

Assignment 1 Report

CZ3006: Net Centric Computing

Academic Year 2016/2017

Semester 2

Student Name: Huang Jian Wei

Matriculation Number: U1521567A

Lab Group: TS1

1. My Task

1.1 Full duplex Data Communication

Full duplex communication means that data transmission can be done in both direction, sending and receiving. One way to achieve this is to have two separate communication channel, "forward" and "reverse" channel, and use each as simplex data traffic. One disadvantage of this setup is that bandwidth of the "reverse" channel will be wasted.

In our setup, we achieve full duplex commination by setting a field in the frame header to distinguish between frame types, such as data or acknowledgement. This means that traffic can be sent and receive in both ways in a single circuit.

```
a test from site 1
     Sending frame: seq = 0 ack =
                                       Kind = DATA
kind = DATA
WP: Sending frame: seq = 1 ack = 7
                                                     info = 1
                                                                      the 2nd line
                           2 \text{ ack} = 7
                                       kind = DATA
                                                                      the 3rd line
SWP: Sending
             frame: seq
                                                     info = 2
                                       kind = DATA
                                                     info = 3
SWP: Sending frame: seq =
                            3 ack =
                                                                      the 4th line
SWP: Sending frame: seq
                                       kind = DATA
                                                     info = 4
                                                                      the 5th line
                         = 4 ack = 0
SWP: Sending
                                       kind =
             frame:
                          = 5 ack =
                                     0
                                              DATA
                                                     info = 5
                                                                      the 6th
                                                                              line
                     seq
SWP: Sending
             frame: seq =
                            6 ack =
                                     0
                                       kind =
                                              DATA
                                                     info = 6
                                                                      the 7th line
                           7 \text{ ack} = 4
SWP: Sending frame: seq
                                       kind =
                                              DATA
                                                     info = 7
                                                                      the 8th line
SWP: Sending
             frame:
                          = 0 ack =
                                       kind
                                              DATA
                                                                      the 9th
                     seq
SWP: Sending frame: seq
                            1 \text{ ack} = 4
                                       kind =
                                              DATA
                                                     info = 9
                                                                      the 10th line
                            2 \text{ ack} = 4
WP: Sending
             frame:
                     seq
                                       kind =
                                              DATA
                                                     info = 10
                                                                      the 11th line
                                       kind
                                              DATA
                                                                      the 12th
WP: Sending
             frame:
                     seq
                            3 ack
                                                     nfo
                                                         = 11
SWP: Sending frame: seq
                            4 \text{ ack} =
                                       kind = DATA
                                                     info = 12
                                                                      the 13th line
SWP: Sending frame: seq
                          = 5 ack =
                                       kind = DATA
                                                     info
                                                         = 13
                                                                      the 14th line
                                       kind = DATA
SWP: Sending frame: seq
                          = 6 ack =
                                                     info
                                                         = 14
                                                                      the 15th line
SWP: Sending frame: seq
                                       kind = DATA
                                                                      the 16th line
                         = 7 ack = 1
                                                     info = 15
SWP: Sending
                                       kind =
             frame: seq
                            0 ack
                                              DATA
                                                                      the 17th line
```

Figure 1. Distinguish between the different kind of frames e.g Kind = DATA

The possible value for "Kind" field can be as such; DATA, the data that was meant for the receiver. ACK, for frames that notify the sender that data has been successful transmitted. Lastly, NAK means that sender is required to send some missing frames.

Another possible way to reduce wastage of bandwidth is through "piggybag" strategy. By delaying outgoing acknowledgement until they can get a free ride on the next outgoing frame.

```
s.seq = next_frame;
s.ack = (frame_expected + MAX_SEQ) % (MAX_SEQ + 1);
if (frame_kind == PFrame.NAK) {
    no_nak = false;
}
```

1.2 In-order delivery of packets to the network layer

To make sure that the delivery of packets is in-order to the network layer, the sliding protocol uses frame sequence number to make sure that only packets whose sequence number falls in the frame window will be received by the receiver. If packets whose sequence number does not fall into the window range, it will be discard and send a negative acknowledgement to the sender to send the correct frame.

When using Protocol 6(Selective repeat strategy), receiver may accept range that are not in the receiving window, hence resulting in packets not received in order. To solve this, protocol 6 has an array of buffer to stores frames that are within the window and only send them once all frames in the buffer are in the correct order.

```
if (between(expected_frame, temp_frame.seq,upper_limit) && (recieved[temp_frame.seq % NR_BUFS] == false)) {
    recieved[temp_frame.seq % NR_BUFS] = true;
    in_buffer[temp_frame.seq % NR_BUFS] = temp_frame.info;
    while (recieved[expected_frame % NR_BUFS]) {
        to_network_layer(in_buffer[expected_frame % NR_BUFS]);
        no_nak = true;
        recieved[expected_frame % NR_BUFS] = false;

expected_frame = inc(expected_frame);
        upper_limit = inc(upper_limit);
        start_ack_timer();
      }
    }
}
```

1.3. Selective repeat retransmission strategy

For protocol 6 of the sliding window protocol, we use selective repeat retransmission strategy to only transmit the frame that is expired. Compared to Protocol 5 of the sliding window protocol, this could cut down on the number of frames being resend.

This strategy make use of an array of timers, one for each individual timer so that instead of transmitting all outstanding frame, it only retransmits the expired frame.

Implementation:

```
to_physical_layer(s);
if (frame_kind == PFrame.DATA) {
    start_timer(next_frame);
}
private void start_timer(int seq) {
    stop_timer(seq);
    frame_timer[seq % NR_BUFS] = new Timer();
    frame_timer[seq % NR_BUFS].schedule(new ReTask(swe, seq), 200);
}
```

However, there is still one problem in this strategy. Since sliding window move in a circular fashion, there may be an overlap of sequence number which may cause the receiver to be unable to separate the old frames and the newer frames.

To solve this issue, we must ensure that the old and new sequence number does not overlap in the sliding window. Using $(MAX_SEQ + 1)/2$, we can make sure that the window will always be half of the maximum sequence number, hence we can differentiate between the old frames and the newer frames.

```
public static final int MAX_SEQ = 7;
public static final int NR BUFS = (MAX SEQ + 1)/2;
```

1.4. Synchronization with the network layer by granting credits

The sliding window protocol must be synchronized with the network layer to ensure that there is enough time to receive packets from the physical layer.

By granting credits to the network layer based on the number of buffer available, we ensure that network layer only sends the maximum number of frames within the sending window.

Initially after the protocol has been set up, the network layer will be given the credit based on the full window size, allowing the virtual machine to send up to 4 packets before processing packets that has been received from another virtual machine. Over time, the network layer will be granted credits based on the acknowledgement sent by the receiver and the amount of available buffer, allowing the network layer to be synchronized to the data linked layer, sending and receiving window.

```
private void enable_network_layer(int nr_of_bufs) {
   //network layer is permitted to send if credit is available
        swe.grant_credit(nr_of_bufs);
}

while (between(expected_ack, temp_frame.ack,next_frame_send)) {
        stop_timer(expected_ack % NR_BUFS);
        expected_ack = inc(expected_ack);
        enable_network_layer(1);
    }
}
```

1.5. Negative Acknowledgement

In the selective repeat transmission protocol, receiver is allowed to be able to receive frames outof-order, as long as the frames are within the window range. However, this means that some of frame to be "missing", hence we will require a way to tell the sender that we are missing a certain frame.

The Boolean "no_nak" will be used to track whether if an expected packet has been received. If there is an error in receiving the packet, after a period of time a negative acknowledgement for the packet will be sent. In the source code, the no_nak will be set to false when a negative acknowledgement has to be sent.

1.6. Separate acknowledgement when the reverse traffic is light or more

Piggyback is useful to reduce bandwidth within the channel, however, when the reverse traffic is light, we should also implement a separate acknowledgement to make sure that the channel is optimize to the fullest.

We can achieve this by implementing a timer that will send a separate and individual acknowledgement frame once the timer expired.

Implementation

```
private void send_frame(int frame_kind, int next_frame, int frame_expected, Packet buffer[])
  PFrame s = new PFrame();
  s.kind = frame_kind;
    if (frame_kind == PFrame.DATA) {
       s.info = buffer[next_frame % NR_BUFS];
    s.seq = next_frame;
    s.ack = (frame_expected + MAX_SEQ) % (MAX_SEQ + 1);
    if (frame kind == PFrame.NAK) {
       no_nak = false;
    to_physical_layer(s);
    if (frame_kind == PFrame.DATA) {
       start_timer(next_frame);
    stop_ack_timer();
 private void start_ack_timer( ) {
       stop_ack_timer();
    //starts another timer for sending separate ack
    ack timer = new Timer();
    ack_timer.schedule(new AckTask(swe), 100);
  }
```

Conclusion

Hence by implementing certain functions in the protocol mentioned above, we are able to ensure that the protocol is able to withstand quality level 3 of the Network Simulator.

