Connection closed without completion.

**Port 4009**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4008. There was a three-way handshake in the start and also the connection ended with the standard termination sequence.

Connection closed without completion.

**Port 4010**

On this port, I found a lot of “TCP Dup ACK” i.e packets had to be retransmitted due to loss. There were relatively more TCP DUP ACKs than port 4009. There was a three-way handshake in the start and also the connection ended with the standard termination sequence. Connection closed without completion.

**Conclusion for Part 1**

From what I have analysed, the strategy that the server and client use to maintain throughput is by retransmitting packets and sending duplicate acknowledgements. This indicates that there was packet loss and that the client received packets that were out of order at times. Moreover, duplicate acks are also used to invoke fast retransmission which is why I saw a lot of retransmission as the port number increased.

**Part 2**

Filter: tcp.analysis.retransmission

**Port 4000**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 31356 | 31356 (100.0%) | — |
| Time span, s | 6.823 | 6.823 | — |
| Average pps | 4595.9 | 4595.9 | — |
| Average packet size, B | 1136 | 1136 | — |
| Bytes | 35625201 | 35625201 (100.0%) | 0 |
| Average bytes/s | 5221 k | 5221 k | — |
| Average bits/s | 41 M | 41 M | — |

Retransmitted Packets (1/31356) \* 100 = 0.003 %

**Port 4001**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 51346 | 51346 (100.0%) | — |
| Time span, s | 28.576 | 28.576 | — |
| Average pps | 1796.8 | 1796.8 | — |
| Average packet size, B | 730 | 730 | — |
| Bytes | 37473145 | 37473145 (100.0%) | 0 |
| Average bytes/s | 1311 k | 1311 k | — |
| Average bits/s | 10 M | 10 M | — |

Retransmitted Packets (451/51346) \* 100 = 0.88 %

**Port 4002**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 51993 | 51993 (100.0%) | — |
| Time span, s | 44.810 | 44.810 | — |
| Average pps | 1160.3 | 1160.3 | — |
| Average packet size, B | 722 | 722 | — |
| Bytes | 37564512 | 37564512 (100.0%) | 0 |
| Average bytes/s | 838 k | 838 k | — |
| Average bits/s | 6706 k | 6706 k | — |

Retransmitted Packets (729/51993) \* 100 = 0.01 %

**Port 4003**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 52558 | 52558 (100.0%) | — |
| Time span, s | 81.208 | 81.208 | — |
| Average pps | 647.2 | 647.2 | — |
| Average packet size, B | 715 | 715 | — |
| Bytes | 37598821 | 37598821 (100.0%) | 0 |
| Average bytes/s | 462 k | 462 k | — |
| Average bits/s | 3703 k | 3703 k | — |

Retransmitted Packets (1082/52558) \* 100 = 0.02 %

**Port 4004**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 53141 | 53141 (100.0%) | — |
| Time span, s | 172.766 | 172.766 | — |
| Average pps | 307.6 | 307.6 | — |
| Average packet size, B | 708 | 708 | — |
| Bytes | 37599446 | 37599446 (100.0%) | 0 |
| Average bytes/s | 217 k | 217 k | — |
| Average bits/s | 1741 k | 1741 k | — |

Retransmitted Packets (989/53141) \* 100 = 1.86 %

**Port 4005**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 54425 | 54425 (100.0%) | — |
| Time span, s | 566.827 | 566.827 | — |
| Average pps | 96.0 | 96.0 | — |
| Average packet size, B | 693 | 693 | — |
| Bytes | 37694647 | 37694647 (100.0%) | 0 |
| Average bytes/s | 66 k | 66 k | — |
| Average bits/s | 532 k | 532 k | — |

Retransmitted Packets (1274/54425) \* 100 = 2.34 %

**Port 4006**

Connection reset by peer and connection closed at first attempt. I gave a second attempt.

The second attempt gave me this.

