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Analysis and implementation of Stop&Wait ,Goback N and Selective Repeat algorithms

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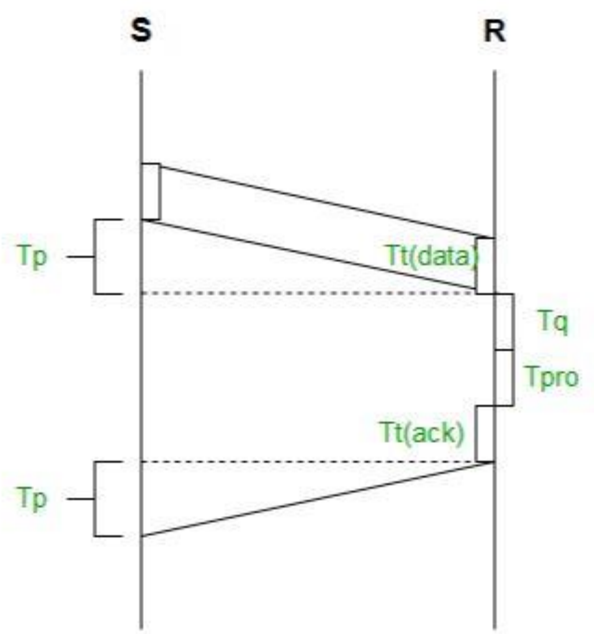
Stop and Wait Protocol

Stop and Wait is a flow control protocol. In which the sender sends one packet and waits for the receiver to acknowledge and then it will send the next packet. In case if the acknowledgment is not received, the sender will retransmit the packet. This is the simplest one and easy to implement. but the main disadvantage is the efficiency is very low.



Tt(data) : Transmission delay for Data packet

Tp(data) : propagation delay for Data packet

Tq: Queuing delay

Tpro: Processing delay

Tt(ack): Transmission delay for acknowledgment

Tp(ack) : Propagation delay for acknowledgment

And we know that the Efficiency (η) :

η = Useful time / Total cycle time.

$$= T_t / (T_t + 2*T_p) = 1 / (1+2*(T_p/T_t))$$

Throughput: Number of bits send per second, which is also known as Effective Bandwidth or Bandwidth utilization.