This report is done by Huang Jian Wei(U1521567A)

2. NetSim Tests

2.1 NetSim Quality Level 0

```
C:\Windows\system32\cmd.exe - java VMach 1
```

```
VMach is making a connection with NetSim...
VMach(60435) <==> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)
SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = 0
SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 1
SWP: Sending frame: seq = 2 ack = 7 kind = DATA info = 2
SWP: Sending frame: seq = 3 ack = 7 kind = DATA info = 3
SWP: Sending frame: seq = 4 ack = 0 kind = DATA info = 3
SWP: Sending frame: seq = 4 ack = 0 kind = DATA info = 5
SWP: Sending frame: seq = 5 ack = 0 kind = DATA info = 5
SWP: Sending frame: seq = 6 ack = 0 kind = DATA info = 5
SWP: Sending frame: seq = 7 ack = 4 kind = DATA info = 7
SWP: Sending frame: seq = 7 ack = 4 kind = DATA info = 7
SWP: Sending frame: seq = 1 ack = 4 kind = DATA info = 8
SWP: Sending frame: seq = 1 ack = 4 kind = DATA info = 8
SWP: Sending frame: seq = 2 ack = 4 kind = DATA info = 10
SWP: Sending frame: seq = 3 ack = 5 kind = DATA info = 11
SWP: Sending frame: seq = 4 ack = 1 kind = DATA info = 11
SWP: Sending frame: seq = 5 ack = 1 kind = DATA info = 12
SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 13
SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 13
SWP: Sending frame: seq = 7 ack = 1 kind = DATA info = 15
SWP: Sending frame: seq = 7 ack = 1 kind = DATA info = 15
SWP: Sending frame: seq = 1 ack = 6 kind = DATA info = 15
SWP: Sending frame: seq = 1 ack = 6 kind = DATA info = 16
SWP: Sending frame: seq = 1 ack = 6 kind = DATA info = 17
SWP: Sending frame: seq = 1 ack = 1 kind = DATA info = 18
SWP: Sending frame: seq = 1 ack = 1 kind = DATA info = 17
SWP: Sending frame: seq = 1 ack = 1 kind = DATA info = 17
SWP: Sending frame: seq = 1 ack = 2 kind = DATA info = 18
SWP: Sending frame: seq = 1 ack = 6 kind = DATA info = 18
SWP: Sending frame: seq = 1 ack = 1 kind = DATA info = 20
SWP: Sending frame: seq = 2 ack = 6 kind = DATA info = 20
SWP: Sending frame: seq = 3 ack = 6 kind = DATA info = 20
SWP: Sending frame: seq = 4 ack = 1 kind = DATA info = 20
SWP: Sending frame: seq = 6 ack = 2 kind = DATA info = 22
SWP: Sending frame: seq = 6 ack = 3 ki
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     this is a test from site 1
the 2nd line
the 3rd line
the 4th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       the 5th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         the 6th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     the 7th line
the 8th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         the 9th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     the 10th line
the 11th line
the 12th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     the 13th line
the 14th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       the 15th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   the 16th line
the 17th line
the 18th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   the 19th line
the 20th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     the 21th line
the 22th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   the 23th line
the 24th line
the 25th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     the 26th line
the 27th line
the 28th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   the 29th line
the 30th line
the 31th line
the 32th line
the 33th line
the 34th line
```

C:\Windows\system32\cmd.exe - Java VMach 2

```
C:\Users\Jianwei\Downloads\ass1>Java vMach 2

Whach is making a connection with Netsim...

Whach(60423) <===> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)

C:\Users\Jianwei\Downloads\ass1>Java vMach 2

Whach is making a connection with NetSim...

Whach(60437) <==> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)

Whach (60437) <==> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)

Whach(60437) <==> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)

SWP: Sending frame: seq = 0 ack = 2 kind = DATA info = 0

SWP: Sending frame: seq = 1 ack = 2 kind = DATA info = 1

SWP: Sending frame: seq = 2 ack = 2 kind = DATA info = 1

SWP: Sending frame: seq = 3 ack = 2 kind = DATA info = 1

SWP: Sending frame: seq = 3 ack = 2 kind = DATA info = 3

SWP: Sending frame: seq = 4 ack = 6 kind = DATA info = 5

SWP: Sending frame: seq = 6 ack = 7 kind = DATA info = 5

SWP: Sending frame: seq = 6 ack = 7 kind = DATA info = 5

SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = 7

SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = 7

The 8th line

SWP: Sending frame: seq = 1 ack = 3 kind = DATA info = 7

The 8th line

SWP: Sending frame: seq = 1 ack = 3 kind = DATA info = 1

SWP: Sending frame: seq = 1 ack = 4 kind = DATA info = 1

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 3 ack = 4 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 3 ack = 5 kind = DATA info = 10

The 11th line

SWP: Sending frame: seq = 0 ack = 1 kind = DATA info = 10

The 11th line
```

Java NetSim 0

```
C:\Users\Jianwei\Downloads\ass1>java NetSim 0
NetSim(Port= 54321) is waiting for connection ...
NetSim accepted connection from: DESKTOP-S7L205N : 60435
NetSim(Port= 54321) is waiting for connection ...
NetSim accepted connection from: DESKTOP-S7L205N : 60437
```

