CAS CS 655 Introduction to Networks
Programming Assignment 2: Implementing a Reliable Transport Protocol

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1 Overview

The general goal will be writing the sending and receiving transport-level code for implementing the Selective Repeat and the Go-Back-N reliable data transfer protocol. Specifically, the procedures in this simulator are for the sending entity (A) and the receiving entity (B). Only unidirectional transfer of data (from A to B) is required. Of course, the B-side will have to send packets to A to acknowledge receipt of data. And Meanwhile we will calculate some statistics to analyze the performance of our implementation.

2 Design:

2.1 Go Back N

I left many unused variables and methods that are used for implementing rdt1.0 - rdt3.0, please ignore them when you see on the source code.

(1) Design

Global Variable(constants):

public static final String DATA_EMPTY = ""; // constant, used for receiver sending back ACK to sender.Filled with “”.

public static final int ACK_NOT_USED =-2; // constant, used for sender sending message to receiver, filled with -2, which is an impossible ACK number for normal ACKs.

public static final int ACK_ACKed =-6; // I saved the ACKed sequence number in variable seq instead to make it the same as sender’s sending format. So ack number will be a negative constant, showing that this is an ACK packet and the status is ACKed.

private Packet packetBuffer; //used in receiver, saving the last Acked packet.

private Packet[] packetBufferAry; // used in sender, saving all the packets in the window

private int[] isAckedWindow = new int[5]; // used in SACK

private ArrayList<Message> messageCongestionBuffer = new ArrayList<Message>(); //a buffer for saving message coming from Application layer, aOutput will take message from this buffer and send it to the receiver if available.

private int window_base; // base for GBN

private int next_seq_num; //nextseqnum for GBN

private int expected_seq_num; //expectedseqnum for GBN

(2) Methods:

protected boolean isCorrupted(Packet packet) // get seq, ack, data from packet, run makeCheckSum(…) function to get the compared checksum and compare it with checksum with the packet.

protected int makeCheckSum(int seqNum,int ackNum, String data) // add seqNum, ackNum and data(turn it into ASCII integers) to the checksum.

protected void aOutput(Message message) //rdt_send in FSM, send the received packet from Application layer, save it into the buffer, then check
if(next_seq_num<window_base+WindowSize),
get the first message in the message buffer, and make it into packet(where sequence number = next_seq_num % LimitSeqNo; ack = ACK_NOT_USED), send it to the layer 3. If (next_seq_num==window_base), start timer, update next_seq_num. If the window is full, do nothing.

protected void aInput(Packet packet) //if the received is corrupted, do nothing, otherwise, update window_base according to the sequence number saved in the packet.(I used variable seq to note the ACK number, which is the sequence number of the received packet from receiver side). And then, since the window is at least one slot available, the function will check the message buffer to see if there's any unsend message, if so, send the first one in the buffer and update next_seq_num. In the end, check window_base if it equals to next_seq_num, if so, stoptimer(…) since all available packet(at least for now) is sent. If not, refresh the timer by stop and start the time again.

protected void aTimerInterrupt() //if time out, resend all the available packet saved in the packetBufferAry.

protected void aInit() //Initialize packetBufferAry, window_base and next_seq_num.

protected void bInput(Packet packet) // check if the packet is corrupted and if it is the sequence number that equals to expected_seq_num. If not, send the packet saved in packetBuffer, which is the last packet Acked. If so, get payload from the packet and send to the Application layer. And then, create a ACK packet(whose ack number is ACK_ACKed, as the Acked packet number is saved in variable seq) with DATA_EMPTY to the sender.

protected void bInit() //initialize SACK, expected_seq_num, packetBuffer

2.2 Selective Repeat:

The sender (A) receives a call from Layer5 and attempts to hand the message off to Layer3. First, a packet is constructed with the proper sequence number, checksum, and payload. The ACK number does not matter for the sender. The sequence number is calculated by a function named updateSeq, which is meant to keep updata of the current sequence number for the current message for A. The checksum is calculated with a function that takes in all of the packet information, turns everything into an integer, and then sums it up. Once the packet is created, A will check to see if there is room in the window to send the packet. If not, A will add the packet to a buffer. The buffer is a linked list of packets with no size limit. This could potentially be bad if millions of messages are being sent because the buffer could grow exponentially and take up a lot of space. But for this assignment I felt a size limit did not matter. If A is able to put the packet in the window, it adds it to a queue of outstanding packets and, if the timer was already running, stops the timer. Then starts the timer and sends the message.

The receiver (B) receives a packets when it gets a message from layer 3. First, B checks to see if the packet is corrupt. This is done with a function that takes a packet and makes sure the checksum is valid for the contents of the packet. If the message is corrupt, then B will do nothing and trigger a timeout on A's side. The downside of this is that A will continue to send messages in the window that B will ignore. However, with a corrupt packet it is hard to tell what this packet should have been, thus any NACK would be hard to create. If the packet is not corrupt, then B will check to see if it is the correct in order packet. To do so, B keeps track of the sequence number he is expecting in a variable called 'seqExpected'. If the packet seq number does not match this number, then B will retransmit an ACK for the last received in order packet. B will continue to do this for any other packets that arrive out of order as well and does not just wait for A's retransmission. The downside to this is that B will send a lot of cumulative ACKS to show that he has received an out of order packet.

However, it is easier for B to just continue reACKing until the correct packet is received. For this assignment, I feel it does not make a huge impact. Once B receives the correct message, he will send an ACK for the message to B.

A will then look for an ACK. As long as the ACK isn't the same as the last ACK he received, he will dequeue packets from the outstanding packets queue until he has found the Acked packet. If the ACK is the same as the last acked packet, then he knows to retransmit the outstanding packets.

If A ever gets a timeout event, he will retransmit all outstanding packets to B and start the timer again. He will then start looking for ACKS from B.