Throughput,

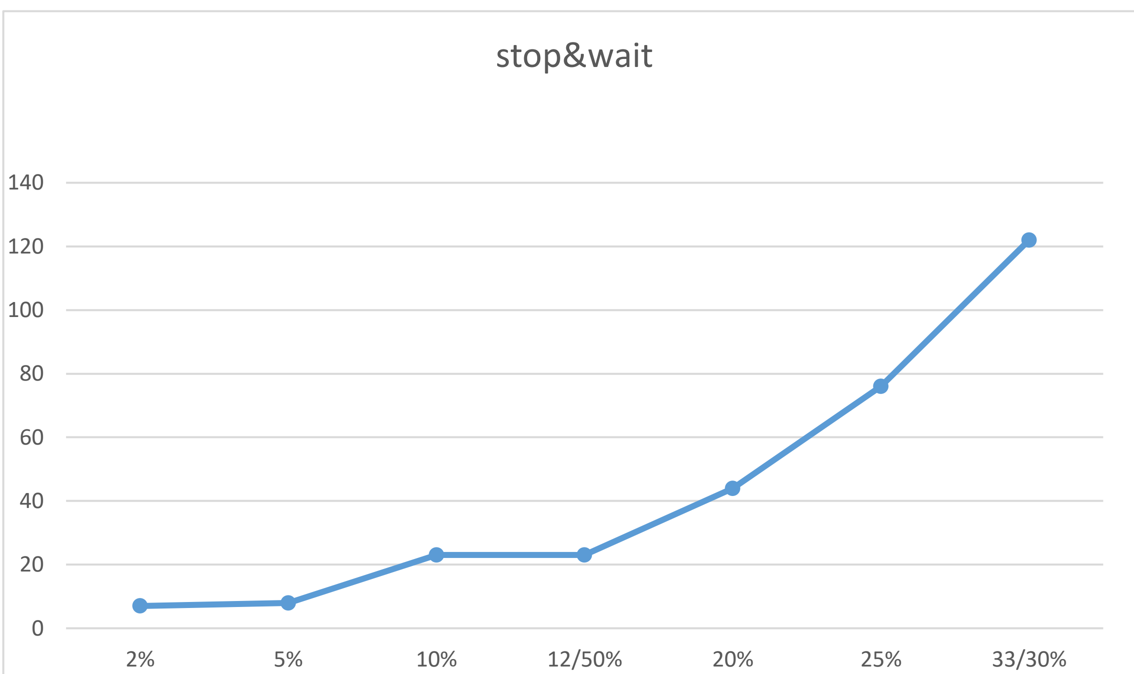
$$= L/(T_t + 2*T_p)$$

$$= ((L/BW)*BW)/(T_t + 2*T_p)$$

$$= T_t/(T_t + 2*T_p) * BW = 1/(1 + 2a) * BW$$

Hence, Throughput = η * BW

BW : BandWidth L : Size of Data packet



Go – Back – N:

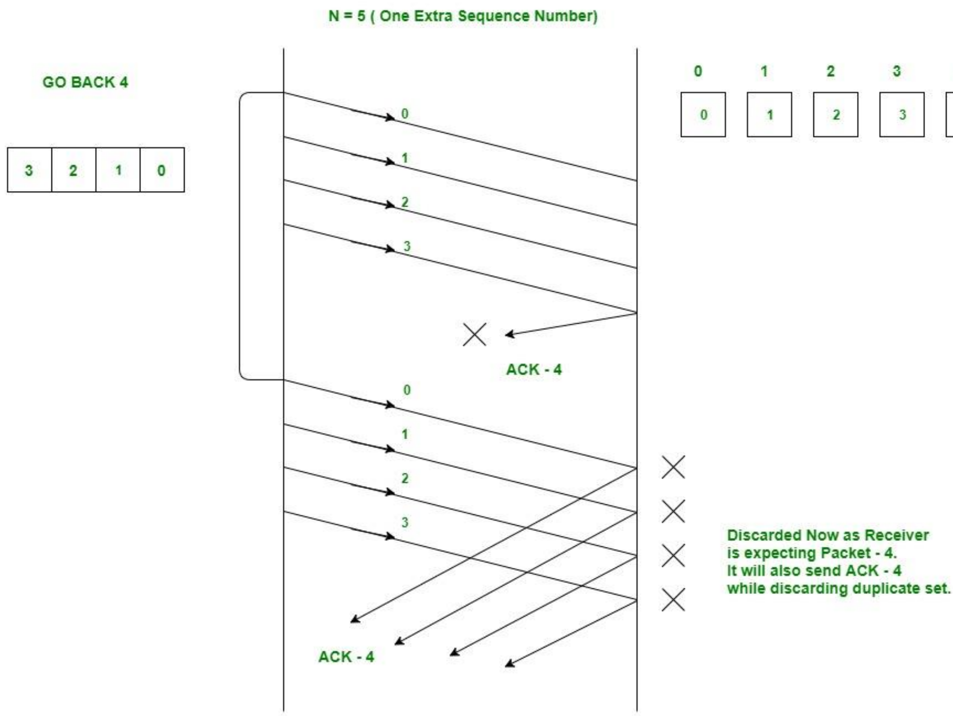
Go-Back-N protocol, also called Go-Back-N Automatic Repeat reQuest, is a data link layer protocol that uses a sliding window method for reliable and sequential delivery of data frames. It is a case of sliding window protocol having to send window size of N and receiving window size of 1.

