Lab 2 Report

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1 Reliable Transport

I implemented reliable transport by using a sliding window. Packets were sent sequentially from n1 to n2, but were only allowed to be sent if they fell within the scope of the window. Node n1 kept track of how many packets it had sent. As soon as n2 properly received a packet and notified n1 by sending an ACK, n1 would then allow the next packet to be sent (sliding the window up by one packet size). (all trace statements omitted in these code snippets)

```
def send_if_possible(self):
  if not self.send_buffer:
    return
  if self.unacked_packet_count * 1000 >= self.window_size:
    return
  packet = self.send_one_packet(self.sequence)
  self.increment_sequence(packet.length)
  self.unacked_packet_count += 1
```

The sending node (n1 in our case) handled ACKs from the receiving node (n2), making sure to reset the timer every time. It would increase it's ACK number whenever it received a new ACK.

```
def handle_ack(self, packet):
  self.unacked_packet_count -= ((packet.ack_number - self.received_ack_number) /
                                self.mss)
  self.cancel_timer()
  self.timer = Sim.scheduler.add(
                 delay=self.timeout, event='new_ack_data', handler=self.retransmit)
  self.received_ack_number = packet.ack_number
  self.send_if_possible()
```

The receiving node (n2) handled packets from the sending node (n1), adding the data it received to a receieve buffer. It would then calculate a cumulative ACK of the highest sequence number it had recieved in order and send that ACK to the sending node.

```
def handle_sequence(self, packet):
  ReliableTransport.stats.add(packet.queueing_delay)
  self.received_sequences.add(packet.sequence)
  self.receive_buffer.append(packet)

  # cumulative ack
  sequence_list = sorted(self.received_sequences)
  for i in range(self.ack/self.mss, len(sequence_list)):
    if sequence_list[i] == self.ack:
      tempPacket = [p for p in self.receive_buffer if p.sequence == self.ack][0]
      self.increment_ack(tempPacket.sequence + tempPacket.length)
      self.app.handle_packet(tempPacket)

```

```
  self.send_ack()
```

The sending node (n1) retransmitted the earliest/lowest (sequentially) packet whenever the timer fired.

```
def retransmit(self,event):
  if self.received_ack_number < len(self.send_buffer):
    packet = self.send_one_packet(self.received_ack_number)
    self.timer = Sim.scheduler.add(delay=self.timeout, event='retransmit',
                                   handler=self.retransmit)
```

As noted in the tables below, average queueing delay increased and throughput decreased as loss rate increased.

Testing Results - test.txt

Loss Rate	Bandwidth	Propagation Delay	Window Size	Average Queueing Delay	Throughput
0%	10 Mbps	10 ms	3000 bytes	0.000024 sec	74052.13 bits/sec
10%	10 Mbps	10 ms	3000 bytes	0.000024 sec	38086.53 bits/sec
20%	10 Mbps	10 ms	3000 bytes	0.000024 sec	19509.53 bits/sec
50%	10 Mbps	10 ms	3000 bytes	0.00000421 sec	3780.60 bits/sec

Testing Results - internet-architecture.pdf

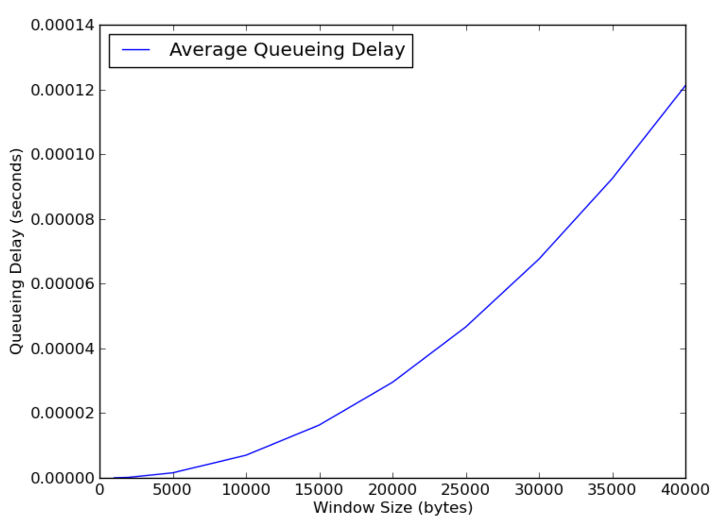
Loss Rate	Bandwidth	Propagation Delay	Window Size	Average Queueing Delay	Throughput
0%	10 Mbps	10 ms	10000 bytes	0.000006990 sec	2013341.93 bits/sec
10%	10 Mbps	10 ms	10000 bytes	0.000006239 sec	27651.27 bits/sec
20%	10 Mbps	10 ms	10000 bytes	0.000004410 sec	13102.93 bits/sec
50%	10 Mbps	10 ms	10000 bytes	0.0000002381 sec	2645.07 bits/sec

I did not implement a dynamic retransmission timer.

2 Experiments

I experimented with window size by sending the same file (internet-architecture.pdf) over a link with a 10 Mbps bandwidth, 10 ms propagation delay, and 0% loss rate. I varied the window size and graphed the throughput and average queueing delay for each window size.

As the window size increases, the average queueing delay of packets increases exponentially.



As the window size increases, link throughput increases logarithmically.