2.2 Functions:

checkSum(packet) --where packet is a structure of type pkt. I implemented a TCP-like checksum, which consists of the sum of the (integer) sequence and ACK field values, added to a character-by-character sum of the payload field of the packet.

updateSeq(int) --update the sequence number in window, if the incremented number exceeded window size, start over.

averageRTT() --compute the average RTT at the end of the statistics.

aOutput(message) --where message is a structure of type msg, containing data to be sent to the B-side. This routine will be called whenever the upper layer at the sending side (A) has a message to send. It firstly created packet and do the checksumming, then make the call to layer3.

aInput(packet) -- In SR, even if it receives a valid ack, it cannot let the window move on, since the ack is selected. It has to wait.

aTimerInterrupt() --This routine will be called when A's timer expires. It can re-transmit the packet by implementing a iterative traverse through the window

aInit() --Initialization of side A.

bInput(packet) --where packet is a structure of type pkt. This routine will be called whenever a packet sent from the A-side arrives at the B-side. packet is the (possibly corrupted) packet sent from the A-side. The structure is similar with aInput(packet). It also has a call to layer 5.

bInit() --Initialization of side B.

2.3 compilation instructions

```
javac Project.java
```

2.4 Fine State Machine

2.4.1 Selective Repeat:

- Initialize
- When data arrives from app, if the next sequence number is within window, send packet, start timer for this packet, and increment next sequence number.
- If timer for some packet expires, resend that packet (Hence selective), restart timer.
- If some packet is ACKed , mark it as ACKed and advance sendbase to next unACKed sent packet.

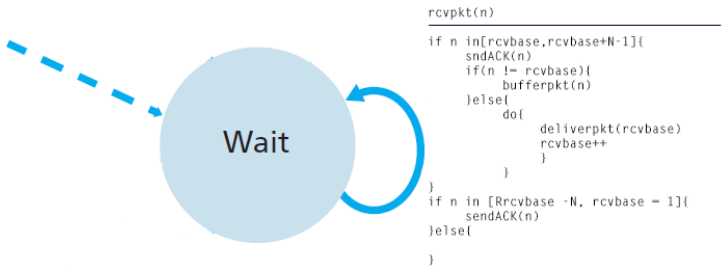

Figure 1 Receiver Side of SR

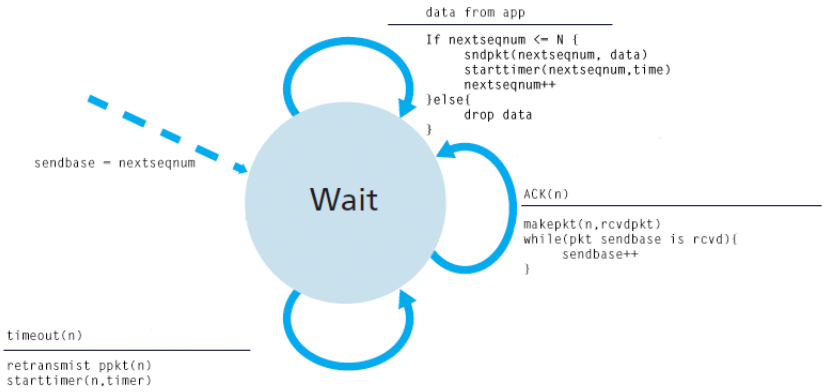

Figure 2 Sender Side of SR

3. Statistics

3.1 Working Efficiency:

(1) works for no loss and no corruption

```
-- * Network Simulator v1.0 * --
Enter number of messages to simulate (> 0): [10] 10
Enter packet loss probability (0.0 for no loss): [0.0] 0
Enter packet corruption probability (0.0 for no corruption): [0.0] 0
Enter average time between messages from sender's layer 5 (> 0.0): [1000] 10
Enter window size (> 0): [8] 8
Enter retransmission timeout (>0.0) [15.0] 10
Enter trace level (>= 0): [0] 3
Enter random seed: [0] 12
```

Result:

```
==============STATISTICS=======================
Number of original packets transmitted by A:10
Number of retransmissions by A:8
Number of data packets delivered to layer 5 at B:10
Number of ACK packets sent by B:10
Number of corrupted packets:0
Ratio of lost packets:0.0
Ratio of corrupted packets:0.0
Average RTT:30.86686300241096
```

(2) works for loss and no corruption

```
-- * Network Simulator v1.0 * --
Enter number of messages to simulate (> 0): [10] 10
Enter packet loss probability (0.0 for no loss): [0.0] 0.2
Enter packet corruption probability (0.0 for no corruption): [0.0] 0
Enter average time between messages from sender's layer 5 (> 0.0): [1000] 10
Enter window size (> 0): [8] 8
Enter retransmission timeout (>0.0) [15.0] 10
Enter trace level (>= 0): [0] 3
Enter random seed: [0] 12
```

Result:

```
==============STATISTICS=======================
Number of original packets transmitted by A:10
Number of retransmissions by A:21
Number of data packets delivered to layer 5 at B:5
Number of ACK packets sent by B:5
Number of corrupted packets:0
Ratio of lost packets:0.5161290322580645
Ratio of corrupted packets:0.0
Average RTT:37.18406323435164
```

(3) works for corruption and no loss

```
-- * Network Simulator v1.0 * --
Enter number of messages to simulate (> 0): [10] 10
Enter packet loss probability (0.0 for no loss): [0.0] 0
Enter packet corruption probability (0.0 for no corruption): [0.0] 0.2
Enter average time between messages from sender's layer 5 (> 0.0): [1000] 10
Enter window size (> 0): [8] 8
Enter retransmission timeout (>0.0) [15.0] 10
Enter trace level (>= 0): [0] 3
Enter random seed: [0] 12
```

Result:

```
==============STATISTICS=======================
Number of original packets transmitted by A:10
Number of retransmissions by A:15
Number of data packets delivered to layer 5 at B:8
Number of ACK packets sent by B:8
Number of corrupted packets:4
Ratio of lost packets:0.36
Ratio of corrupted packets:0.25
Average RTT:21.891266910524088
```

(4) works for both loss and corruption

3.2 Statistical Graph

3.2.1 Selective Repeat:

Parameter Setting: number of messages = 1000, window size = 8, a retransmission timeout = 20, a random seed = 34, a loss probability = 0.1 ~ 0.9, a corruption probability = 0.1 ~ 0.9, a trace level = 3, and a mean time between arrivals = 20.