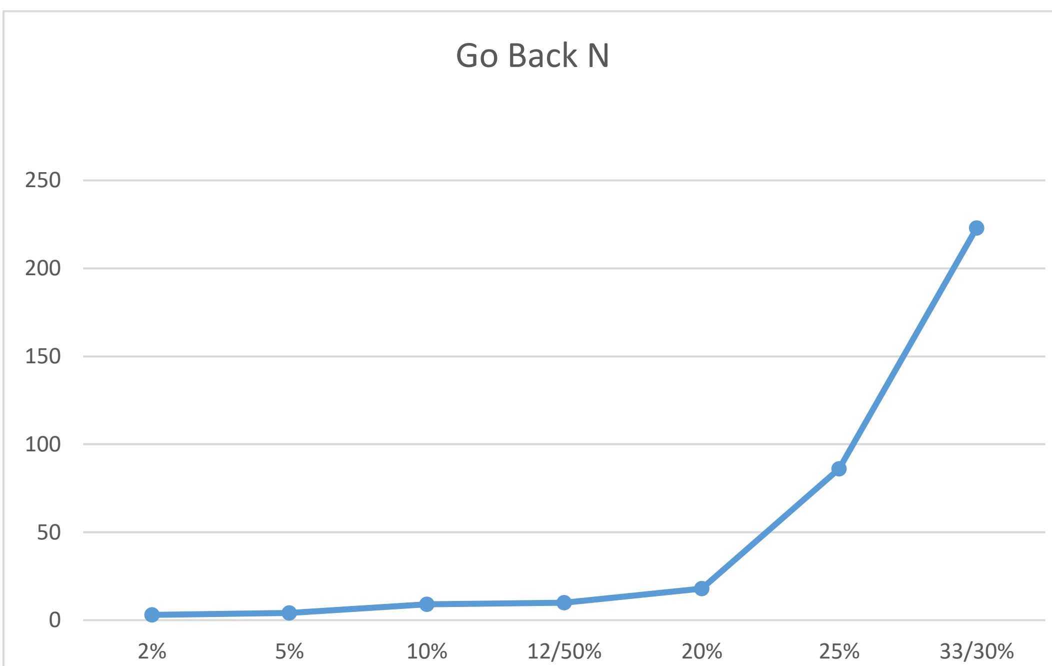
Go – Back – N provides for sending multiple frames before receiving the acknowledgment for the first frame. The frames are sequentially numbered and a finite number of frames. The maximum number of frames that can be sent depends upon the size of the sending window. If the acknowledgment of a frame is not received within an agreed upon time period, all frames starting from that frame are retransmitted.

The size of the sending window determines the sequence number of the outbound frames. If the sequence number of the frames is an n-bit field, then the range of sequence numbers that can be assigned is 0 to 2n−1. Consequently, the size of the sending window is 2n−1. Thus in order to accommodate a sending window size of 2n−1, a n-bit sequence number is chosen.

The sequence numbers are numbered as modulo-n. For example, if the sending window size is 4, then the sequence numbers will be 0, 1, 2, 3, 0, 1, 2, 3, 0, 1, and so on. The number of bits in the sequence number is 2 to generate the binary sequence 00, 01, 10, 11.

The size of the receiving window is 1.


N = 5 (One Extra Sequence Number)
GO BACK 4
3 2 1 0
0 1 2 3 4
ACK - 4
Discarded Now as Receiver
is expecting Packet - 4.
It will also send ACK - 4
while discarding duplicate set.
ACK - 4


Go Back N
250
200
150
100
50
0
2%
5%
10%
12/50%
20%
25%
33/30%

Selective Repeat :

The go-back-n protocol works well if errors are less, but if the line is poor it wastes a lot of bandwidth on retransmitted frames. An alternative strategy, the selective repeat protocol, is to allow the receiver to accept and buffer the frames following a damaged or lost one.

Selective Repeat attempts to retransmit only those packets that are actually lost (due to errors) :

- Receiver must be able to accept packets out of order.
- Since receiver must release packets to higher layer in order, the receiver must be able to buffer some packets.