2.2 NetSim Quality Level 1

```
:\Users\Jianwei\Downloads\ass1>java VMach 1
Mach is making a connection with NetSim...
.Wach is making a connection with NetSim...
Whach (55565) <==> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)
SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = 0
SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 1
SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 2
SWP: Sending frame: seq = 2 ack = 7 kind = DATA info = 2
SWP: Sending frame: seq = 3 ack = 7 kind = DATA info = 3
SWP: Sending frame: seq = 0 ack = 3 kind = DATA info = 0
SWP: Sending frame: seq = 4 ack = 4 kind = DATA info = 4
SWP: Sending frame: seq = 0 ack = 4 kind = NAK info =
SWP: Sending frame: seq = 0 ack = 4 kind = DATA info = 1
SWP: Sending frame: seq = 0 ack = 6 kind = DATA info = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              this is a test from site
the 2nd line
the 3rd line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  the 4th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            this is a test from site the 5th line
                        Sending frame: seq = 4 ack = 4 kind = DATA info = 4
Sending frame: seq = 0 ack = 4 kind = DATA info = 1
Sending frame: seq = 1 ack = 4 kind = DATA info = 1
Sending frame: seq = 0 ack = 6 kind = DATA info = 1
Sending frame: seq = 0 ack = 6 kind = NAK info = 1
Sending frame: seq = 0 ack = 6 kind = NAK info = 2
Sending frame: seq = 2 ack = 7 kind = DATA info = 2
Sending frame: seq = 3 ack = 7 kind = DATA info = 3
Sending frame: seq = 3 ack = 7 kind = DATA info = 3
Sending frame: seq = 4 ack = 3 kind = DATA info = 4
Sending frame: seq = 4 ack = 3 kind = DATA info = 4
Sending frame: seq = 1 ack = 3 kind = DATA info = 1
Sending frame: seq = 6 ack = 7 kind = DATA info = 5
Sending frame: seq = 6 ack = 7 kind = DATA info = 5
Sending frame: seq = 6 ack = 7 kind = DATA info = 6
Sending frame: seq = 0 ack = 7 kind = DATA info = 8
Sending frame: seq = 0 ack = 7 kind = DATA info = 8
Sending frame: seq = 0 ack = 7 kind = DATA info = 9
Sending frame: seq = 1 ack = 7 kind = DATA info = 9
Sending frame: seq = 1 ack = 7 kind = DATA info = 9
Sending frame: seq = 1 ack = 7 kind = DATA info = 12
Sending frame: seq = 3 ack = 7 kind = DATA info = 12
Sending frame: seq = 3 ack = 7 kind = DATA info = 12
Sending frame: seq = 3 ack = 7 kind = DATA info = 12
Sending frame: seq = 3 ack = 7 kind = DATA info = 12
Sending frame: seq = 4 ack = 7 kind = DATA info = 12
Sending frame: seq = 4 ack = 7 kind = DATA info = 12
Sending frame: seq = 4 ack = 7 kind = DATA info = 12
Sending frame: seq = 4 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
Sending frame: seq = 6 ack = 7 kind = DATA info = 12
S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the 3rd line
the 4th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 5th line
the 2nd line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the 7th line
the 8th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 9th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the 10th line
the 11th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 12th line
the 13th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the 13th line
the 14th line
the 11th line
the 15th line
the 15th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 17th line
the 18th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 19th line
the 20th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 21th line
the 22th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the 23th line
the 24th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          the 21th line
the 22th line
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 23th line
the 25th line
the 26th line
                             Sending frame: seq = 1 ack = 0 kind = DATA info = 25 Sending frame: seq = 2 ack = 0 kind = DATA info = 26 Sending frame: seq = 7 ack = 0 kind = DATA info = 23 Sending frame: seq = 7 ack = 1 kind = DATA info = 23 Sending frame: seq = 0 ack = 1 kind = DATA info = 24 Sending frame: seq = 0 ack = 1 kind = DATA info = 27 Sending frame: seq = 0 ack = 1 kind = DATA info = 27 Sending frame: seq = 0 ack = 1 kind = NAK info = Sending frame: seq = 0 ack = 2 kind = ACK info = Sending frame: seq = 0 ack = 2 kind = NAK info =
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the 27th line
the 27th line
the 24th line
the 24th line
the 25th line
the 28th line
SWP:
```

```
the 29th line
the 30th line
SWP: Sending frame: seq = 4 ack = 2 kind = DATA info = 28
SWP: Sending frame: seq = 5 ack = 2 kind = DATA info = 29
                                                                                                 the 27th line
SWP: Sending frame: seq = 2 ack =
                                                   2 kind = DATA info = 26
SWP: Sending frame: seq = 3 ack =
                                                   2 kind = DATA info = 27
                                                                                                 the 28th line
                                                                                                 the 31th line
SWP: Sending frame: seq = 6 ack =
                                                   2 kind = DATA info = 30
SWP: Sending frame: seq = 7 ack =
                                                   2 kind = DATA info = 31
                                                                                                 the 32th line
SWP: Sending frame: seq = 0 ack = 2 kind = DATA info = 32
SWP: Sending frame: seq = 5 ack = 2 kind = DATA info = 29
                                                                                                 the 33th line
                                                                                                 the 30th line
SWP: Sending frame: seq = 0 ack = 6 kind = NAK info =
SWP: Sending frame: seq = 1 ack = 6 kind = DATA info = 33
                                                                                                 the 34th line
SWP: Sending frame: seq = 6 ack = 6 kind = DATA info = 30
                                                                                                 the 31th line
SWP: Sending frame: seq = 7 ack = 6 kind = DATA info = 30
SWP: Sending frame: seq = 0 ack = 6 kind = DATA info = 32
                                                                                                 the 32th line
                                                                                                 the 33th line
SWP: Sending frame: seq = 1 ack = 6 kind = DATA info = 32
SWP: Sending frame: seq = 2 ack = 7 kind = DATA info = 34
                                                                                                 the 34th line the last line
SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = SWP: Sending frame: seq = 0 ack = 7 kind = NAK info = SWP: Sending frame: seq = 0 ack = 7 kind = ACK info =
SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 33
                                                                                                 the 34th line the last line
SWP: Sending frame: seq = 2 ack = 7 kind = DATA info = 34
SWP: Sending frame: seq = 0 ack = 7 kind = ACK info =
SWP: Sending frame: seq = 0 ack = 2 kind = NAK info =
```

```
C:\Users\Jianwei\Downloads\ass1>java VMach 2
VMach is making a connection with NetSim...
VMach(55566) <===> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)
VMGCN(55506) C===> NetSim(DESKTOP-5/L265N/192:108.0.102:)
SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = 0
SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 1
SWP: Sending frame: seq = 2 ack = 7 kind = DATA info = 2
SWP: Sending frame: seq = 3 ack = 7 kind = DATA info = 3
SWP: Sending frame: seq = 0 ack = 7 kind = NAK info =
                                                                       this is a test from site 2
the 2nd line
                                                                       the 3rd line
                                                                       the 4th line
     Sending frame: seq = 4 ack = 0 kind = DATA info = 4
                                                                       the 5th line
     Sending frame: seq = 5 ack = 0 kind = DATA info = 5
                                                                       the 6th line
the 7th line
SWP:
     Sending frame: seq = 6 ack = 0 kind = DATA info = 6
Sending frame: seq = 7 ack = 0 kind = DATA info = 7
SWP:
                                                                       the 8th line
                            0 ack = 0 kind = NAK info =
     Sending frame: seq =
     Sending frame: seq =
                            5 ack = 0 kind = DATA info = 5
                                                                       the 6th line
                            0 ack = 0 kind = DATA info = 8
SWP:
     Sending frame: seq =
                                                                       the 9th line
     Sending frame: seq = 1 ack = 0 kind = DATA info = 9
                                                                       the 10th line
the 11th line
SWP:
                               ack = 0 kind = DATA info = 10
     Sending frame: seq =
     Sending frame: seq =
                                                                       the 8th line
     Sending frame: seq = 3 ack = 0 kind = DATA info = 11 Sending frame: seq = 0 ack = 0 kind = DATA info = 8
                            3 ack = 0 kind = DATA info = 11
                                                                       the 12th line
the 9th line
 SWP:
SWP:
                            4 ack = 0 kind = DATA
                                                                       the 13th line
     Sending frame: seq =
                                                     info = 12
     Sending frame: seq =
                                     0 kind = DATA info = 13
                                                                       the 14th line
     Sending frame: seq
                                                     info = 14
                                                                       the 15th line
     Sending frame: seq =
                             7 ack = 0 kind = DATA info = 15
 SWP:
                                                                       the 16th line
     Sending frame: seq = 4 ack =
                                      4 kind = DATA
                                                                       the 13th line
                                                     info = 12
                            0 ack
                                      5 kind = DATA
                                                                       the 17th line
     Sending frame: seq =
     Sending frame: seq =
                                      5 kind = DATA info = 17
     Sending frame: seq = Sending frame: seq =
                                      5 kind = DATA
                                                     info = 18
info = 19
                                                                       the 19th line
the 20th line
                            2
                               ack
     Sending frame: seq
SWP: Sending frame: seq = 0 ack = 1 kind =
                                                     NAK info =
SWP: Sending frame: seq = 0 ack = 3 kind =
                                                     DATA info = 16
                                                                               the 17th line
SWP: Sending frame: seq = 1 ack = 3 kind =
                                                     DATA info = 17
                                                                               the 18th line
SWP: Sending frame: seq = 2 ack = 3 kind
                                                     DATA info = 18
                                                                                the 19th line
SWP: Sending frame: seq = 3 ack = 3 kind
                                                     DATA info = 19
                                                                               the 20th line
SWP: Sending frame: seq = 0 ack = 3 kind = NAK info =
SWP: Sending frame: seq = 0 ack = 7 kind = ACK info =
                                                     NAK info =
SWP: Sending frame: seq = 0 ack = 3 kind =
                                                     DATA info = 16
                                                                               the 17th line
SWP: Sending frame: seq
                             = 1 ack = 3 kind
                                                     DATA info = 17
                                                                               the 18th line
SWP: Sending frame: seq =
                               2 \text{ ack} = 3 \text{ kind}
                                                     DATA info = 18
                                                                               the 19th line
SWP: Sending frame: seq = 3 ack = 3 kind
                                                     DATA info = 19
                                                                               the 20th line
SWP: Sending frame: seq = 0 ack = 3 kind = NAK info =
SWP: Sending frame: seq = 4 ack = 3 kind =
                                                     DATA info = 20
                                                                               the 21th line
SWP: Sending frame: seq
                                                     DATA info = 21
                             = 5 ack = 3 kind =
                                                                               the 22th line
SWP: Sending frame: seq
                                6 \text{ ack} = 3 \text{ kind} =
                                                     DATA info = 22
                                                                               the 23th line
SWP:
     Sending frame: seq = 7 ack = 3 kind
                                                     DATA info = 23
                                                                               the 24th line
SWP: Sending frame: seq = 4 ack = 3 kind =
                                                     DATA info = 20
                                                                               the 21th line
SWP: Sending frame: seq = 0 ack = 3 kind = DATA info = 24
                                                                               the 25th line
SWP: Sending frame: seq
                            = 1 ack = 3 kind =
                                                     DATA info = 25
                                                                               the 26th line
SWP: Sending frame: seq
                             = 2 ack = 3 kind =
                                                     DATA info = 26
                                                                               the 27th line
SWP:
     Sending frame: seq = 3 ack = 3 kind
                                                     DATA info = 27
                                                                               the 28th line
SWP: Sending frame: seq = 4 ack = 6 kind =
                                                                               the 29th line
                                                     DATA info = 28
SWP: Sending frame: seq = 1 ack = 6 kind =
                                                     DATA info = 25
                                                                               the 26th line
SWP: Sending frame: seq = 0 ack = 6 kind = NAK info =
SWP: Sending frame: seq
                             = 0 ack = 7 kind =
                                                     NAK info =
WP:
     Sending frame: seq =
                               5 ack =
                                         7 kind
                                                     DATA info = 29
                                                                               the 30th line
SWP: Sending frame: seq =
                                2 \text{ ack} = 7 \text{ kind}
                                                     DATA info = 26
                                                                               the 27th line
SWP: Sending frame: seq = 3 ack = 1 kind =
SWP: Sending frame: seq = 0 ack = 1 kind =
                                                     DATA info = 27
                                                                               the 28th line
                                                     NAK info =
SWP: Sending frame: seq
                            = 6 ack = 1 kind =
                                                     DATA info = 30
                                                                               the 31th line
                                                                                the 29th line
SWP: Sending frame: seq = 4 ack = 1 kind
                                                     DATA info = 28
SWP: Sending frame: seq =
                               5 ack = 4 kind
                                                     DATA info = 29
                                                                               the 30th line
SWP: Sending frame: seq = 0 ack = 4 kind =
SWP: Sending frame: seq = 3 ack = 4 kind =
                                                     NAK info =
                                                     DATA info = 27
                                                                               the 28th line
SWP: Sending frame: seq = 6 ack = 5 kind =
                                                     DATA info = 30
                                                                               the 31th line
SWP: Sending frame: seq
                             = 7 ack = 5 kind =
                                                     DATA info = 31
                                                                               the 32th line
SWP: Sending frame: seq = 0 ack = 5 kind =
                                                     DATA info = 32
                                                                               the 33th line
SWP: Sending frame: seq = 1 ack = 5 kind = DATA info = 33
SWP: Sending frame: seq = 2 ack = 5 kind = DATA info = 34
                                                                               the 34th line
                                                                               the last line
SWP: Sending frame: seq = 0 ack = 0 kind = NAK info =
SWP: Sending frame: seq
                             = 7 ack = 0 kind =
                                                     DATA info = 31
                                                                               the 32th line
SWP: Sending frame: seq = 0 ack = 0 kind =
                                                     DATA info = 32
                                                                               the 33th line
SWP: Sending frame: seq = 1 ack = 0 kind
                                                     DATA info = 33
                                                                               the 34th line
SWP: Sending frame: seq = 2 ack = 0 kind = DATA info = 34
                                                                               the last line
SWP: Sending frame: seq = 0 ack = 1 kind = DATA info = 32
                                                                               the 33th line
SWP: Sending frame: seq = 1 ack = 1 kind = DATA info = 33
                                                                               the 34th line
SWP:
     Sending frame: seq = 2 ack = 2 kind =
                                                     DATA info = 34
                                                                               the last line
     Sending frame: seq = 0 ack
                                       = 2 kind
                                                     DATA info = 32
                                                                               the 33th line
WP:
SWP: Sending frame: seq = 1 ack = 2 kind = DATA info = 33
                                                                               the 34th line
```