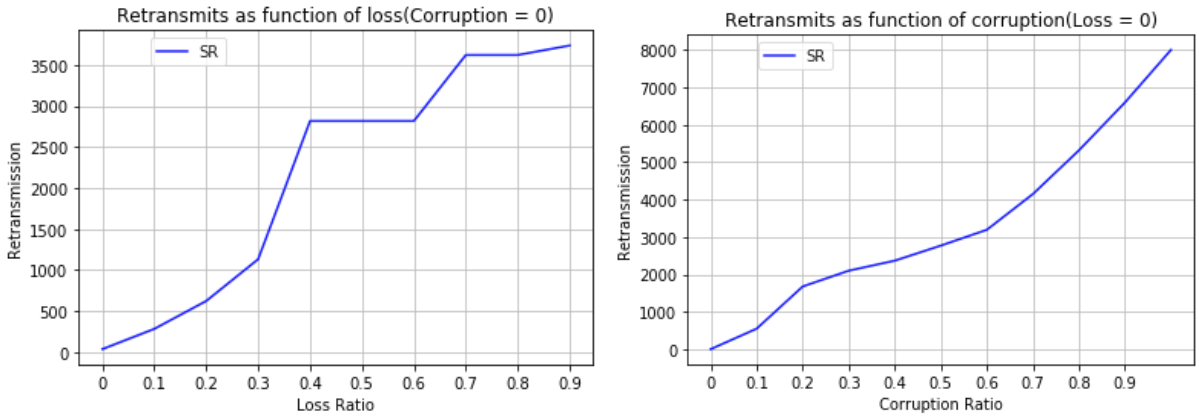

Figure 3 Retransmits as fuction for Loss and Corruption

The number of retransmits is increasing following within the raising of loss ratio(with no corruption) or corruption ratio(with no loss).

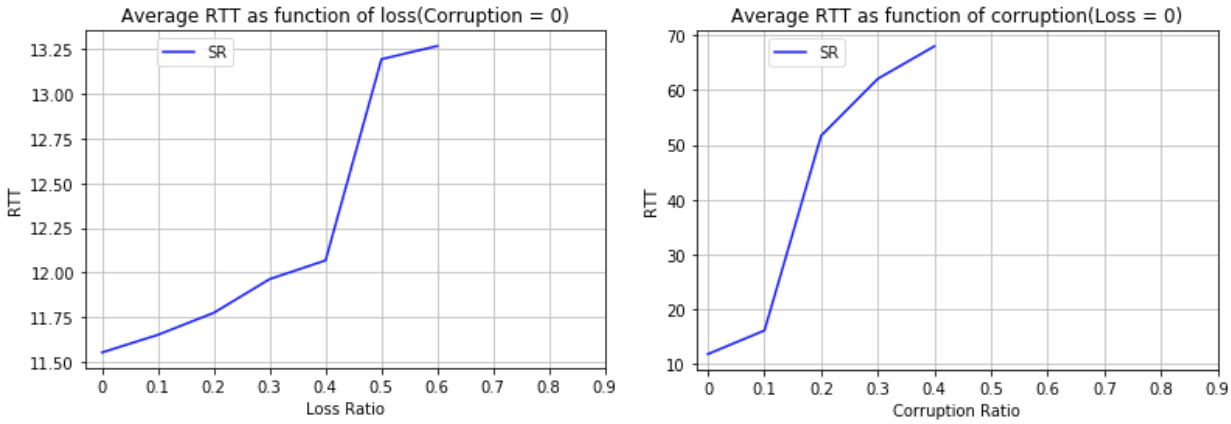

Figure 4 Aver-RTT as Function for Loss and Corruption

Infinite RTT is observed after setting loss ratio over 0.4, since the quantity of retransimission is increased rapidly, which cause the the communication between sender and receiver become extremely un-efficient.

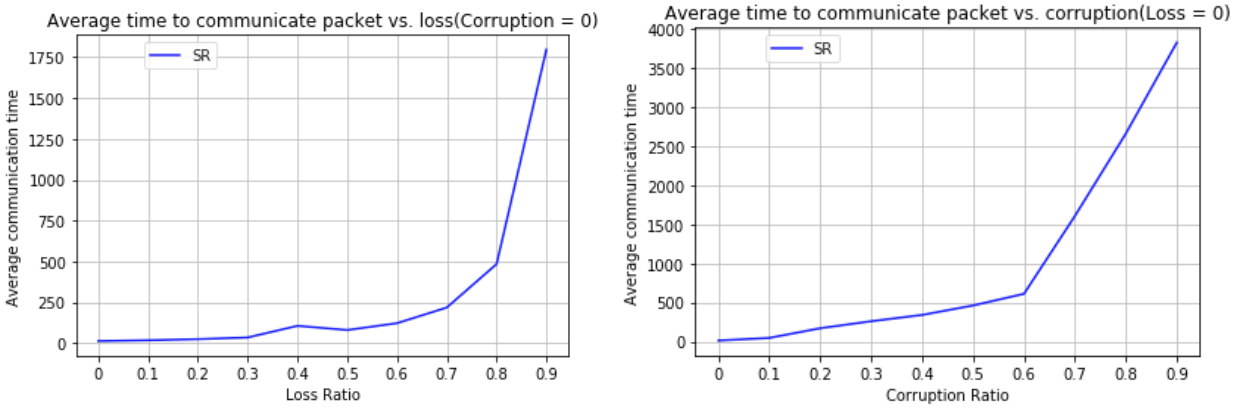

Figure 5 Average time to communicate packet as a function of Loss and Corruption

Average time to communicate packet is increasing when increasing the ratio of loss or corruption.

3.2.2 SR vs GBN

Parameter Setting: number of messages = 1000, window size = 8, a retransmission timeout = 20, a random seed = 34, a loss probability = 0.1 ~ 0.9, a corruption probability = 0.1 ~ 0.9, a trace level = 3, and a mean time between arrivals = 20.