64 32.0M 64 20.6M 0 0 14646 0 0:38:11 0:24:35 0:13:36 5065\* transfer closed with 11943290 bytes remaining to read

64 32.0M 64 20.6M 0 0 14648 0 0:38:10 0:24:35 0:13:35 4792

\* Closing connection 0

curl: (18) transfer closed with 11943290 bytes remaining to read

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 37505 | 37505 (100.0%) | — |
| Time span, s | 1722.776 | 1722.776 | — |
| Average pps | 21.8 | 21.8 | — |
| Average packet size, B | 660 | 660 | — |
| Bytes | 24737348 | 24737348 (100.0%) | 0 |
| Average bytes/s | 14 k | 14 k | — |
| Average bits/s | 114 k | 114 k | — |

The connection timed out after almost 28 minutes. So, there was a lot of packet loss.

Retransmitted Packets (4116/37505) \* 100 = 10.97 %

**Port 4007**

The connection was timed out and I had this response in the terminal

16 32.0M 16 5324k 0 0 12234 0 0:45:42 0:07:25 0:38:17 4523\* transfer closed with 28094474 bytes remaining to read

16 32.0M 16 5331k 0 0 12248 0 0:45:39 0:07:25 0:38:14 7448

\* Closing connection 0

curl: (18) transfer closed with 28094474 bytes remaining to read

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 9941 | 9941 (100.0%) | — |
| Time span, s | 511.689 | 511.689 | — |
| Average pps | 19.4 | 19.4 | — |
| Average packet size, B | 646 | 646 | — |
| Bytes | 6422251 | 6422251 (100.0%) | 0 |
| Average bytes/s | 12 k | 12 k | — |
| Average bits/s | 100 k | 100 k | — |

Retransmitted Packets (1578/9941) \* 100 = 15.87 %

**Port 4008**

8 32.0M 8 2703k 0 0 5630 0 1:39:19 0:08:11 1:31:08 1060\* transfer closed with 30786338 bytes remaining to read

8 32.0M 8 2703k 0 0 5630 0 1:39:19 0:08:11 1:31:08 1002

\* Closing connection 0

curl: (18) transfer closed with 30786338 bytes remaining to read

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 5355 | 5355 (100.0%) | — |
| Time span, s | 574.294 | 574.294 | — |
| Average pps | 9.3 | 9.3 | — |
| Average packet size, B | 612 | 612 | — |
| Bytes | 3276361 | 3276361 (100.0%) | 0 |
| Average bytes/s | 5705 | 5705 | — |
| Average bits/s | 45 k | 45 k | — |

Retransmitted Packets (429/5355) \* 100 = 8.01 %

**Port 4009**

4 32.0M 4 1448k 0 0 6361 0 1:27:55 0:03:53 1:24:02 1902\* transfer closed with 32068178 bytes remaining to read

4 32.0M 4 1451k 0 0 6362 0 1:27:54 0:03:53 1:24:01 2791

\* Closing connection 0

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 2807 | 2807 (100.0%) | — |
| Time span, s | 243.636 | 243.636 | — |
| Average pps | 11.5 | 11.5 | — |
| Average packet size, B | 622 | 622 | — |
| Bytes | 1745786 | 1745786 (100.0%) | 0 |
| Average bytes/s | 7165 | 7165 | — |
| Average bits/s | 57 k | 57 k | — |

Retransmitted Packets (303/2807) \* 100 = 10.79 %

**Port 4010**

0 32.0M 0 185k 0 0 1022 0 9:07:12 0:03:05 9:04:07 0\* Recv failure: Connection reset by peer

0 32.0M 0 185k 0 0 1021 0 9:07:44 0:03:05 9:04:39 0

\* Closing connection 0

curl: (56) Recv failure: Connection reset by peer

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 901 | 901 (100.0%) | — |
| Time span, s | 203.699 | 203.699 | — |
| Average pps | 4.4 | 4.4 | — |
| Average packet size, B | 433 | 433 | — |
| Bytes | 390474 | 390474 (100.0%) | 0 |
| Average bytes/s | 1916 | 1916 | — |
| Average bits/s | 15 k | 15 k | — |

