

Name: Chandrawanshi Mangesh Shivaji
Roll Number : 1801cs16
CS359 Assignment 5
Filename : Lab5_Report_1801CS16.pdf

Note: Please keep all the files in same directory before compilation as well as while usage

1. Go Back N Protocol

```
// Compilation details
$ gcc -o client_gbn client_gbn.c
$ gcc -o server_gbn server_gbn.c
```

```
// Run
$ ./client_gbn WINDOW_SIZE
$ ./server_gbn WINDOW_SIZE
```

To get reasonable output, keep WINDOW_SIZE same for both server and client

Client :

- Send Messages along with sequence number
- Receive ACK or NAK from the server, depending on the sent message order cummulatively.
- ACK x - represents all messages from sequence number 0 to x are successfully received by the server
- In the ACK scenario user may send messages from sequence number x + 1 (hopefully in order)
- NAK x - represents that message x is not received by the server, all messages from 0 to (x-1) are successfully received
- In the NAK scenario user may send messages from sequence number x again in order

Server:

- Receive Message along with sequence number from the client
- In case of inorder receipt of messages, send ack with last received sequence number
- In case of out of order receipt of messages, send nak with expected sequence number

Example1 : Result for in order transfer of messages

Example2 : Result for out of order transfer of messages

Following are command line results for both the examples sequentially.

1. Client Side (inorder gbn)

```
$ ./client_gbn 4
[+]Client socket created successfully.
Window Size is 4, Use sequence numbers starting from 0
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Manchester City face Manchester United in
0
the 185th Manchester derby on Sunday in a game
1
that, less than two months ago, was shaping up
2
to be a potential Premier League title decider.
3
ACK 3
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
United climbed to the top of the table with a 1-0
4
win at Burnley on Jan. 12, moving seven points clear
5
of City (who had two games in hand) to raise hopes of
6
a first title at Old Trafford since 2013. But when United
7
ACK 7
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
8
team will find themselves 14 points behind Pep
9
Guardiola's men following a 21-point swing in just seven weeks.
10
Heading into the weekend, City and United are the top two
11
ACK 11
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Leicester can climb into second with a win
12
at Brighton on Saturday
13
so how close are the two teams
14
in terms of quality?
15
ACK 15
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
ESPN tests the strength
16
of the squads by
17
selecting a combined XI
18
from the two teams.
19
ACK 19
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
exit
```

1.Server Side (inorder gbn)

```
$ ./server_gbn 4
[+]Server socket created successfully
[+]Binding successfull.
Received Message from Client : Manchester City face Manchester United in
Sequence Number: 0
Received Message from Client : the 185th Manchester derby on Sunday in a game
Sequence Number: 1
Received Message from Client : that, less than two months ago, was shaping up
Sequence Number: 2
Received Message from Client : to be a potential Premier League title decider.
Sequence Number: 3
Received Message from Client : United climbed to the top of the table with a 1-0
Sequence Number: 4
Received Message from Client : win at Burnley on Jan. 12, moving seven points clear
Sequence Number: 5
Received Message from Client : of City (who had two games in hand) to raise hopes of
Sequence Number: 6
Received Message from Client : a first title at Old Trafford since 2013. But when United
Sequence Number: 7
Received Message from Client : travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
Sequence Number: 8
Received Message from Client : team will find themselves 14 points behind Pep
Sequence Number: 9
Received Message from Client : Guardiola's men following a 21-point swing in just seven weeks.
Sequence Number: 10
Received Message from Client : Heading into the weekend, City and United are the top two
Sequence Number: 11
Received Message from Client : Leicester can climb into second with a win
Sequence Number: 12
Received Message from Client : at Brighton on Saturday
Sequence Number: 13
Received Message from Client : so how close are the two teams
Sequence Number: 14
Received Message from Client : in terms of quality?
Sequence Number: 15
Received Message from Client : ESPN tests the strength
Sequence Number: 16
Received Message from Client : of the squads by
Sequence Number: 17
Received Message from Client : selecting a combined XI
Sequence Number: 18
Received Message from Client : from the two teams.
Sequence Number: 19
```

In the above example, all messages are transferred sequentially by client without in sequence number error. All are received and displayed on server side. Commulative ACK is send by the server after each window transfer.