SWP: Sending frame: seq = 2 ack = 2 kind = DATA info = 34

the last line

Java NetSim 1

```
C:\Users\Jianwei\Downloads\ass1>java NetSim 1
NetSim(Port= 54321) is waiting for connection ...
NetSim accepted connection from: DESKTOP-S7L205N : 55565
NetSim(Port= 54321) is waiting for connection ...
NetSim accepted connection from: DESKTOP-S7L205N : 55566
VMach 1 loose frame seq = 0 error counter = 1
VMach 1 loose frame seq = 1 error counter = 2
VMach 1 loose frame seq = 3 error counter = 3
VMach 2 loose frame seq = 5 error counter = 1
VMach 2 loose frame seq = 7 error counter = 2
VMach 1 loose frame seq = 1 error counter = 4
VMach 2 loose frame seq = 0 error counter = 3
VMach 2 loose frame seq = 4 error counter = 4
VMach 2 loose frame seq = 0 error counter = 5
VMach 2 loose frame seq = 1 error counter = 6
VMach 1 loose frame seq = 0 error counter = 5
VMach 1 loose frame seq = 2 error counter = 6
VMach 1 loose frame seq = 4 error counter = 7
/Mach 2 loose frame seq = 0 error counter = 7
/Mach 1 loose frame seg = 4 error counter = 8
/Mach 2 loose frame seg = 0 error counter = 8
VMach 1 loose frame seg = 7 error counter = 9
VMach 2 loose frame seq = 1 error counter = 9
VMach 2 loose frame seq = 2 error counter = 10
VMach 2 loose frame seq = 3 error counter = 11
VMach 1 loose frame seq = 0 error counter = 10
VMach 1 loose frame seq = 5 error counter = 11
VMach 1 loose frame seq = 0 error counter = 12
VMach 1 loose frame seg = 2 error counter = 13
VMach 1 loose frame seg = 0 error counter = 14
VMach 2 loose frame seg = 3 error counter = 12
VMach 2 loose frame seg = 0 error counter = 13
VMach 1 loose frame seq = 0 error counter = 15
VMach 1 loose frame seq = 5 error counter = 16
VMach 2 loose frame seq = 4 error counter = 14
VMach 1 loose frame seq = 6 error counter = 17
VMach 1 loose frame seq = 1 error counter = 18
VMach 2 loose frame seq = 7 error counter = 15
VMach 2 loose frame seq = 0 error counter = 16
VMach 2 loose frame seq = 2 error counter = 17
VMach 2 loose frame seq = 0 error counter = 18
VMach 1 loose frame seq = 0 error counter = 19
VMach 1 loose frame seq = 1 error counter = 20
VMach 2 loose frame seq = 0 error counter = 19
VMach 1 loose frame seq = 2 error counter = 21
VMach 1 loose frame seq = 0 error counter = 22
Mach 2 loose frame seq = 0 error counter = 20
/Mach 2 loose frame seg = 2 error counter = 21
```