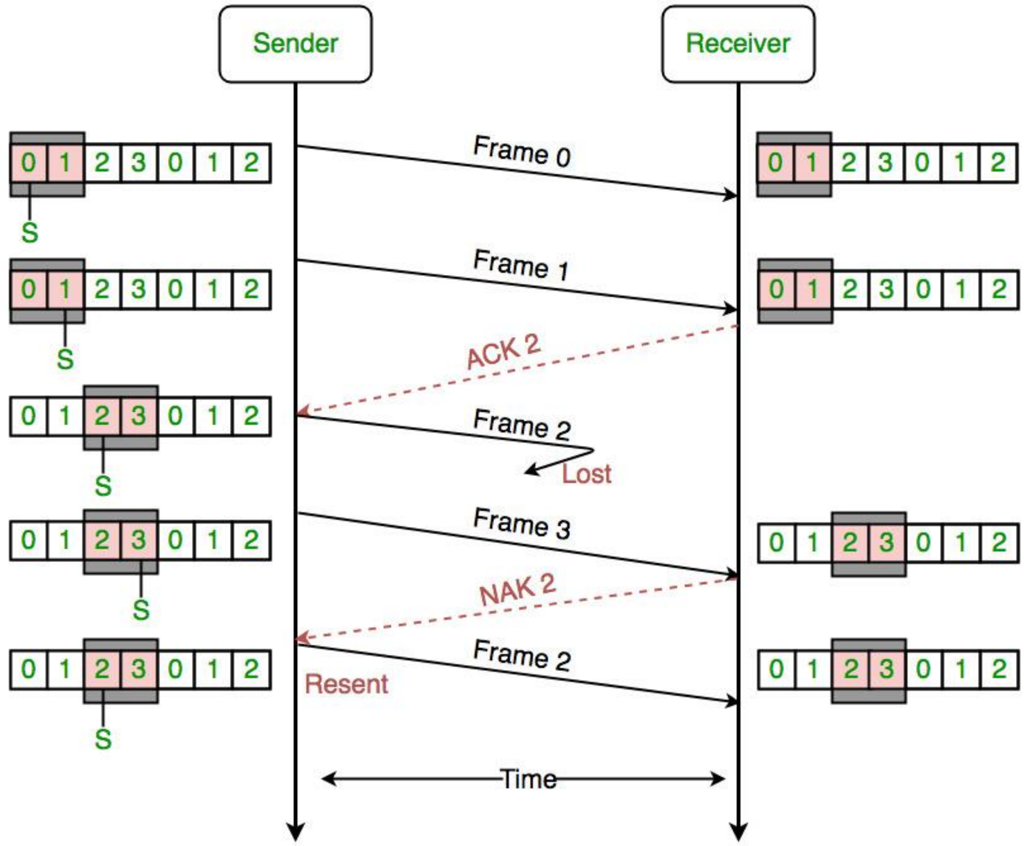
Retransmission requests :