2. Client Side (out of order gbn)

```
$ ./client_gbn 4
[+]Client socket created successfully.
Window Size is 4, Use sequence numbers starting from 0
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Manchester City face Manchester United in
0
the 185th Manchester derby on Sunday in a game
1
that, less than two months ago, was shaping up
2
to be a potential Premier League title decider.
3
ACK 3
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
United climbed to the top of the table with a 1-0
4
of City (who had two games in hand) to raise hopes of
6
a first title at Old Trafford since 2013. But when United
7
travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
8
NAK 5
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
win at Burnley on Jan. 12, moving seven points clear
5
of City (who had two games in hand) to raise hopes of
6
a first title at Old Trafford since 2013. But when United
7
travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
8
ACK 8
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
team will find themselves 14 points behind Pep
9
Guardiola's men following a 21-point swing in just seven weeks.
10
Heading into the weekend, City and United are the top two
11
at Brighton on Saturday
13
NAK 12
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Leicester can climb into second with a win
12
at Brighton on Saturday
13
so how close are the two teams
14
in terms of quality?
15
ACK 15
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
ESPN tests the strength
16
of the squads by
17
selecting a combined XI
18
from the two teams.
19
ACK 19
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
exit
[+]Closing the connection.
```


2. Server Side (out of order gbn)

```
$ ./server_gbn 4
[+]Server socket created successfully
[+]Binding successfull.
Received Message from Client : Manchester City face Manchester United in
Sequence Number: 0
Received Message from Client : the 185th Manchester derby on Sunday in a game
Sequence Number: 1
Received Message from Client : that, less than two months ago, was shaping up
Sequence Number: 2
Received Message from Client : to be a potential Premier League title decider.
Sequence Number: 3
Received Message from Client : United climbed to the top of the table with a 1-0
Sequence Number: 4
Message Discarded, (Sequence Number Out of Order) : Expected = 5, Found = 6
Message Discarded, (Sequence Number Out of Order) : Expected = 5, Found = 7
Message Discarded, (Sequence Number Out of Order) : Expected = 5, Found = 8
Received Message from Client : win at Burnley on Jan. 12, moving seven points clear
Sequence Number: 5
Received Message from Client : of City (who had two games in hand) to raise hopes of
Sequence Number: 6
Received Message from Client : a first title at Old Trafford since 2013. But when United
Sequence Number: 7
Received Message from Client : travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
Sequence Number: 8
Received Message from Client : team will find themselves 14 points behind Pep
Sequence Number: 9
Received Message from Client : Guardiola's men following a 21-point swing in just seven weeks.
Sequence Number: 10
Received Message from Client : Heading into the weekend, City and United are the top two
Sequence Number: 11
Message Discarded, (Sequence Number Out of Order) : Expected = 12, Found = 13
Received Message from Client : Leicester can climb into second with a win
Sequence Number: 12
Received Message from Client : at Brighton on Saturday
Sequence Number: 13
Received Message from Client : so how close are the two teams
Sequence Number: 14
Received Message from Client : in terms of quality?
Sequence Number: 15
Received Message from Client : ESPN tests the strength
Sequence Number: 16
Received Message from Client : of the squads by
Sequence Number: 17
Received Message from Client : selecting a combined XI
Sequence Number: 18
Received Message from Client : from the two teams.
Sequence Number: 19
```

In the above example, messages with sequence number 5 and 12 are skipped by the user initially. In this case server discards all the messages in the current window and sends NAK with expected sequence number to client. Client then resends messages in appropriate order and receives cumulative ACK.

Wireshark Analysis For Go Back N

// See Packet Capture files in zip

Caputer File for Example 1 : go_back_n_inorder.pcapng

Capture File for Example 2 : go_back_n_outoforder.pcapng

Total Packets Capture in Ex1 = 45 and in Ex2 = 54

So, 2 incorrect sequence number orders result in additional 9 packets, as we have to send many messages in the current windw which are discarded again.