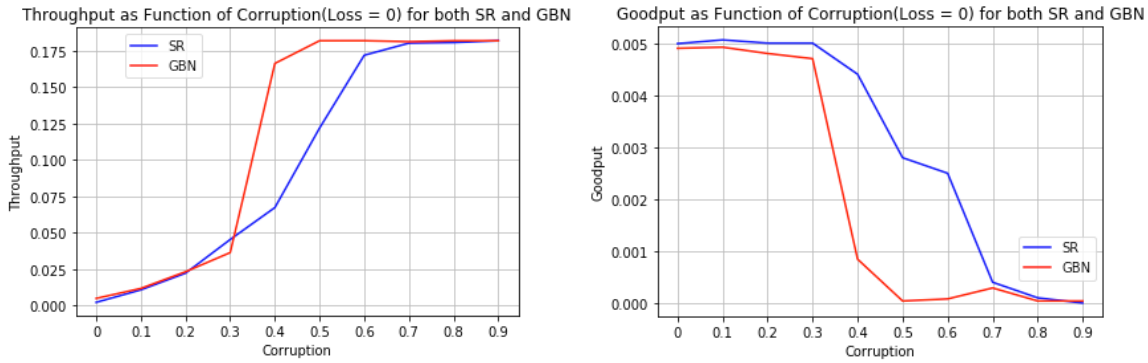

Figure 6 Throughput and Goodput calculation for zero-loss

When corruption ratio is increasing, the throughput increased rapidly for both GBN and SR. Meanwhile, the goodput performance of SR seems better than GBN.

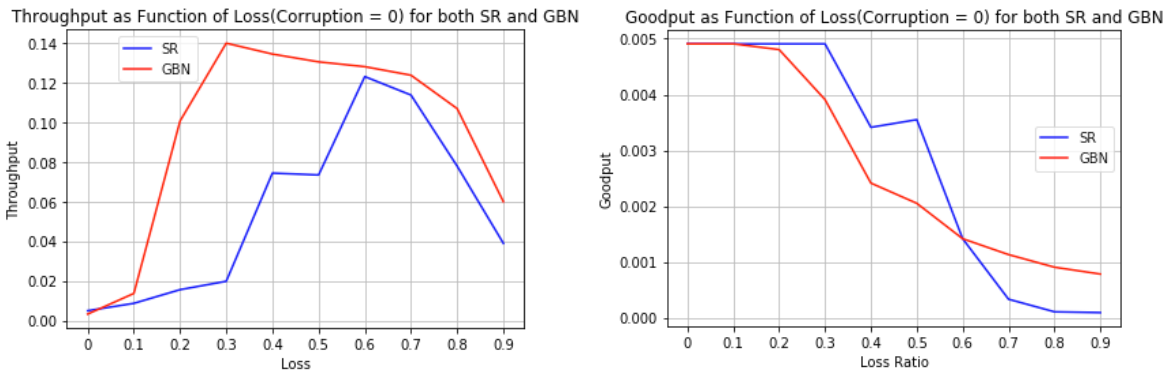

Figure 7 Throughput and Goodput calculation for zero-corruption

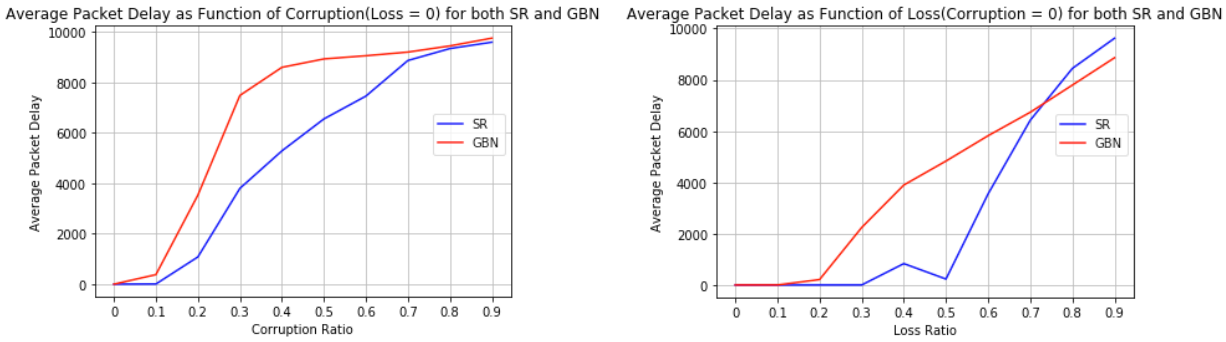

Figure 8 Average Packet Delay as a function for Loss and Corruption

5 Sample Output Trace

5.1 Go Back N

(1) Case 1:

-- * Network Simulator v1.0 * --
Enter number of messages to simulate (> 0): [10] 30
Enter packet loss probability (0.0 for no loss): [0.0] 0.2
Enter packet corruption probability (0.0 for no corruption): [0.0] 0.2
Enter average time between messages from sender's layer 5 (> 0.0): [1000] 1000
Enter window size (> 0): [8] 8
Enter retransmission timeout (>0.0) [15.0] 15
Enter trace level (>= 0): [0] 3
Enter random seed: [0] 1234
|aInit| : window_base: 0
|aInit| : next_seq_num: 0
|bInit| : expected_seq_num is: 0.
|bInit| : packet with seq number:-1 is stored in Buffer
generateNextArrival(): called
generateNextArrival(): time is 0.0
generateNextArrival(): future time for event 1 at entity 0 will be 217.16971343119602