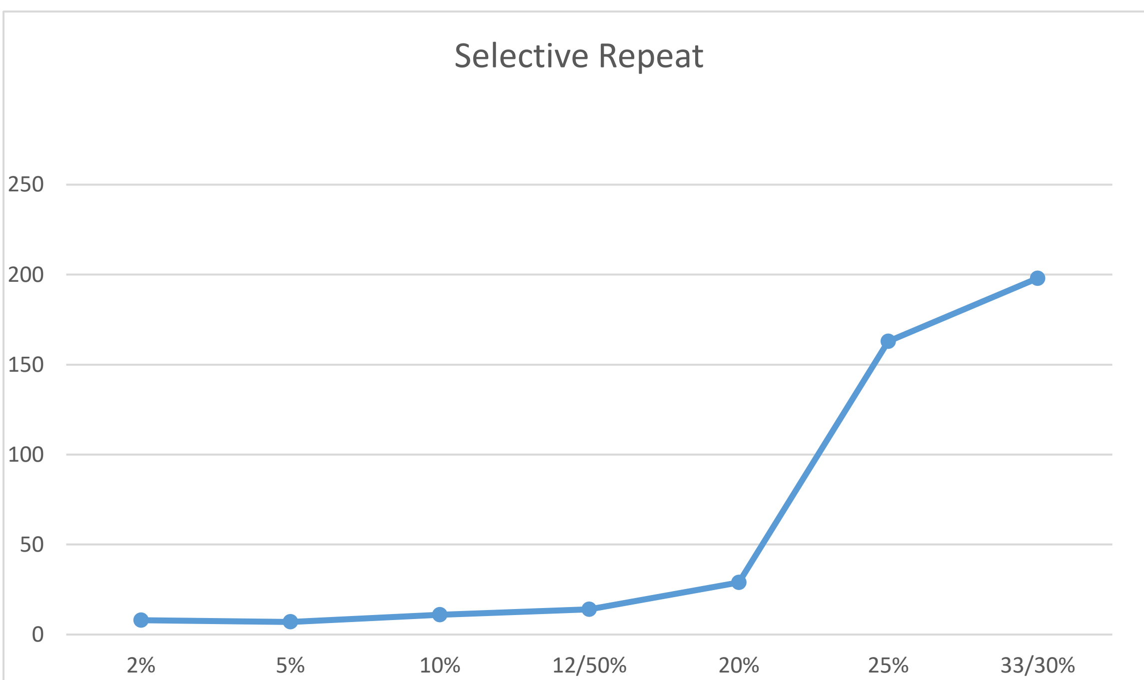
- **Implicit –** The receiver acknowledges every good packet, packets that are not ACKed before a time-out are assumed lost or in error.Notice that this approach must be used to be sure that every packet is eventually received.
- **Explicit –** An explicit NAK (selective reject) can request retransmission of just one packet. This approach can expedite the retransmission but is not strictly needed.

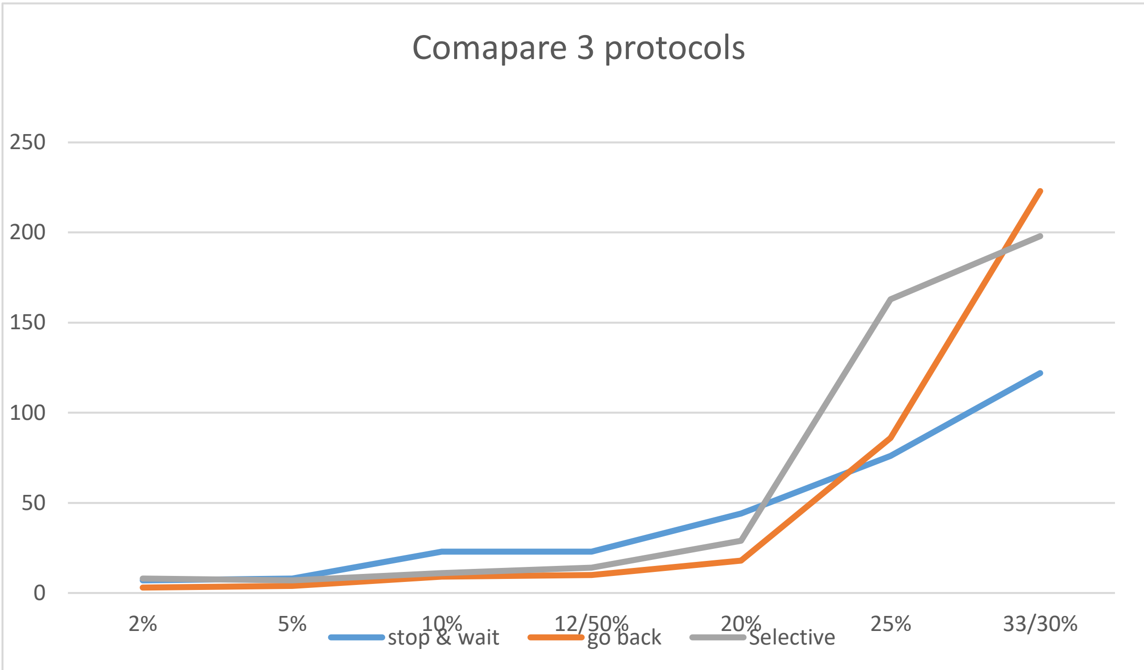
This protocol(SRP) is mostly identical to GBN protocol, except that buffers are used and the receiver, and the sender, each maintain a window of size. SRP works better when the link is very unreliable. Because in this case, retransmission tends to happen more frequently, selectively retransmitting frames is more efficient than retransmitting all of them. SRP also requires full duplex link. backward acknowledgements are also in progress.