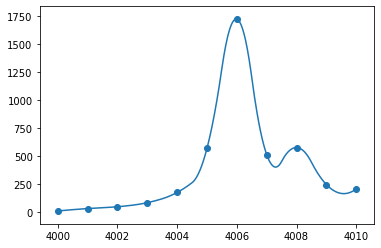
Retransmitted Packets (134/901) \* 100 = 14.87 %

**Conclusion for Part 2**

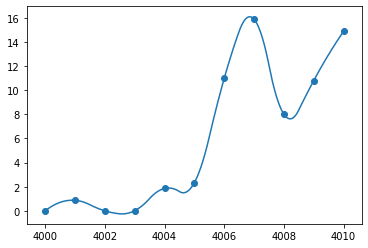
I mentioned that in conclusion for part 1 that there were a lot of retransmission as the port number increased. And the graph above supports that claim because the port number on the

x-axis and the time on the y-axis indicates that the time taken to download the file increases as the port number increases which means which means that the packet loss got greater and greater with each port and after port 4006, the connection kept getting timed out which is why the time reduced meaning that the packet loss was very high on port 4007, 4008, 4009, 4010.

The graph below shows the time (s) on the y-axis and the port number on the x-axis.

****

The graph below shows all the retransmission percentages (y-axis) against the port number (x-axis). This means that as the port number increases the percentage of packets that are retransmitted gets high which supports the claim of Dr Ian Batten that there is an increase in packet loss as we increase the port number of the website we are analysing.



**Part 3**

**Port 4011**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 33534 | 33534 (100.0%) | — |
| Time span, s | 6.816 | 6.816 | — |
| Average pps | 4919.6 | 4919.6 | — |
| Average packet size, B | 1068 | 1068 | — |
| Bytes | 35799522 | 35799522 (100.0%) | 0 |
| Average bytes/s | 5251 k | 5251 k | — |
| Average bits/s | 42 M | 42 M | — |

Retransmitted Packets (2/33534) \* 100 = 0.006 %

**Port 4012**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 32414 | 32414 (100.0%) | — |
| Time span, s | 5.440 | 5.440 | — |
| Average pps | 5958.6 | 5958.6 | — |
| Average packet size, B | 1101 | 1101 | — |
| Bytes | 35696577 | 35696577 (100.0%) | 0 |
| Average bytes/s | 6562 k | 6562 k | — |
| Average bits/s | 52 M | 52 M | — |

Retransmitted Packets (4/32414) \* 100 = 0.01 %

**Port 4013**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 33351 | 33351 (100.0%) | — |
| Time span, s | 5.264 | 5.264 | — |
| Average pps | 6336.1 | 6336.1 | — |
| Average packet size, B | 1072 | 1072 | — |
| Bytes | 35762399 | 35762399 (100.0%) | 0 |
| Average bytes/s | 6794 k | 6794 k | — |
| Average bits/s | 54 M | 54 M | — |

Retransmitted Packets (1/33351) \* 100 = 0.003 %

**Port 4014**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 32306 | 32306 (100.0%) | — |
| Time span, s | 5.524 | 5.524 | — |
| Average pps | 5848.1 | 5848.1 | — |
| Average packet size, B | 1105 | 1105 | — |
| Bytes | 35689456 | 35689456 (100.0%) | 0 |
| Average bytes/s | 6460 k | 6460 k | — |
| Average bits/s | 51 M | 51 M | — |

Retransmitted Packets (3/32306) \* 100 = 0.009 %

**Port 4015**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 31936 | 31936 (100.0%) | — |
| Time span, s | 6.404 | 6.404 | — |
| Average pps | 4986.8 | 4986.8 | — |
| Average packet size, B | 1117 | 1117 | — |
| Bytes | 35663590 | 35663590 (100.0%) | 0 |
| Average bytes/s | 5568 k | 5568 k | — |
| Average bits/s | 44 M | 44 M | — |