EVENT time: 217.16971343119602 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 217.16971343119602
generateNextArrival(): future time for event 1 at entity 0 will be 336.802270577105
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:0 is made
toLayer3: seqnum: 0 acknum: -2 checksum: 1938 payload: aaaaaaaaaaaaaaaaaaaa
toLayer3: scheduling arrival on other side
|aOutput| : packet with seq number:0 is sent
startTimer: starting timer at 217.16971343119602
|aOutput| : timer is started
|aOutput| : next_seq_num now becomes: 1.

```
EVENT time: 219.39637440107424  type: 2  entity: 1
|bInput| : packet 0is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:0 is stored in Buffer
toLayer3: seqnum: 0  acknum: -6  checksum: -6  payload:
toLayer3: scheduling arrival on other side
|bInput| : packet with seq number:0 is sent
|bInput| : expected_seq_num becomes: 1.

EVENT time: 221.30524613177892  type: 2  entity: 0
|aInput| : packet0is received without corruption.
|aInput| : window_base becomes: 1.
|aInput| : timer is stopped
stopTimer: stopping timer at 221.30524613177892

EVENT time: 336.802270577105  type: 1  entity: 0
generateNextArrival(): called
generateNextArrival(): time is 336.802270577105
generateNextArrival(): future time for event 1 at entity 0 will be 416.57765434736166
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:1 is made
toLayer3: seqnum: 1  acknum: -2  checksum: 1959  payload: bbbbbbbbbbbbbbbbbbbb
toLayer3: packet being lost
|aOutput| : packet with seq number:1 is sent
startTimer: starting timer at 336.802270577105
|aOutput| : timer is started
|aOutput| : next_seq_num now becomes: 2.

EVENT time: 351.802270577105  type: 0  entity: 0
|aTimerInterrupt| : time out.
startTimer: starting timer at 351.802270577105
|aTimerInterrupt| : timer is started
|aTimerInterrupt| : packet with seq number:1 is resent.
toLayer3: seqnum: 1  acknum: -2  checksum: 1959  payload: bbbbbbbbbbbbbbbbbbbb
toLayer3: packet being corrupted
toLayer3: scheduling arrival on other side
```

(2) Case 2:

```
-- * Network Simulator v1.0 * --
Enter number of messages to simulate (> 0): [10] 30
Enter packet loss probability (0.0 for no loss): [0.0] 0.25
Enter packet corruption probability (0.0 for no corruption): [0.0] 0.25
Enter average time between messages from sender's layer 5 (> 0.0): [1000] 10
Enter window size (> 0): [8] 8
Enter retransmission timeout (>0.0) [15.0] 15
Enter trace level (>= 0): [0] 1
Enter random seed: [0] 1234
|aInit| : window_base: 0
|aInit| : next_seq_num: 0
```

|bInit| : expected_seq_num is: 0.
|bInit| : packet with seq number:-1 is stored in Buffer
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:0 is made
|aOutput| : packet with seq number:0 is sent
|aOutput| : timer is started
|aOutput| : next_seq_num now becomes: 1.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:1 is made
|aOutput| : packet with seq number:1 is sent
|aOutput| : next_seq_num now becomes: 2.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:2 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:2 is sent
|aOutput| : next_seq_num now becomes: 3.
|bInput| : packet 0is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:0 is stored in Buffer
toLayer3: packet being lost
|bInput| : packet with seq number:0 is sent
|bInput| : expected_seq_num becomes: 1.
|bInput| : packet 1is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:1 is stored in Buffer
toLayer3: packet being corrupted
|bInput| : packet with seq number:1 is sent
|bInput| : expected_seq_num becomes: 2.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:3 is made
|aOutput| : packet with seq number:3 is sent
|aOutput| : next_seq_num now becomes: 4.
packet is not correct or corrupted, sent ACK 1 back to sender
toLayer3: packet being lost
|bInput| : packet with seq number:1 is sent
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aTimerInterrupt| : packet with seq number:0 is resent.
toLayer3: packet being lost
|aTimerInterrupt| : packet with seq number:1 is resent.
toLayer3: packet being corrupted
|aTimerInterrupt| : packet with seq number:2 is resent.
|aTimerInterrupt| : packet with seq number:3 is resent.
packet is not correct or corrupted, sent ACK 1 back to sender
|bInput| : packet with seq number:1 is sent
|bInput| : packet 2is received correctly.

Packet 2 sending is lost

|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:2 is stored in Buffer
toLayer3: packet being lost
|bInput| : packet with seq number:2 is sent
|bInput| : expected_seq_num becomes: 3.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:4 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:4 is sent
|aOutput| : next_seq_num now becomes: 5.
|bInput| : packet 3is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:3 is stored in Buffer
|bInput| : packet with seq number:3 is sent
|bInput| : expected_seq_num becomes: 4.
|aInput| : packet1is received without corruption.
|aInput| : window_base: 0
|aInput| : next sequence number: 2
|aInput| : offset: 2
|aInput| : window_base becomes: 2.
|aInput| : timer is restarted
|aInput| : packet3is received without corruption.
|aInput| : window_base: 2
|aInput| : next sequence number: 4
|aInput| : offset: 2
|aInput| : window_base becomes: 4.
|aInput| : timer is restarted
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:5 is made
toLayer3: packet being corrupted
|aOutput| : packet with seq number:5 is sent
|aOutput| : next_seq_num now becomes: 6.
packet is not correct or corrupted, sent ACK 3 back to sender
|bInput| : packet with seq number:3 is sent
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aTimerInterrupt| : packet with seq number:4 is resent.
|aTimerInterrupt| : packet with seq number:5 is resent.
|bInput| : packet 4is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:4 is stored in Buffer
toLayer3: packet being corrupted
|bInput| : packet with seq number:4 is sent
|bInput| : expected_seq_num becomes: 5.
|aInput| : packet3is received without corruption.
|aInput| : window_base becomes: 4.
|aInput| : timer is restarted
|bInput| : packet 5is received correctly.

The sender wait for ACK2, but packet 2 is lost, now sender receives ACK3, so it forwards two steps further.