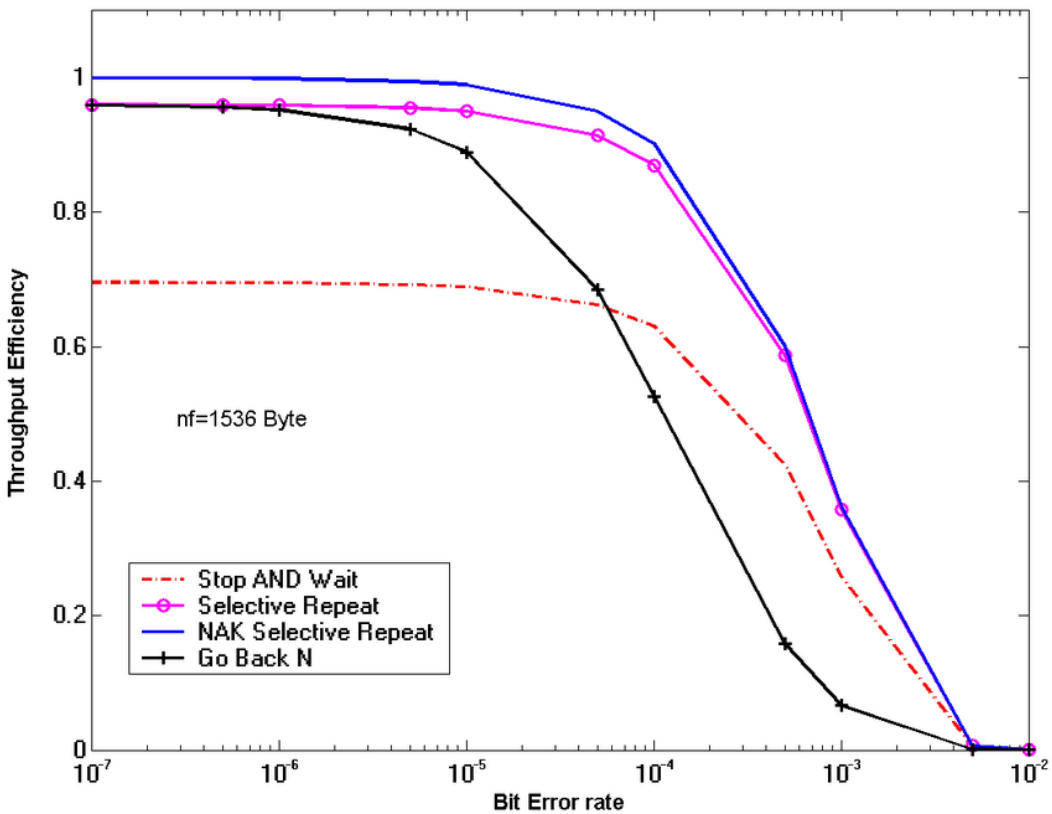
- Sender's Windows (Ws) = Receiver's Windows (Wr).
- Window size should be less than or equal to half the sequence number in SR protocol. This is to avoid packets being recognized incorrectly. If the windows size is greater than half the sequence number space, then if an ACK is lost, the sender may send new packets that the receiver believes are retransmissions.