2. Selective Repeat Protocol

```
// Compilation details
$ gcc -o client_sel_rep client_sel_rep.c
$ gcc -o server_sel_rep server_sel_rep.c

// Run
$ ./client_sel_rep WINDOW_SIZE
$ ./server_sel_rep WINDOW_SIZE
```

To get reasonable output, keep WINDOW_SIZE same for both server and client
Description :

Client:

- Send Messages along with sequence numbers
- Receive ACK or NAK from the server, depending on the sent message order for each message
- ACK x - represents message with sequence number x is successfully received by the server. If all are ACK, user may send messages from sequence number x + 1 (hopefully in order)
- NAK x - represents that message x is not received by the server. If any one is NAK , user may send message with sequence number x first, and then follow previous order no need to send all packages from x+1 again

Server:

- Receive messages along with sequence numbers from client
- If message sequence number is not expected (out of order) and buffer is not full, buffer the message and store sequence number
- else display the message along with sequence number, along with all previously buffered messages and sequence numbers if present

Example1 : Result for in order transfer of messages

Example2 : Result for out of order transfer of messages

Following are command line results for both the examples sequentially.

1. Client Side (sr in order)

```
$ ./client_sel_rep 4
[+]Client socket created successfully.
Window Size is 4, Use sequence numbers starting from 0
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Manchester City face Manchester United in
0
the 185th Manchester derby on Sunday in a game
1
that, less than two months ago, was shaping up
2
to be a potential Premier League title decider.
3
ACK 0
ACK 1
ACK 2
ACK 3
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
United climbed to the top of the table with a 1-0
4
win at Burnley on Jan. 12, moving seven points clear
5
of City (who had two games in hand) to raise hopes of
6
a first title at Old Trafford since 2013. But when United
7
ACK 4
ACK 5
ACK 6
ACK 7
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
8
team will find themselves 14 points behind Pep
9
Guardiola's men following a 21-point swing in just seven weeks.
10
Heading into the weekend, City and United are the top two
11
ACK 8
ACK 9
ACK 10
ACK 11
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Leicester can climb into second with a win
12
at Brighton on Saturday
13
so how close are the two teams
14
in terms of quality?
15
ACK 12
ACK 13
ACK 14
ACK 15
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
ESPN tests the strength
16
of the squads by
17
selecting a combined XI
18
from the two teams.
19
ACK 16
ACK 17
ACK 18
ACK 19
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
exit
[+]Closing the connection.
```

2. Server Side (sr inorder)

```
$ ./server_sel_rep 4
[+]Server socket created successfully
[+]Binding successfull.
Received Message from Client : Manchester City face Manchester United in
Sequence Number: 0
Received Message from Client : the 185th Manchester derby on Sunday in a game
Sequence Number: 1
Received Message from Client : that, less than two months ago, was shaping up
Sequence Number: 2
Received Message from Client : to be a potential Premier League title decider.
Sequence Number: 3
Received Message from Client : United climbed to the top of the table with a 1-0
Sequence Number: 4
Received Message from Client : win at Burnley on Jan. 12, moving seven points clear
Sequence Number: 5
Received Message from Client : of City (who had two games in hand) to raise hopes of
Sequence Number: 6
Received Message from Client : a first title at Old Trafford since 2013. But when United
Sequence Number: 7
Received Message from Client : travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
Sequence Number: 8
Received Message from Client : team will find themselves 14 points behind Pep
Sequence Number: 9
Received Message from Client : Guardiola's men following a 21-point swing in just seven weeks.
Sequence Number: 10
Received Message from Client : Heading into the weekend, City and United are the top two
Sequence Number: 11
Received Message from Client : Leicester can climb into second with a win
Sequence Number: 12
Received Message from Client : at Brighton on Saturday
Sequence Number: 13
Received Message from Client : so how close are the two teams
Sequence Number: 14
Received Message from Client : in terms of quality?
Sequence Number: 15
Received Message from Client : ESPN tests the strength
Sequence Number: 16
Received Message from Client : of the squads by
Sequence Number: 17
Received Message from Client : selecting a combined XI
Sequence Number: 18
Received Message from Client : from the two teams.
Sequence Number: 19
```

In the above example, all messages are transferred sequentially by client without in sequence number error. All are received and displayed on server side. Individual ACKs for each message are send by the server after each window transfer.