Packet 3 ACK is received twice.

|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:5 is stored in Buffer
toLayer3: packet being corrupted
|bInput| : packet with seq number:5 is sent
|bInput| : expected_seq_num becomes: 6.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:6 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:6 is sent
|aOutput| : next_seq_num now becomes: 7.
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aTimerInterrupt| : packet with seq number:4 is resent.
|aTimerInterrupt| : packet with seq number:5 is resent.
toLayer3: packet being corrupted
|aTimerInterrupt| : packet with seq number:6 is resent.
toLayer3: packet being corrupted
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:7 is made
toLayer3: packet being corrupted
|aOutput| : packet with seq number:7 is sent
|aOutput| : next_seq_num now becomes: 8.
packet is not correct or corrupted, sent ACK 5 back to sender
toLayer3: packet being lost
|bInput| : packet with seq number:5 is sent
packet is not correct or corrupted, sent ACK 5 back to sender
|bInput| : packet with seq number:5 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:8 is made
|aOutput| : packet with seq number:8 is sent
|aOutput| : next_seq_num now becomes: 9.
packet is not correct or corrupted, sent ACK 5 back to sender
|bInput| : packet with seq number:5 is sent
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aTimerInterrupt| : packet with seq number:4 is resent.
toLayer3: packet being lost
|aTimerInterrupt| : packet with seq number:5 is resent.
|aTimerInterrupt| : packet with seq number:6 is resent.
|aTimerInterrupt| : packet with seq number:7 is resent.
|aTimerInterrupt| : packet with seq number:8 is resent.
|aInput| : packet5is received without corruption.
|aInput| : window_base: 4
|aInput| : next sequence number: 6
|aInput| : offset: 2
|aInput| : window_base becomes: 6.
|aInput| : timer is restarted

Packet 5 ACK is corrupted

aTimerInterrupt will re-send packet 4-6 to receiver.

ACK 5 is lost

Received ACK5 and forward by two steps.

|aInput| : packet5is received without corruption.
|aInput| : window_base becomes: 6.
|aInput| : timer is restarted
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:9 is made
|aOutput| : packet with seq number:9 is sent
|aOutput| : next_seq_num now becomes: 10.
packet is not correct or corrupted, sent ACK 5 back to sender
|bInput| : packet with seq number:5 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:10 is made
toLayer3: packet being corrupted
|aOutput| : packet with seq number:10 is sent
|aOutput| : next_seq_num now becomes: 11.
packet is not correct or corrupted, sent ACK 5 back to sender
|bInput| : packet with seq number:5 is sent
|aInput| : packet5is received without corruption.
|aInput| : window_base becomes: 6.
|aInput| : timer is restarted
|aInput| : packet5is received without corruption.
|aInput| : window_base becomes: 6.
|aInput| : timer is restarted
packet is not correct or corrupted, sent ACK 5 back to sender
toLayer3: packet being lost
|bInput| : packet with seq number:5 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:11 is made
|aOutput| : packet with seq number:11 is sent
|aOutput| : next_seq_num now becomes: 12.
|bInput| : packet 6is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:6 is stored in Buffer
toLayer3: packet being lost
|bInput| : packet with seq number:6 is sent
|bInput| : expected_seq_num becomes: 7.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:12 is made
|aOutput| : packet with seq number:12 is sent
|aOutput| : next_seq_num now becomes: 13.
|bInput| : packet 7is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:7 is stored in Buffer
|bInput| : packet with seq number:7 is sent
|bInput| : expected_seq_num becomes: 8.
|aInput| : packet7is received without corruption.
|aInput| : window_base: 6

|aInput| : next sequence number: 8
|aInput| : offset: 2
|aInput| : window_base becomes: 8.
|aInput| : timer is restarted
|bInput| : packet 8is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:8 is stored in Buffer
toLayer3: packet being lost
|bInput| : packet with seq number:8 is sent
|bInput| : expected_seq_num becomes: 9.
|bInput| : packet 9is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:9 is stored in Buffer
|bInput| : packet with seq number:9 is sent
|bInput| : expected_seq_num becomes: 10.
packet is not correct or corrupted, sent ACK 9 back to sender
|bInput| : packet with seq number:9 is sent
|aInput| : packet9is received without corruption.
|aInput| : window_base: 8
|aInput| : next sequence number: 10
|aInput| : offset: 2
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:13 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:13 is sent
|aOutput| : next_seq_num now becomes: 14.
packet is not correct or corrupted, sent ACK 9 back to sender
toLayer3: packet being corrupted
|bInput| : packet with seq number:9 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:14 is made
|aOutput| : packet with seq number:14 is sent
|aOutput| : next_seq_num now becomes: 15.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:15 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:15 is sent
|aOutput| : next_seq_num now becomes: 0.
|aInput| : packet9is received without corruption.
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
packet is not correct or corrupted, sent ACK 9 back to sender
|bInput| : packet with seq number:9 is sent
packet is not correct or corrupted, sent ACK 9 back to sender
|bInput| : packet with seq number:9 is sent

|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:0 is made
|aOutput| : packet with seq number:0 is sent
|aOutput| : next_seq_num now becomes: 1.
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aInput| : packet9is received without corruption.
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
packet is not correct or corrupted, sent ACK 9 back to sender
toLayer3: packet being lost
|bInput| : packet with seq number:9 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:1 is made
|aOutput| : packet with seq number:1 is sent
|aOutput| : next_seq_num now becomes: 2.
|aInput| : packet9is received without corruption.
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
packet is not correct or corrupted, sent ACK 9 back to sender
|bInput| : packet with seq number:9 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:2 is made
|aOutput| : packet with seq number:2 is sent
|aOutput| : next_seq_num now becomes: 3.
|aInput| : packet9is received without corruption.
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:3 is made
|aOutput| : packet with seq number:3 is sent
|aOutput| : next_seq_num now becomes: 4.
packet is not correct or corrupted, sent ACK 9 back to sender
|bInput| : packet with seq number:9 is sent
|aInput| : packet9is received without corruption.
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:4 is made
|aOutput| : packet with seq number:4 is sent
|aOutput| : next_seq_num now becomes: 5.
packet is not correct or corrupted, sent ACK 9 back to sender
toLayer3: packet being corrupted
|bInput| : packet with seq number:9 is sent
packet is not correct or corrupted, sent ACK 9 back to sender