- Sender can transmit new packets as long as their number is with W of all unACKed packets.
- Sender retransmit un-ACKed packets after a timeout – Or upon a NAK if NAK is employed.
- Receiver ACKs all correct packets.
- Receiver stores correct packets until they can be delivered in order to the higher layer.
- In Selective Repeat ARQ, the size of the sender and receiver window must be at most one-half of 2^m.


Sender
Receiver
Frame 0
Frame 1
ACK 2
Frame 2
Lost
Frame 3
NAK 2
Frame 2
Resent
Time
S


Selective Repeat
250
200
150
100
50
0
2%
5%
10%
12/50%
20%
25%
33/30%

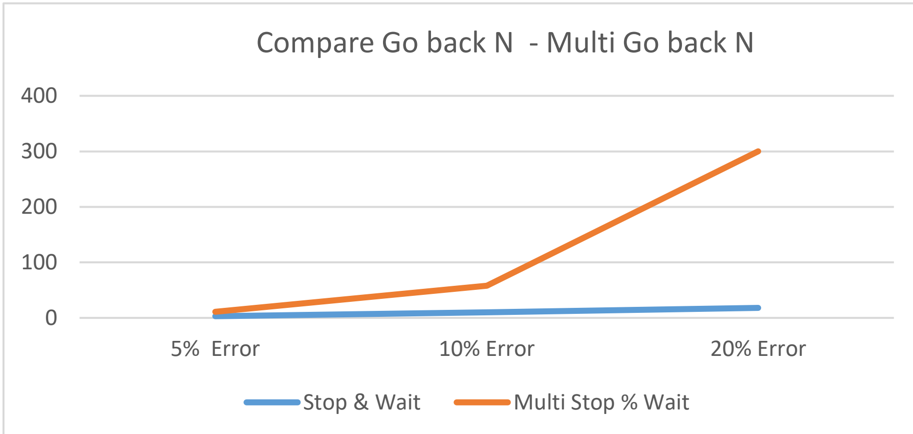


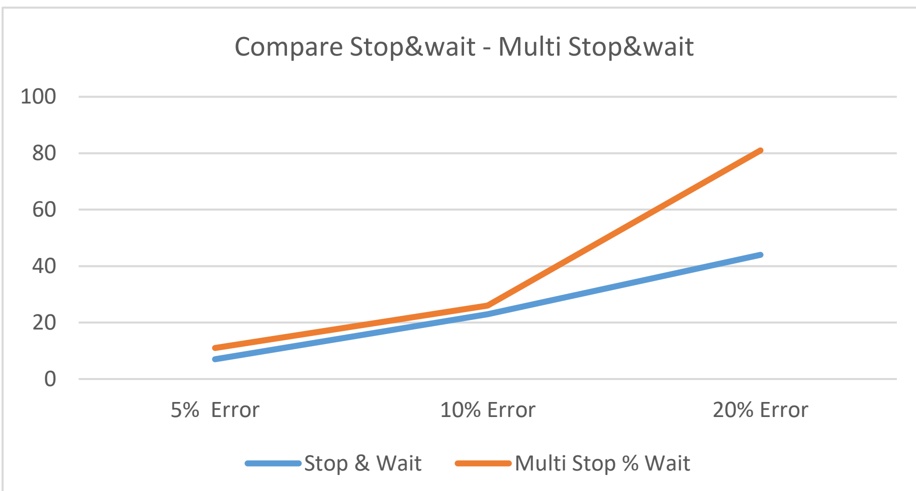


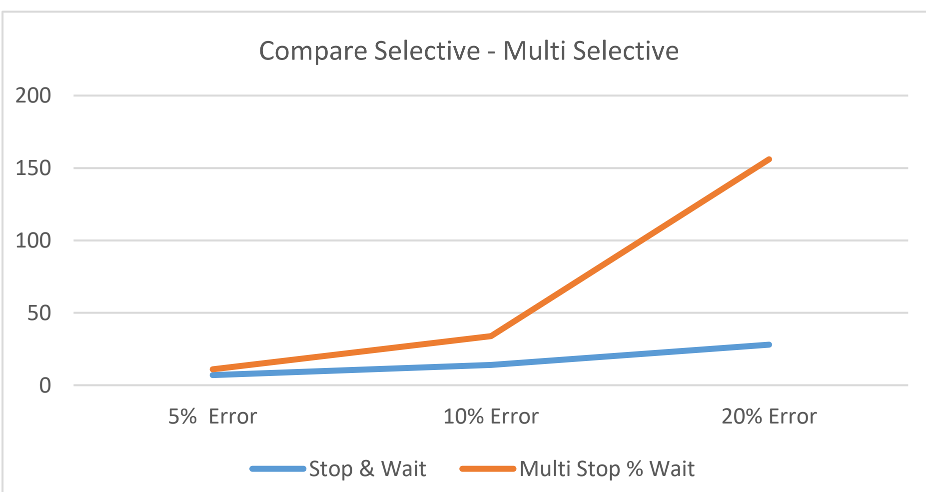
It is clear that with increasing error in each protocol the efficiency decreases .In addition, it should be noted that Stop&Wait has less efficiency than others from the beginning.

[Multiple Receiver Strategies for Minimizing Packet Loss in Dense Sensor Networks]

Bernhard Firner, Chenren Xu, Richard Howard, and Yanyong Zhang







	Stop and Wait ARQ	Go back N	Selective Repeat	Remarks
Efficiency	1 / (1+2a)	N / (1+2a)	N / (1+2a)	Go back N and Selective Repeat gives better efficiency than Stop and Wait ARQ.
Window Size	Sender Window Size = 1 Receiver Window Size = 1	Sender Window Size = N Receiver Window Size = 1	Sender Window Size = N Receiver Window Size = N	Buffer requirement in Selective Repeat is very large. If the system does not have lots of memory, then it is better to choose Go back N.
Minimum number of sequence numbers required	2	N+1	2 x N	Selective Repeat requires large number of bits in sequence number field.
Retransmissions required if a packet is lost	Only the lost packet is retransmitted	The entire window is retransmitted	Only the lost packet is retransmitted	Selective Repeat is far better than Go back N in terms of retransmissions required.

Bandwidth Requirement	Bandwidth requirement is Low	Bandwidth requirement is high because even if a single packet is lost, entire window has to be retransmitted. Thus, if error rate is high, it wastes a lot of bandwidth.	Bandwidth requirement is moderate	Selective Repeat is better than Go back N in terms of bandwidth requirement.