2.3 NetSim Quality Level 2

```
C:\Windows\system32\cmd.exe - java VMach 1
Mach is making a connection with NetSim...
/Mach(59314) <===> NetSim(DESKTOP-S7L205N/192.168.0.102:54321)
                                                                                                                                                                                  this is a test from site 1 the 2nd line
  WP: Sending frame: seq = 0 ack = 0 kind = DATA info = 0
  WP: Sending frame: seq = 0 ack = 0 kind = DATA info = 1
WP: Sending frame: seq = 1 ack = 0 kind = DATA info = 1
WP: Sending frame: seq = 2 ack = 0 kind = DATA info = 2
                                                                                                                                                                                   the 3rd line
           Sending frame: seq = 3 ack = 0 kind = DATA info = 3
Sending frame: seq = 4 ack = 4 kind = DATA info = 4
           Sending frame: seq = 0 ack = 4 kind = NAK info =
Sending frame: seq = 0 ack = 5 kind = ACK info =
  WP: Sending frame: seq = 2 ack = 5 kind = DATA info = 2
                                                                                                                                                                                   the 3rd line
 NW: Sending frame: seq = 2 ack = 5 kind = DATA info = 2 low: Sending frame: seq = 1 ack = 5 kind = DATA info = 2 low: Sending frame: seq = 3 ack = 5 kind = DATA info = 3 low: Sending frame: seq = 4 ack = 5 kind = DATA info = 4 low: Sending frame: seq = 0 ack = 5 kind = NAK info = 4 low: Sending frame: seq = 5 ack = 5 kind = DATA info = 5 low: Sending frame: seq = 2 ack = 5 kind = DATA info = 2 low: Sending frame: seq = 2 ack = 5 kind = DATA info = 2 low: Sending frame: seq = 2 ack = 1 kind = low: Info = 2 low: Sending frame: seq = 2 ack = 1 kind = low: Info = 2 low: Sending frame: seq = 2 ack = 1 kind = low: Info = 2 low: Sending frame: seq = 2 ack = 1 kind = low: Info = 2 low: I
                                                                                                                                                                                   the 4th line
                                                                                                                                                                                  the 5th line
                                                                                                                                                                                  the 6th line
                                                                                                                                                                                   the 3rd line
 WP: Sending frame: seq = 2 ack = 5 kind = DAIA info = 2
WP: Sending frame: seq = 0 ack = 1 kind = NAK info = 0
WP: Sending frame: seq = 6 ack = 1 kind = DATA info = 6
WP: Sending frame: seq = 7 ack = 1 kind = DATA info = 7
WP: Sending frame: seq = 0 ack = 1 kind = DATA info = 8
WP: Sending frame: seq = 1 ack = 1 kind = DATA info = 9
WP: Sending frame: seq = 0 ack = 1 kind = ACK info =
                                                                                                                                                                                  the 7th line
the 8th line
                                                                                                                                                                                  the 9th line
                                                                                                                                                                                  the 10th line
             Sending frame: seq = 6 ack = 1 kind = DATA info = 6
  WP: Sending frame: seq = 7 ack = 1 kind = DATA info = 7
WP: Sending frame: seq = 0 ack = 1 kind = DATA info = 8
                                                                                                                                                                                   the 8th line
                                                                                                                                                                                   the 9th line
           Sending frame: seq = 1 ack = 1 kind = DATA info = 9
                                                                                                                                                                                   the 10th line
           Sending frame: seq = 2 ack = 1 kind = DATA info = 10
Sending frame: seq = 3 ack = 1 kind = DATA info = 11
                                                                                                                                                                                   the 11th line
                                                                                                                                                                                   the 12th line
 WP: Sending frame: seq = 3 ack = 1 kind = DATA info = 11
WP: Sending frame: seq = 4 ack = 1 kind = DATA info = 12
WP: Sending frame: seq = 5 ack = 1 kind = DATA info = 13
WP: Sending frame: seq = 0 ack = 1 kind = ACK info =
WP: Sending frame: seq = 2 ack = 1 kind = DATA info = 10
WP: Sending frame: seq = 3 ack = 1 kind = DATA info = 10
WP: Sending frame: seq = 4 ack = 5 kind = DATA info = 12
WP: Sending frame: seq = 6 ack = 5 kind = DATA info = 14
WP: Sending frame: seq = 7 ack = 5 kind = DATA info = 14
WP: Sending frame: seq = 7 ack = 5 kind = DATA info = 14
                                                                                                                                                                                   the 13th line
                                                                                                                                                                                  the 14th line
                                                                                                                                                                                   the 11th line
                                                                                                                                                                                  the 12th line
                                                                                                                                                                                  the 13th line
                                                                                                                                                                                   the 15th line
                                                                                                                                                                                  the 16th line
           Sending frame: seq = 7 ack = 5 kind = DATA info = 15
Sending frame: seq = 0 ack = 6 kind = DATA info = 16
Sending frame: seq = 1 ack = 6 kind = DATA info = 17
                                                                                                                                                                                   the 17th line
                                                                                                                                                                                   the 18th line
   NP: Sending frame: seq = 0 ack = 6 kind = NAK info =
            Sending frame: seq = 2 ack = 6 kind = DATA info = 18
                                                                                                                                                                                   the 19th line
  WP: Sending frame: seq = 7 ack = 6 kind = DATA info = 15
                                                                                                                                                                                   the 16th line
            Sending frame: seq = 0 ack = 6 kind = DATA info = 16
                                                                                                                                                                                   the 17th line
           Sending frame: seq = 1 ack = 6 kind = DATA info = 17
                                                                                                                                                                                   the 18th line
                                                                                                                                                                                  the 20th line
the 21th line
           Sending frame: seq = 3 ack = 6 kind = DATA info = 19
            Sending frame: seq = 4 ack = 6 kind = DATA info = 20
 NWP: Sending frame: seq = 4 ack = 6 kind = DATA info = 20
WP: Sending frame: seq = 5 ack = 6 kind = DATA info = 22
WP: Sending frame: seq = 6 ack = 6 kind = DATA info = 22
WP: Sending frame: seq = 4 ack = 6 kind = DATA info = 20
WP: Sending frame: seq = 7 ack = 6 kind = DATA info = 23
WP: Sending frame: seq = 0 ack = 6 kind = DATA info = 24
WP: Sending frame: seq = 1 ack = 6 kind = DATA info = 25
                                                                                                                                                                                   the 22th line
                                                                                                                                                                                   the 21th line
                                                                                                                                                                                  the 24th line
the 25th line
SWP: Sending frame: seq = 2 ack = 2 kind = DATA info = 26
SWP: Sending frame: seq = 7 ack = 2 kind = DATA info = 23
SWP: Sending frame: seq = 3 ack = 2 kind = DATA info
SWP: Sending faces
                                                                                                                                                                                                                          the 27th line the 24th line
                                                                                                                                                                                                                          the 28th line
the 29th line
                Sending frame: seq =
                                                                                                                          kind = DATA info = 28
 SWP: Sending frame: seq = 5 ack = 2 kind = DATA info = 29
SWP: Sending frame: seq = 6 ack = 2 kind = DATA info = 39
SWP: Sending frame: seq = 6 ack = 2 kind = DATA info = 39
SWP: Sending frame: seq = 5 ack = 2 kind = DATA info = 29
SWP: Sending frame: seq = 7 ack = 2 kind = DATA info = 31
SWP: Sending frame: seq = 0 ack = 2 kind = DATA info = 32
                                                                                                                                                                                                                          the 30th line
                                                                                                                                                                                                                          the 31th line
                                                                                                                                                                                                                          the 30th line
                                                                                                                                                                                                                          the 32th line
                                                                                                                                                                                                                          the 33th line
 SWP: Sending frame: seq = 1 ack = 4 kind = DATA info = 33
SWP: Sending frame: seq = 2 ack = 4 kind = DATA info = 34
SWP: Sending frame: seq = 0 ack = 4 kind = NAK info =
                                                                                                                                                                                                                          the last line
                Sending frame: seq = 0 ack =
                                                                                                                   0 kind = NAK info
  WP:
                Sending frame: seq = 0 ack =
                                                                                                                   0 kind = ACK info =
               Sending frame: seq = 0 ack = Sending frame: seq = 0 ack = Sending frame: seq = 0 ack =
  WP.
                                                                                                                  2 kind = NAK info =
4 kind = NAK info =
  SWP:
                                                                                                                          kind = NAK info =
kind = NAK info =
               Sending frame: seq = 0 ack = Sending frame: seq = 0 ack =
    WP:
                                                                  seq = 0 ack = 1 kind = ACK info =
seq = 0 ack = 2 kind = ACK info =
                Sending frame:
```

2.4 NetSim Quality Level 3

C:\Users\lianwei\Downl	oads\ass1>java VMach 1	
VMach is making a conn		
	Sim(DESKTOP-S7L205N/192.168.0.102:54321)	
		this is a test fro
SWP: Sending frame: se		the 2nd line
SWP: Sending frame: se		the 3rd line
SWP: Sending frame: se		the 4th line this is a test fro
SWP: Sending frame: Se	eq = 0 ack = 7 kind = DATA into = 0 eq = 0 ack = 0 kind = NAK info =	this is a test fro
SWP: Sending frame: se		the 3rd line
		the 5th line
		the 6th line
		the 4th line
SWP: Sending frame: se	q = 0 ack = 4 kind = NAK info =	
SWP: Sending frame: se		the 3rd line
		the 5th line
	q = 5 ack = 4 kind = DATA info = 5 q = 0 ack = 4 kind = ACK info =	the 6th line
		the 4th line
		the 3rd line
		the 5th line
SWP: Sending frame: se	q = 5 ack = 4 kind = DATA info = 5	the 6th line
		the 7th line
		the 8th line
		the 9th line
		the 10th line
		the 7th line the 8th line
		the 9th line
		the 10th line
		the 7th line
SWP: Sending frame: se		the 11th line
		the 12th line
		the 13th line
	q = 0 ack = 7 kind = NAK info =	
	q = 1 ack = 1 kind = DATA info = 9 q = 0 ack = 1 kind = NAK info =	the 10th line
		the 14th line
SWP: Sending frame: se		the 15th line
		the 16th line
SWP: Sending frame: se		the 13th line
	q = 0 ack = 2 kind = NAK info =	
SWP: Sending frame: se	q = 0 ack = 5 kind = NAK info =	
SWP: Sending frame: se	q = 0 ack = 6 kind = NAK info =	
		the 14th line
		the 15th line
		the 16th line the 13th line
	eq = 4 ack = 6 kind = DATA info = 12 eq = 0 ack = 6 kind = ACK info =	the 15th Time
	eq = 0 ack = 2 kind = NAK info =	
		the 14th line
		the 15th line
SWP: Sending frame: se	q = 7 ack = 2 kind = DATA info = 15	the 16th line
		the 13th line
		the 17th line
	q = 0 ack = 6 kind = ACK info =	the 14th line
		the 14th line the 15th line
		the 15th line
	eq = 0 ack = 6 kind = DATA info = 15	che 10th 11he
The second secon	4	