|bInput| : packet with seq number:9 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:5 is made
|aOutput| : packet with seq number:5 is sent
|aOutput| : next_seq_num now becomes: 6.
packet is not correct or corrupted, sent ACK 9 back to sender
toLayer3: packet being lost
|bInput| : packet with seq number:9 is sent
|aInput| : packet9is received without corruption.
|aInput| : window_base becomes: 10.
|aInput| : timer is restarted
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:6 is made
|aOutput| : packet with seq number:6 is sent
|aOutput| : next_seq_num now becomes: 7.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:7 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:7 is sent
|aOutput| : next_seq_num now becomes: 8.
packet is not correct or corrupted, sent ACK 9 back to sender
toLayer3: packet being lost
|bInput| : packet with seq number:9 is sent
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:8 is made
|aOutput| : packet with seq number:8 is sent
|aOutput| : next_seq_num now becomes: 9.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:9 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:9 is sent
|aOutput| : next_seq_num now becomes: 10.
packet is not correct or corrupted, sent ACK 9 back to sender
toLayer3: packet being corrupted
|bInput| : packet with seq number:9 is sent
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:10 is made
|aOutput| : packet with seq number:10 is sent
startTimer: Warning: Attempting to start a timer that is already running
|aOutput| : timer is started

```
|aOutput| : next_seq_num now becomes: 11.
|bInput| : packet 10is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:10 is stored in Buffer
toLayer3: packet being lost
|bInput| : packet with seq number:10 is sent
|bInput| : expected_seq_num becomes: 11.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:11 is made
toLayer3: packet being lost
|aOutput| : packet with seq number:11 is sent
|aOutput| : next_seq_num now becomes: 12.
|aTimerInterrupt| : time out.
|aTimerInterrupt| : timer is started
|aTimerInterrupt| : packet with seq number:10 is resent.
toLayer3: packet being lost
|aTimerInterrupt| : packet with seq number:11 is resent.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:12 is made
|aOutput| : packet with seq number:12 is sent
|aOutput| : next_seq_num now becomes: 13.
|bInput| : packet 11is received correctly.
|bInput| : payload is sent to Layer 5
|bInput| : packet with seq number:11 is stored in Buffer
|bInput| : packet with seq number:11 is sent
|bInput| : expected_seq_num becomes: 12.
|aOutput| : message received from above.
|aOutput| : messageCongestionBuffer add new message, buffer size now is: 1
|aOutput| : packet with seq number:13 is made
|aOutput| : packet with seq number:13 is sent
|aOutput| : next_seq_num now becomes: 14.
Simulator terminated at time 246.10858485671565
```

5.2 Selective Repeat

```
-- * Network Simulator v1.0 * --
Enter number of messages to simulate (> 0): [10] 1000
Enter packet loss probability (0.0 for no loss): [0.0] .1
Enter packet corruption probability (0.0 for no corruption): [0.0] .1
Enter average time between messages from sender's layer 5 (> 0.0): [1000] 200
Enter window size (> 0): [8] 8
Enter retransmission timeout (>0.0) [15.0] 20
Enter trace level (>= 0): [0] 3
Enter random seed: [0] 1234
Initializing A.
```

Initializing B.
generateNextArrival(): called
generateNextArrival(): time is 0.0
generateNextArrival(): future time for event 1 at entity 0 will be 43.4339426862392

EVENT time: 43.4339426862392 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 43.4339426862392
generateNextArrival(): future time for event 1 at entity 0 will be 67.36045411542099
toLayer3: seqnum: 0 acknum: 0 checksum: 1940 payload: aaaaaaaaaaaaaaaaaaaa
toLayer3: scheduling arrival on other side
startTimer: starting timer at 43.4339426862392

EVENT time: 45.66060365611743 type: 2 entity: 1
B:received packet.
B:Sending ACK #0
toLayer3: seqnum: 0 acknum: 0 checksum: 0 payload:
toLayer3: scheduling arrival on other side

EVENT time: 47.569475386822106 type: 2 entity: 0
stopTimer: stopping timer at 47.569475386822106

EVENT time: 67.36045411542099 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 67.36045411542099
generateNextArrival(): future time for event 1 at entity 0 will be 83.31553086947233
toLayer3: seqnum: 1 acknum: 0 checksum: 1961 payload: bbbbbbbbbbbbbbbbbbbb
toLayer3: packet being lost
startTimer: starting timer at 67.36045411542099

EVENT time: 83.31553086947233 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 83.31553086947233
generateNextArrival(): future time for event 1 at entity 0 will be 238.65474410229803
toLayer3: seqnum: 2 acknum: 0 checksum: 1982 payload: cccccccccccccccccccc
toLayer3: packet being corrupted
toLayer3: scheduling arrival on other side

Sending ACK for sequence no 2, but ACK is corrupted

EVENT time: 84.74373607593004 type: 2 entity: 1
B:received packet.

Corrupted Packet received by B

EVENT time: 87.36045411542099 type: 0 entity: 0
startTimer: starting timer at 87.36045411542099
toLayer3: seqnum: 1 acknum: 0 checksum: 1961 payload: bbbbbbbbbbbbbbbbbbbb
toLayer3: scheduling arrival on other side
A:Retransmiting packet#1
toLayer3: seqnum: 2 acknum: 0 checksum: 1982 payload: cccccccccccccccccccc
toLayer3: scheduling arrival on other side
A:Retransmiting packet#2

Packet is retransmissed

EVENT time: 89.32782982879115 type: 2 entity: 1
B:received packet.
B:Sending ACK #1
toLayer3: seqnum: 1 acknum: 1 checksum: 2 payload:
toLayer3: packet being lost

EVENT time: 94.00918607135226 type: 2 entity: 1
B:received packet.
B:Sending ACK #2
toLayer3: seqnum: 2 acknum: 2 checksum: 4 payload:
toLayer3: scheduling arrival on other side

EVENT time: 97.6786706137272 type: 2 entity: 0
stopTimer: stopping timer at 97.6786706137272

EVENT time: 238.65474410229803 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 238.65474410229803
generateNextArrival(): future time for event 1 at entity 0 will be 529.581591235084
toLayer3: seqnum: 3 acknum: 0 checksum: 2003 payload: ddddddddddddddddddddd
toLayer3: scheduling arrival on other side
startTimer: starting timer at 238.65474410229803