Acknowledgements	Uses independent acknowledgement for each packet	Uses cumulative acknowledgements (but may use independent acknowledgements as well)	Uses independent acknowledgement for each packet	Sending cumulative acknowledgements reduces the traffic in the network but if it is lost, then the ACKs for all the corresponding packets are lost.
Type of Transmission	Half duplex	Full duplex	Full duplex	Go back N and Selective Repeat are better in terms of channel usage.

a = Ratio of Propagation delay and Transmission delay,

Here are three concepts that are included in this implementation :

First ,we need to consider Specified channel response time to calculate efficiency and utility. We used the Sleeping function for this purpose. The function sleep gives a simple way to make the program wait for a short interval. If your program doesn't use signals (except to terminate), then you can expect sleep to wait reliably throughout the specified interval.

Second ,Frames are formed in data link layer of the OSI whereas Packets are formed in Network layer, 'Framing errors' are the number of packets received with an invalid frame checksum (FCS). This is typically a physical issue. However, the obvious thing is that the error rate increases with increasing frame length .

And finally To implement an error occurring in the this project, Three types of errors were examined in general:

Sending error : implemented with send function and occures when the data could not sent successfully

Receiving error : implemented with receive function and occures when the data could not deliver successfully

Timing error : It is not possible to implement this mode in programming languages where the compiler interprets the code line by line , So it is not possible for data to be delayed. Random function is used to probability distribution , So we took that into account in this project, given the particular probability.