SWP:	Sending	frame:	seq =	7	ack	= 6	kind	=	DATA	info =	15	the	16th	line
	Sending													
	Sending												17th	
SWP:	Sending Sending	frame:	seq =	: 5	ack	= 6	Kind		DATA	info =	13		14th 15th	
SWP:	Sending	frame:	seq =	. 7	ack	= 0	kind	=	DATA	info =	15		16th	
SWP:	Sending	frame:	seq -		ack	= 1	kind	_	ΠΔΤΔ	info =	16		17th	
SWP:	Sending Sending	frame:	sea =	. a	ack	= 4	kind		NAK	info =	10	ciic	17 (11	11110
SWP:	Sending	frame:	seq =		ack	= 4	kind		DATA	info =	13	the	14th	line
SWP:	Sending	frame:	seq =		ack		kind		DATA	info =	17		18th	
SWP:	Sending	frame:	seq =	2	ack	= 4	kind		DATA	info =	18		19th	
SWP:	Sending	frame:	seq =		ack	= 4	kind		DATA	info =	19		20th	
SWP:	Sending Sending	frame:	seq =	: 4	ack	= 4	kind		DATA	info =	20	the	21th	line
SWP:	Sending	frame:	seq =	. 0	ack	= 6	kind		ACK 1	into =	4.7		4011	
SWP:	Sending Sending	frame:	seq =	: 1	ack	= 6	Kind	=	DATA	1n+o =	1/	tne	18th	line
SWP.	Sending	frame:	seq =	. 2	ack	- 6	kind		DATA	info -	12	the	19th	line
SWP:	Sending	frame:	seg =	5	ack	= 0	kind	_	DΔΤΔ	info =	21		22th	
SWP:	Sending	frame:	sea =	: 6	ack	= 0	kind		DATA	info =	22		23th	
SWP:	Sending Sending	frame:	seq =		ack	= 0	kind		DATA	info =	19	the	20th	line
SWP:	Sending	frame:	seq =	: 4	ack	= 0	kind		DATA	info =	20	the	21th	line
SWP:	Sending	frame:	seq =		ack	= 0	kind		DATA	info =	21		22th	
	Sending												23th	
SWP:	Sending	frame:	seq =	: 4	ack	= 0	kind		DATA	info =	20		21th	
SWP:	Sending Sending	trame:	seq =	: 3	ack	= 0	Kind		DATA	into =	19		20th 24th	
SWP:	Sending	frame:	seq =		ack	- 0	kind	=	DATA	info =	23		24th	
SWP.	Sending	frame:	seq =	. a	ack	= 0 - a	kind		DATA	info =	21		25th	
	Sending										24	ciic	23011	TINC
SWP:	Sending	frame:	sea =	: 1	ack	= 0	kind	=	DATA	info =	25	the	26th	line
SWP:	Sending	frame:	seq =	6	ack	= 0	kind		DATA	info =	22		23th	
SWP:	Sending Sending	frame:	seq =		ack	= 0	kind		DATA	info =	23		24th	
SWP:	Sending	frame:	seq =	- 1	ack	= 0	kind		DATA	info =	25		26th	
SWP:	Sending	frame:	seq =	2	ack	= 0	kind		DATA	info =	26		27th	
SWP:	Sending	frame:	seq =	: 3	ack	= 0	kind		DATA	into =	27		28th	
SWP:	Sending Sending	frame:	seq =	. 4	ack	= 0	kind		DATA	into =	28	the	29th	line
SWP.	Sending	frame:	seq =	. 1	ack	= 2	kind		DATA	info =	25	the	26th	line
SWP:	Sending	frame:	sea =		ack	= 2	kind	_	DATA	info =	26		27th	
SWP:	Sending	frame:	sea =	: 3	ack	= 2	kind		DATA	info =	27		28th	
SWP:	Sending	frame:	seq =		ack	= 2	kind		DATA	info =	28		29th	
SWP:	Sending	frame:	seq =		ack		kind		DATA	info =	29		30th	
SWP:	Sending	frame:	seq =	6	ack		kind		DATA	info =	30		31th	
SWP:	Sending	frame:	seq =	: 7	ack	= 2	kind		DATA	info =	31		32th	
SWP:	Sending Sending	frame:	seq =	. 0	ack	= 2	K1nd		DATA	into =	32	the	33th	line
	Sending Sending										30	the	31th	line
SWP.	Sending	frame:	sea -	- 5	ack	= 2	kind		DATA	info =	29		30th	
	Sending												32th	
SWP:	Sending	frame:	seq =	. 0	ack	= 2	kind		DATA	info =	32		33th	
SWP:	Sending	frame:	seq =	: 6	ack	= 2	kind		DATA	info =	30	the	31th	line
SWP:	Sending	frame:	seq =		ack		kind		DATA	info =	29		30th	
SWP:	Sending	frame:	seq =		ack		kind		DATA	info =	31		32th	
	Sending												33th	
SWP:	Sending	frame:	seq =	1	ack	= 2	kind		DATA	into =	33		34th	
SWP:	Sending Sending	frame:	seq =	1	ack	= 2	kind		DATA	info =	33		last 34th	
SWP:	Sending	frame:	seq =	2	ack	= 2	kind	Ī	DATA	info =	34		last	
SWP:	Sending	frame:	sea =	1	ack	= 2	kind		DATA	info =	33		34th	
SWP:	Sending	frame:	seq =	2	ack	= 2	kind		DATA	info =	34		last	
SWP:	Sending	frame:	seq =		ack	= 2	kind		DATA	info =	33		34th	
	Sending											the	last	line

```
C:\Users\Jianwei\Downloads\ass1>java VNach 2

VMach is making a connection with NetSim...

VWach(G1349) \( -=> \) NetSim(DESKTOP-S7L285N/192.168.0.102:54321)

SWP: Sending frame: seq = 0 ack = 7 kind = NAK info =

SWP: Sending frame: seq = 0 ack = 7 kind = DATA info = 0

SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 1

SWP: Sending frame: seq = 1 ack = 7 kind = DATA info = 1

SWP: Sending frame: seq = 3 ack = 7 kind = DATA info = 1

SWP: Sending frame: seq = 3 ack = 7 kind = DATA info = 2

the 3rd line

SWP: Sending frame: seq = 3 ack = 1 kind = DATA info = 3

SWP: Sending frame: seq = 4 ack = 1 kind = DATA info = 3

SWP: Sending frame: seq = 4 ack = 1 kind = DATA info = 4

the 5th line

SWP: Sending frame: seq = 3 ack = 1 kind = DATA info = 4

the 5th line

SWP: Sending frame: seq = 3 ack = 1 kind = DATA info = 3

the 4th line

SWP: Sending frame: seq = 5 ack = 1 kind = DATA info = 3

the 4th line

SWP: Sending frame: seq = 5 ack = 1 kind = DATA info = 3

the 4th line

SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 3

the 4th line

SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 3

the 4th line

SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 3

the 4th line

SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 5

the 6th line

SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 7

the 8th line

SWP: Sending frame: seq = 6 ack = 1 kind = DATA info = 8

the 9th line

SWP: Sending frame: seq = 0 ack = 1 kind = DATA info = 8

the 9th line

SWP: Sending frame: seq = 6 ack = 5 kind = DATA info = 8

the 6th line

SWP: Sending frame: seq = 0 ack = 1 kind = DATA info = 8

the 7th line

SWP: Sending frame: seq = 0 ack = 5 kind = DATA info = 8

the 6th line

SWP: Sending frame: seq = 6 ack = 5 kind = DATA info = 6

the 7th line

SWP: Sending frame: seq = 6 ack = 5 kind = DATA info = 6

the 7th line

SWP: Sending frame: seq = 7 ack = 5 kind = DATA info = 6

the 7th line

SWP: Sending frame: seq = 6 ack = 5 kind = DATA info = 7

the 8th line

SWP: Sending frame: seq = 6 ack = 5 kind = D
```

```
the 15th line
the 16th line
                                                                                                                                                                                                                      the 17th line
the 18th line
the 19th line
the 16th line
 WP:
                                                                                                                                                                                                                       the 17th line
                                                                                                                                                                                                                       the 19th line
                                                                                                                                                                                                                     the 19th line
the 20th line
the 21th line
the 22th line
the 23th line
SWP:
 WP:
                                                                                                                                                                                                                       the 24th line
                                                                                                                                                                                                                      the 25th line
the 26th line
the 27th line
 WP:
                                                                                                                                                                                                                    the 24th line
the 25th line
the 26th line
the 27th line
the 28th line
the 29th line
the 30th line
the 31th line
the 32th line
SWP:
WP:
                                                                                                                                                                                                                     the 30th line
the 34th line
the last line
the 32th line
                                                                                                                                                                                                                      the 34th line
the last line
           Sending frame: seq = 0 ack = 4 kind = NAK info = Sending frame: seq = 0 ack = 5 kind = NAK info = Sending frame: seq = 1 ack = 5 kind = DATA info = 33 Sending frame: seq = 2 ack = 5 kind = DATA info = 34 Sending frame: seq = 0 ack = 6 kind = NAK info = Sending frame: seq = 1 ack = 0 kind = DATA info = 33 Sending frame: seq = 1 ack = 0 kind = DATA info = 34 Sending frame: seq = 2 ack = 0 kind = DATA info = 34 Sending frame: seq = 0 ack = 4 kind = NAK info = Sending frame: seq = 0 ack = 5 kind = NAK info =
                                                                                                                                                                                                                       the 34th line
the last line
SWP:
                                                                                                                                                                                                                       the 34th line
the last line
SWP .
```