Retransmitted Packets (4/31936) \* 100 = 0.01 %

**Port 4016**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 31136 | 31136 (100.0%) | — |
| Time span, s | 5.764 | 5.764 | — |
| Average pps | 5402.0 | 5402.0 | — |
| Average packet size, B | 1144 | 1144 | — |
| Bytes | 35610718 | 35610718 (100.0%) | 0 |
| Average bytes/s | 6178 k | 6178 k | — |
| Average bits/s | 49 M | 49 M | — |

Retransmitted Packets (3/31136) \* 100 = 0.01 %

**Port 4017**

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 31187 | 31187 (100.0%) | — |
| Time span, s | 5.061 | 5.061 | — |
| Average pps | 6162.5 | 6162.5 | — |
| Average packet size, B | 1142 | 1142 | — |
| Bytes | 35618333 | 35618333 (100.0%) | 0 |
| Average bytes/s | 7038 k | 7038 k | — |
| Average bits/s | 56 M | 56 M | — |

Retransmitted Packets (10/31187) \* 100 = 0.03 %

**Port 4018**

0 32.0M 0 14754 0 0 25 0 15d 12h 0:09:31 15d 12h 0\* Recv failure: Connection reset by peer

0 32.0M 0 14754 0 0 25 0 15d 12h 0:09:32 15d 12h 0

\* Closing connection 0

curl: (56) Recv failure: Connection reset by peer

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 99281 | 99281 (100.0%) | — |
| Time span, s | 587.144 | 587.144 | — |
| Average pps | 169.1 | 169.1 | — |
| Average packet size, B | 729 | 729 | — |
| Bytes | 72329222 | 72329222 (100.0%) | 0 |
| Average bytes/s | 123 k | 123 k | — |
| Average bits/s | 985 k | 985 k | — |

Retransmitted Packets (206/99281) \* 100 = 0.21 %

**Port 4019**

0 0 0 0 0 0 0 0 --:--:-- 0:01:26 --:--:-- 0\* Recv failure: Connection reset by peer

0 0 0 0 0 0 0 0 --:--:-- 0:01:26 --:--:-- 0

\* Closing connection 0

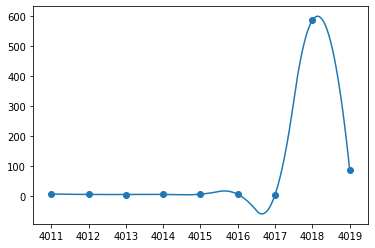
curl: (56) Recv failure: Connection reset by peer

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement | Captured | Displayed | Marked |
| Packets | 732 | 732 (100.0%) | — |
| Time span, s | 86.426 | 86.426 | — |
| Average pps | 8.5 | 8.5 | — |
| Average packet size, B | 430 | 430 | — |
| Bytes | 314640 | 314640 (100.0%) | 0 |
| Average bytes/s | 3640 | 3640 | — |
| Average bits/s | 29 k | 29 k | — |

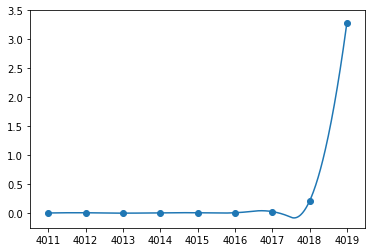
Retransmitted Packets (24/732) \* 100 = 3.28 %

**Conclusion for Part 3**

Below, the time (s) is shown on the y-axis against the port number on the y-axis. The one thing to notice here is that the packet loss is not too much here because I didn’t see much duplicate acknowledgements for this and the time to download the files was very small from port 4011 to port 4017. At port 4018, there was high packet loss and on port 4019, the packet loss and duplicate acknowledgements were so high that the connection was timed out or either reset by the peer. Dr Ian Batten mentioned in the assignment that the packet loss would get higher from port 4011 to 2019 but he also mentioned that this also depends on the network of the client.



Below, the retransmission percentage (y-axis) is shown against the port number (x-axis). Notice here that the percentage of the packets that are retransmitted is almost constant from ports 4011 to port 4018 and there is a sudden intense increase in the retransmission percentage on port 4019.

****

**Ending Note**

We can’t exactly know how many packets got lost or trace them but we can find out if there is high packet loss.