EVENT time: 241.6328928495132 type: 2 entity: 1
B:received packet.
B:Sending ACK #3
toLayer3: seqnum: 3 acknum: 3 checksum: 6 payload:
toLayer3: scheduling arrival on other side

EVENT time: 249.96951200903345 type: 2 entity: 0
stopTimer: stopping timer at 249.96951200903345

EVENT time: 529.581591235084 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 529.581591235084
generateNextArrival(): future time for event 1 at entity 0 will be 924.1126743369853
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
startTimer: starting timer at 529.581591235084

EVENT time: 536.3943601794488 type: 2 entity: 1
B:received packet.
B:Sending ACK #4
toLayer3: seqnum: 4 acknum: 4 checksum: 8 payload:
toLayer3: packet being corrupted
toLayer3: scheduling arrival on other side

EVENT time: 538.9286477248451 type: 2 entity: 0

EVENT time: 549.581591235084 type: 0 entity: 0

startTimer: starting timer at 549.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 555.8367870113224 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 569.581591235084 type: 0 entity: 0
startTimer: starting timer at 569.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: packet being lost
A:Retransmiting packet#4

Sending Seq no.4 lost on its way

EVENT time: 589.581591235084 type: 0 entity: 0
startTimer: starting timer at 589.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 590.6389965514084 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 609.581591235084 type: 0 entity: 0
startTimer: starting timer at 609.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 613.6595049897762 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 629.581591235084 type: 0 entity: 0
startTimer: starting timer at 629.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 631.8214362010559 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 649.581591235084 type: 0 entity: 0
startTimer: starting timer at 649.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 657.4935758537553 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 669.581591235084 type: 0 entity: 0
startTimer: starting timer at 669.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 675.3344218268379 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 689.581591235084 type: 0 entity: 0
startTimer: starting timer at 689.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 694.5046540726951 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 709.581591235084 type: 0 entity: 0
startTimer: starting timer at 709.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 713.6037476729637 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 729.581591235084 type: 0 entity: 0
startTimer: starting timer at 729.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 738.0162663655507 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 749.581591235084 type: 0 entity: 0
startTimer: starting timer at 749.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 756.9673146763512 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 769.581591235084 type: 0 entity: 0
startTimer: starting timer at 769.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 776.7387920773949 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 789.581591235084 type: 0 entity: 0
startTimer: starting timer at 789.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 791.0161137730033 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 809.581591235084 type: 0 entity: 0
startTimer: starting timer at 809.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 817.669362468337 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 829.581591235084 type: 0 entity: 0
startTimer: starting timer at 829.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 833.6432996612446 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 849.581591235084 type: 0 entity: 0
startTimer: starting timer at 849.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 851.1713003936887 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 869.581591235084 type: 0 entity: 0
startTimer: starting timer at 869.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 873.488113040559 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 889.581591235084 type: 0 entity: 0
startTimer: starting timer at 889.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4

EVENT time: 893.1304971465194 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 909.581591235084 type: 0 entity: 0
startTimer: starting timer at 909.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: packet being lost
A:Retransmiting packet#4

EVENT time: 924.1126743369853 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 924.1126743369853
generateNextArrival(): future time for event 1 at entity 0 will be 1241.9812616351817
toLayer3: seqnum: 5 acknum: 0 checksum: 2045 payload: ffffffffffffffffffff
toLayer3: scheduling arrival on other side

EVENT time: 929.581591235084 type: 0 entity: 0
startTimer: starting timer at 929.581591235084
toLayer3: seqnum: 4 acknum: 0 checksum: 2024 payload: eeeeeeeeeeeeeeeeeeee
toLayer3: packet being corrupted
toLayer3: scheduling arrival on other side
A:Retransmiting packet#4
toLayer3: seqnum: 5 acknum: 0 checksum: 2045 payload: ffffffffffffffffffff
toLayer3: scheduling arrival on other side
A:Retransmiting packet#5

Sending Seq no.5

EVENT time: 933.6688131351664 type: 2 entity: 1
B:received packet.

B:Sending ACK #5
toLayer3: seqnum: 5 acknum: 5 checksum: 10 payload:
toLayer3: scheduling arrival on other side

EVENT time: 936.3201086458936 type: 2 entity: 1
B:received packet.

EVENT time: 940.7040009765922 type: 2 entity: 1
B:received packet.
B:received out-dated packet, discard it

EVENT time: 943.3639332255011 type: 2 entity: 0
stopTimer: stopping timer at 943.3639332255011

EVENT time: 1241.9812616351817 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 1241.9812616351817
generateNextArrival(): future time for event 1 at entity 0 will be 1468.8802758873255
toLayer3: seqnum: 6 acknum: 0 checksum: 2066 payload: gggggggggggggggggggg
toLayer3: scheduling arrival on other side
startTimer: starting timer at 1241.9812616351817

Sending Seq no.6

EVENT time: 1249.6364329966125 type: 2 entity: 1
B:received packet.
B:Sending ACK #6
toLayer3: seqnum: 6 acknum: 6 checksum: 12 payload:
toLayer3: scheduling arrival on other side

EVENT time: 1251.8496353038117 type: 2 entity: 0
stopTimer: stopping timer at 1251.8496353038117

EVENT time: 1468.8802758873255 type: 1 entity: 0
generateNextArrival(): called
generateNextArrival(): time is 1468.8802758873255
generateNextArrival(): future time for event 1 at entity 0 will be 1627.3689992980742
toLayer3: seqnum: 7 acknum: 0 checksum: 2087 payload: hhhhhhhhhhhhhhhhhhhh
toLayer3: scheduling arrival on other side
startTimer: starting timer at 1468.8802758873255

EVENT time: 1477.7813348796044 type: 2 entity: 1
B:received packet.
B:Sending ACK #7
toLayer3: seqnum: 7 acknum: 7 checksum: 14 payload:
toLayer3: scheduling arrival on other side

EVENT time: 1487.2938016907253 type: 2 entity: 0
stopTimer: stopping timer at 1487.2938016907253

…