Java NetSim 3

```
C:\Users\Jianwei\Downloads\ass1>java NetSim 3
NetSim(Port= 54321) is waiting for connection ...
NetSim accepted connection from: DESKTOP-S7L205N : 61339
NetSim(Port= 54321) is waiting for connection ...
NetSim accepted connection from: DESKTOP-S7L205N : 61340
VMach 1 Check sum error for seq = 0 error counter = 1
WMach 1 loose frame seq = 2 error counter = 2
VMach 1 Check sum error for seq = 3 error counter = 3
VMach 2 loose frame seq = 1 error counter = 1
VMach 1 Check sum error for seq = 0 error counter = 4
VMach 1 Check sum error for seq = 2 error counter = 5
WMach 1 loose frame seq = 4 error counter = 6
VMach 1 Check sum error for seq = 5 error counter = 7
Whach 1 Check sum error for seq = 2 error counter = 7
Whach 2 Check sum error for seq = 2 error counter = 8
Whach 2 Check sum error for seq = 5 error counter = 3
Whach 2 Check sum error for seq = 7 error counter = 4
VMach 2 loose frame seg = 0 error counter = 5
VMach 1 Check sum error for seq = 3 error counter = 9
/Mach 2 loose frame seq = 5 error counter = 6
/Mach 2 Check sum error for seq = 6 error counter = 7
VMach 1 Check sum error for seq = 6 error counter = 10
VMach 1 Check sum error for seq = 0 error counter = 11
VMach 2 Check sum error for seq = 0 error counter = 8
VMach 1 Check sum error for seq = 1 error counter = 12
/Mach 1 loose frame seq = 6 error counter = 13
/Mach 2 loose frame seq = 0 error counter = 9
/Mach 2 loose frame seq = 5 error counter = 10
Whach 2 Check sum error for seq = 6 error counter = 10
Whach 2 Check sum error for seq = 7 error counter = 12
Whach 2 Check sum error for seq = 0 error counter = 12
/Mach 1 Check sum error for seq = 1 error counter = 14
Whach 2 loose frame seq = 0 error counter = 14
VMach 1 Check sum error for seq = 4 error counter = 15
VMach 2 loose frame seq = 6 error counter = 15
Whach 2 loose frame seq = 2 error counter = 15

VMach 2 loose frame seq = 3 error counter = 17
VMach 1 Check sum error for seq = 5 error counter = 16
/Mach 1 Check sum error for seq = 6 error counter = 17
VMach 1 Check sum error for seq = 4 error counter = 18
VMach 2 Check sum error for seq = 3 error counter = 18
VMach 2 Check sum error for seq = 6 error counter = 19
WMach 1 Check sum error for seq = 0 error counter = 19
WMach 1 Check sum error for seq = 0 error counter = 19
/Mach 1 Check sum error for seq = 5 error counter = 20
/Mach 1 Check sum error for seq = 6 error counter = 21
VMach 1 loose frame seq = 4 error counter = 22
VMach 1 Check sum error for seq = 0 error counter = 23
VMach 2 loose frame seq = 1 error counter = 21
VMach 1 Check sum error for seq = 5 error counter = 24
/Mach 1 Check sum error for seq = 6 error counter = 25
VMach 2 loose frame seq = 2 error counter = 22
VMach 1 loose frame seq = 7 error counter = 26
VMach 1 loose frame seq = 0 error counter = 27
VMach 1 Check sum error for seq = 0 error counter = 28
/Mach 1 Check sum error for seq = 5 error counter = 29
VMach 1 loose frame seq = 6 error counter = 30
/Mach 2 loose frame seq = 7 error counter = 23
WMach 2 Check sum error for seq = 1 error counter = 24
VMach 1 loose frame seq = 0 error counter = 31
```

```
VMach 2 Check sum error for seq = 2 error counter = 25
VMach 1 loose frame seq = 5 error counter = 32
VMach 1 Check sum error for seq = 7 error counter = 33
VMach 2 loose frame seq = 0 error counter = 26
VMach 2 Check sum error for seq = 5 error counter = 27
VMach 1 loose frame seq = 0 error counter = 34
VMach 1 loose frame seq = 1 error counter = 35
VMach 2 Check sum error for seq = 7 error counter = 28
VMach 1 Check sum error for seq = 3 error counter = 36
VMach 1 loose frame seq = 4 error counter = 37
VMach 2 loose frame seq = 0 error counter = 29
VMach 2 Check sum error for seq = 1 error counter = 30
VMach 1 loose frame seq = 0 error counter = 38
VMach 2 loose frame seq = 2 error counter = 31
VMach 1 loose frame seq = 2 error counter = 39
VMach 1 loose frame sed = 5 error counter = 40
VMach 2 loose frame seq = 0 error counter = 32
VMach 1 Check sum error for seq = 6 error counter = 41
VMach 2 loose frame seq = 0 error counter = 33
VMach 1 loose frame seq = 4 error counter = 42
VMach 2 loose frame sed = 0 error counter = 34
VMach 2 loose frame seq = 1 error counter = 35
VMach 2 loose frame seq = 2 error counter = 36
VMach 1 loose frame seq = 5 error counter = 43
VMach 1 Check sum error for seq = 6 error counter = 44
VMach 1 loose frame seg = 3 error counter = 45
VMach 2 Check sum error for seq = 0 error counter = 37
VMach 2 loose frame seq = 1 error counter = 38
VMach 1 loose frame seq = 1 error counter = 46
VMach 1 Check sum error for seq = 1 error counter = 47
VMach 1 Check sum error for seq = 2 error counter = 48
VMach 1 Check sum error for seq = 0 error counter = 49
VMach 2 loose frame seq = 2 error counter = 39
VMach 1 loose frame seq = 6 error counter = 50
VMach 2 loose frame seq = 0 error counter = 40
VMach 2 Check sum error for seq = 0 error counter = 41
VMach 1 Check sum error for seq = 0 error counter = 51
VMach 1 loose frame seq = 6 error counter = 52
VMach 1 loose frame seq = 5 error counter = 53
VMach 1 loose frame seq = 7 error counter = 54
VMach 1 loose frame seq = 0 error counter = 55
VMach 1 loose frame seq = 5 error counter = 56
VMach 1 Check sum error for seq = 7 error counter = 57
VMach 1 Check sum error for seq = 0 error counter = 58
VMach 1 Check sum error for seq = 1 error counter = 59
VMach 1 Check sum error for seq = 2 error counter = 60
VMach 1 loose frame seq = 1 error counter = 61
VMach 2 Check sum error for seq = 0 error counter = 42
VMach 1 Check sum error for seq = 2 error counter = 62
```