2. Client Side (sr outoforder)

```
./client_sel_rep 4
[+]Client socket created successfully.
Window Size is 4, Use sequence numbers starting from 0
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Manchester City face Manchester United in
0
the 185th Manchester derby on Sunday in a game
1
that, less than two months ago, was shaping up
2
to be a potential Premier League title decider.
3
ACK 0
ACK 1
ACK 2
ACK 3
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
United climbed to the top of the table with a 1-0
4
of City (who had two games in hand) to raise hopes of
6
a first title at Old Trafford since 2013. But when United
7
travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
8
ACK 4
NAK 5
ACK 6
ACK 7
ACK 8
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
win at Burnley on Jan. 12, moving seven points clear
5
team will find themselves 14 points behind Pep
9
Guardiola's men following a 21-point swing in just seven weeks.
10
Heading into the weekend, City and United are the top two
11
ACK 5
ACK 9
ACK 10
ACK 11
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
at Brighton on Saturday
13
so how close are the two teams
14
in terms of quality?
15
ESPN tests the strength
16
NAK 12
ACK 13
ACK 14
ACK 15
ACK 16
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
Leicester can climb into second with a win
12
of the squads by
17
selecting a combined XI
18
from the two teams.
19
ACK 12
ACK 17
ACK 18
ACK 19
*****
*****
Enter current set of messages (count = (4)WINDOW_SIZE) to send ('exit' to quit):
(Format for each msg : line1 = data_msg, line2 = seq_num)
exit
[+]Closing the connection.
```

2. Server Side (sr outoforder)

```
$ ./server_gbn 4
[+]Server socket created successfully
[+]Binding successfull.
Received Message from Client : Manchester City face Manchester United in
Sequence Number: 0
Received Message from Client : the 185th Manchester derby on Sunday in a game
Sequence Number: 1
Received Message from Client : that, less than two months ago, was shaping up
Sequence Number: 2
Received Message from Client : to be a potential Premier League title decider.
Sequence Number: 3
Received Message from Client : United climbed to the top of the table with a 1-0
Sequence Number: 4
Message Discarded, (Sequence Number Out of Order) : Expected = 5, Found = 6
Message Discarded, (Sequence Number Out of Order) : Expected = 5, Found = 7
Message Discarded, (Sequence Number Out of Order) : Expected = 5, Found = 8
Received Message from Client : win at Burnley on Jan. 12, moving seven points clear
Sequence Number: 5
Received Message from Client : of City (who had two games in hand) to raise hopes of
Sequence Number: 6
Received Message from Client : a first title at Old Trafford since 2013. But when United
Sequence Number: 7
Received Message from Client : travel to the Etihad on Sunday, Ole Gunnar Solskjaer's
Sequence Number: 8
Received Message from Client : team will find themselves 14 points behind Pep
Sequence Number: 9
Received Message from Client : Guardiola's men following a 21-point swing in just seven weeks.
Sequence Number: 10
Received Message from Client : Heading into the weekend, City and United are the top two
Sequence Number: 11
Message Discarded, (Sequence Number Out of Order) : Expected = 12, Found = 13
Received Message from Client : Leicester can climb into second with a win
Sequence Number: 12
Received Message from Client : at Brighton on Saturday
Sequence Number: 13
Received Message from Client : so how close are the two teams
Sequence Number: 14
Received Message from Client : in terms of quality?
Sequence Number: 15
Received Message from Client : ESPN tests the strength
Sequence Number: 16
Received Message from Client : of the squads by
Sequence Number: 17
Received Message from Client : selecting a combined XI
Sequence Number: 18
Received Message from Client : from the two teams.
Sequence Number: 19
```

In the above example, messages with sequence number 5 and 12 are skipped by the user initially. In this case server buffers all the other out of sequence messages in the current window and sends NAK for 5 and 12 and ACK for all other displayed and buffered messages. Client then sends messages with NAK (along with other messages ahead) and receives individual ACK.

Wireshark Analysis For Selective Repeat

// See Packet Capture files in zip

Caputer File for Example 1 : selective_repeat_inorder.pcapng

Capture File for Example 2 : selective_repeat_outoforder.pcapng

Total Packets Capture in Ex1 = 60 and in Ex2 = 62

So, 2 incorrect sequence number orders result in additional 2 packets, as we have to send only messages out of sequence.