3. Source Code

```
File: SWP.java
This class implements the sliding window protocol
Used by VMach class
Uses the following classes: SWE, Packet, PFrame, PEvent
Author: Professor SUN Chengzheng
School of Computer Engineering
Nanyang Technological University
Singapore 639798
import java.util.Timer;
import java.util.TimerTask;
public class SWP {
the following are provided, do not change them!!
====*/
 //the following are protocol constants.
 public static final int MAX_SEQ = 7;
 public static final int NR BUFS = (MAX SEQ + 1)/2;
 // the following are protocol variables
 private int oldest_frame = 0;
 private PEvent event = new PEvent();
 private Packet out_buf[] = new Packet[NR_BUFS];
       //declare in_buffer which is a packet data type
 private Packet in buffer[] = new Packet[NR BUFS];
 //the following are used for simulation purpose only
 private SWE swe = null;
 private String sid = null;
 //Constructor
 public SWP(SWE sw, String s){
   swe = sw;
   sid = s;
 //the following methods are all protocol related
 private void init(){
```

```
for (int i = 0; i < NR_BUFS; i++){
         out_buf[i] = new Packet();
   }
 private void wait_for_event(PEvent e){
   swe.wait_for_event(e); //may be blocked
   oldest_frame = e.seq; //set timeout frame seq
 private void enable_network_layer(int nr_of_bufs) {
 //network layer is permitted to send if credit is available
       swe.grant_credit(nr_of_bufs);
 }
 private void from_network_layer(Packet p) {
   swe.from_network_layer(p);
 private void to_network_layer(Packet packet) {
       swe.to_network_layer(packet);
 private void to_physical_layer(PFrame fm) {
   System.out.println("SWP: Sending frame: seq = " + fm.seq +
                        " ack = " + fm.ack + " kind = " +
                        PFrame.KIND[fm.kind] + " info = " + fm.info.data );
   System.out.flush();
   swe.to_physical_layer(fm);
 private void from_physical_layer(PFrame fm) {
   PFrame fm1 = swe.from_physical_layer();
       fm.kind = fm1.kind;
       fm.seq = fm1.seq;
       fm.ack = fm1.ack:
       fm.info = fm1.info;
 }
____*
implement your Protocol Variables and Methods below:
____*/
```

```
//between method that is similar to protocol 5. Checks the frame numbers if it is valid
public static boolean between(int a, int b, int c){
       return ((a \le b) \&\& (b < c)) \parallel ((c < a) \&\& (a <= b)) \parallel ((b < c) \&\& (c < a));
  }
 //A java method to send the frames
private void send_frame(int frame_kind, int next_frame, int frame_expected, Packet buffer[])
// Construct and send a data, ack, or nak frame.
   PFrame s = new PFrame();
  s.kind = frame kind; // 3 kind of frames == data, ack, or nak
     if (frame_kind == PFrame.DATA) {
       s.info = buffer[next_frame % NR_BUFS];
     s.seq = next_frame; //only meaningful for data frames
     s.ack = (frame\_expected + MAX\_SEQ) \% (MAX\_SEQ + 1);
     if (frame_kind == PFrame.NAK) {
       no_nak = false; //one nak per frame
     to_physical_layer(s); //transmit the frame
     if (frame kind == PFrame.DATA) {
       start_timer(next_frame);
    stop_ack_timer(); //no need for separate ack frame
 public void protocol6() {
    init();
       int expected_ack;
                                            //expected frame acknowledgement
                                            //Frame number of the next frame to be sent
       int next frame send;
       int expected_frame;
                                            //Frame expected to be recieved by reciever
                                            //index of the buffer
       int index;
       int upper_limit;
                                            //upper limit of the buffer
       boolean recieved[] = new boolean[NR BUFS];
                                                           //To Keep track of frames arrived
       PFrame temp frame = new PFrame();
                                                           //declare the temporary frame
```

boolean no_nak = true; //no nak has been sent yet

```
enable_network_layer(NR_BUFS);
                                                   //initialize network layer
 //initialize the counter variables
 expected_ack = 0;
 next\_frame\_send = 0;
 expected_frame = 0;
  upper_limit = NR_BUFS;
 index = 0:
 for(int i = 0; i < NR\_BUFS; i++)
        recieved[i] = false;
 while(true) {
wait_for_event(event);
   switch(event.type) {
     case (PEvent.NETWORK LAYER READY):
          //When network layer is ready, fetch new packets from network layer and put the
          packets in the out buffer of the sender
          from_network_layer(out_buf[next_frame_send%NR_BUFS]);
        //transmit data fetched, which is in the senders' buffer from the network layer over
         the network
          send_frame(PFrame.DATA,next_frame_send,expected_frame,out_buf);
          //Next frame to be sent from the buffer will be incremented
          next_frame_send = inc(next_frame_send);
      break;
     case (PEvent.FRAME_ARRIVAL ):
          from_physical_layer(temp_frame);
          if (temp_frame.kind == PFrame.DATA)
  //A complete and undamaged frame is recieved
  if ((temp_frame.seq != expected_frame) && no_nak)
   send_frame(PFrame.NAK, 0, expected_frame, out_buf);
  else
 //If the recieved frame is not a data frame
  start_ack_timer();
```

```
//Check if the frame recieved is between the expected frames of the sliding window and recieved frame is not duplicated
```

```
if (between(expected_frame, temp_frame.seq,upper_limit) && (recieved[temp_frame.seq %
NR_BUFS] == false)) {
 //This allows the frames to be accepted in any order of arrival in the reciever
 recieved[temp_frame.seq % NR_BUFS] = true;
 //If the data frame recieved is not damaged and falls between the expected frame and the limit
 of the sliding window buffer, add the frame into the input buffer
 in_buffer[temp_frame.seq % NR_BUFS] = temp_frame.info;
 while (recieved[expected_frame % NR_BUFS]) {
//Pass frames recieved from the physical layer by the sender to the network layer
to_network_layer(in_buffer[expected_frame % NR_BUFS]);
no nak = true;
//mark the undamaged data frame recieved by the reciever as recieved
recieved[expected_frame % NR_BUFS] = false;
//Increment the lower expected in the sliding window when the complete expected frame is
recieved by the reciever machine
expected frame = inc(expected frame);
//When a complete and undamaged frame is recieved, the upper edge of the sliding window is
also incremented
              upper_limit = inc(upper_limit);
              //start the ack timer
                start_ack_timer();
            }
//If the frame in the reciever's side is NAK, we will check that the frame is in between the current
sliding window and resend the data of the frame which the NAK has been recieved
     if ((temp_frame.kind == PFrame.NAK)
           && between(expected ack,
           ((temp_frame.ack + 1) % (MAX_SEQ +1)), next_frame_send))
              {
//send the data of the frame for which NAK has been recieved by the sender of the data
   send_frame(PFrame.DATA, ((temp_frame.ack + 1)%(MAX_SEQ + 1)),
   expected_frame, out_buf);
while (between(expected_ack, temp_frame.ack,next_frame_send)) {
```

//If a complete and undamaged frame is recieved

```
stop_timer(expected_ack % NR_BUFS);
       //In the sender's sliding window increase the expected sliding window for the ack to be
      recieved for the sent data frames
           expected_ack = inc(expected_ack);
                //always free 1 buffer slot if ack has been done
           enable_network_layer(1);
      break;
       case (PEvent.CKSUM_ERR):
       if (no_nak) {
           //damaged frame
           send frame(PFrame.NAK, 0, expected frame,out buf);
         }
        break;
        case (PEvent.TIMEOUT):
      //If the timer is expired for the oldest frame, then resend the data for the frame for which
      the timer has expired
         send_frame(PFrame.DATA, oldest_frame,expected_frame, out_buf);
             break:
          case (PEvent.ACK_TIMEOUT):
      //If ack timer expired in the reciever's side for the frame that has been recieved, send the
      ACK again
         send_frame(PFrame.ACK, 0, expected_frame,out_buf);
           break:
      default:
      System.out.println("SWP: undefined event type = " + event.type);
      System.out.flush();
/* Note: when start timer() and stop timer() are called,
 the "seq" parameter must be the sequence number, rather
 than the index of the timer array.
 of the frame associated with this timer,
 Timer frame_timer[] = new Timer[NR_BUFS];
 Timer ack_timer;
 public static int inc(int num) {
    num = ((num + 1) \% (MAX\_SEQ + 1));
    return num:
```

} }

}

```
private void start_timer(int seq) {
  stop_timer(seq);
 //create new timer
 frame_timer[seq % NR_BUFS] = new Timer();
 //schedule the task for execution after 200ms
 frame_timer[seq % NR_BUFS].schedule(new ReTask(swe, seq), 200);
private void stop_timer(int seq) {
     if (frame_timer[seq % NR_BUFS] != null) {
     frame_timer[seq % NR_BUFS].cancel();
   }
}
private void start_ack_timer( ) {
     stop ack timer();
   //starts another timer for sending separate ack
   ack_timer = new Timer();
   ack_timer.schedule(new AckTask(swe), 100);
}
private void stop_ack_timer() {
     if (ack_timer != null) {
     ack timer.cancel();
   }
}
//for retransmission timer
class ReTask extends TimerTask {
   private SWE swe = null;
   public int seqnr;
   public ReTask(SWE sw, int seq) {
     swe = sw;
     seqnr = seq;
   }
   public void run() {
     //stops this timer and discard any
     //scheduled tasks for the current segnr
     stop_timer(seqnr);
     swe.generate_timeout_event(seqnr);
}
//for ack timer
```

```
class AckTask extends TimerTask {
    private SWE swe = null;
    public AckTask(SWE sw) {
       swe = sw;
    public void run() {
       // stop the timer
       stop_ack_timer();
       swe.generate_acktimeout_event();
    }
  }
}//End of class
/* Note: In class SWE, the following two public methods are available:
 . generate_acktimeout_event() and
 . generate_timeout_event(seqnr).
 To call these two methods (for implementing timers),
 the "swe" object should be referred as follows:
  swe.generate_acktimeout_event(), or
  swe.generate_timeout_event(seqnr).
```