FLOW CONTROL AND ERROR CONTROL MECHANISM IN DATA LINK LAYER(DLL) USING ARQ TECHNIQUES

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Abstract— Data link layer deals with flow control and error control mechanism in networks. in generally there are three protocols are used for flow control and error control mechanism, The efficient transmission of data over unreliable channels that can lose, reorder and duplicate messages due to router or receiver limited buffer space, are retransmitted by the source. If the error detected the receiver can try to obtain the error by using three flow and error control protocol ARQ techniques, Selective repeat protocol gives better transmission efficiency than other protocols. In selective repeat ARQ, only the specific damaged or lost frame is retransmitted. If a frame is corrupted in transit, a NAK is returned and the frame is resent out of sequence .the receiving device must be able to sort the frames, it has and insert the retransmitted frame into its proper place in the sequence, in this paper using ARQ techniques, comparing transmission efficiency of three protocols and selective repeat protocol is ideal.[1][2]

Keywords— **ACK, GOBACK, ARQ, NAK ,BUFFER, BANDWIDTH, TRANSMISSION EFFICIENCY**

I. INTRODUCTION

In data link layer, for effective communication and make sure the high reliable and secure data communication. An effective and good interface is required between two machines. Something is necessary because of some constraints. The constraints are the sender and receivers have the limited speed and memory and there are two major types error, they are frame loss and frame damage. To solve these problems develop the error control policies for error detection, original ACK and timer. The Major function of the data link layer is if error occurred at the transmission time the correct the error and make the error free data. The important function of data link layer to convince all these requirements are the error control and flow control.

Data link layer have to correct these problems:-

• Bits stream convert into frames

• Transmit the frames and repair the frames

• Maximum value of any transmission errors

When the sender send a frame packet and in between error and some inconsistency or modified data occur then the receiver receive the error massage(corrupted message) and if error is detected then receiver send a request to the sender retransmit the data or packet. So with the help of flow control policy or error control protocols so with the help of flow control policy or error control protocols sender send again corrected data. an error is detected in an exchange , is returned the specified frame are retransmitted this process is called **Automatic Repeat Request (ARQ)[1]** Three types of ARQ schemes have already produced standards these are stop and wait ARQ, Go back N ARQ, and Selective repeat ARQ. ARQ can effectively implement the flow control, which allows the receiver to be able to adjust the flow of data from the sender to receive buffer from overflowing. There are three ARQ techniques; **3.**Our objective is to devise suitable mechanism for efficient and reliable communication between the two machines through the link. This will require great deal of coordination between the two machines. A layer of logic is added above the physical interface to achieve the necessary control and management referred to as **Data Link Control**. Key components of the data link control are:

Frame synchronization: The beginning and end of a data block (called *frame*) should be distinguishable.

Addressing: In case of multipoint communication the identity of the two stations involved in the communication are to be specified.

Flow control: The sender should send frames at a rate such that the receiver is not overwhelmed.

Error control: Any bit errors introduced by the transmission system should be corrected.

Control and data on the same link: The receiver must be able to distinguish control information from the data being transmitted.

Link management: Procedures for the management of the initiation, maintenance, and termination of a sustained data exchange.

I. SLIDING WINDOW PROTOCOLS

This shows a different performance in terms of their efficiency, complexity and buffer requirement. Sliding window protocol assumes full duplex communication. It uses
two types of frames, first data and second acknowledgment.
One of important features of all the sliding windows protocol
is that each outbound frame contains a sequence number, ranging from 0 to 2n -1, where the value of n can be arbitrary. Sliding window refers to imaginary boxes at the transmitter and receiver. This window provides the upper limit on the number of frames that can be transmitted before
Acknowledgment requirement. Window holds the number of frame to provide above mention limit. The frames which are
being transmitted to send are falling in sending window similarly frames to be accepted are store in the receiving window. This sliding window protocol is widely used in communication. Protocol such as TCP,HDLC and SPX .The
poor quality communication channels where the data probably will get duplicated, last or reorder, can provide efficient data transfer with high complexity. This protocol is establishing protocol in ISO-051 Protocol stack.

2.1 Significance of Sender's and Receiver's Windows:

Both the senders and receivers windows are needed not to be of same size. The input sequence obtained from sending host are required to be transmitted via an unreliable network, they must be delivered on the receiving host on the same order in which they appear in the input sequence. So that the correctness condition for sliding window protocol is satisfied. The sequence no. within the sender's window gives the number of frame sent but not yet acknowledge. The frames in the sender's window are stored so that they can be possibly retransmitted in the case of damage while travelling to receiver. The receiver window represents not the number of frame receive but the no. of frame that may still be received before an ACK is sent. Because sliding window of receiver strings from left when frame of data are received and expand to right when ACK is sent. The receiver window contains (n-1) spaces for frame.[1]

2.2 A One Bit Sliding Window Protocol (Stop and Wait ARQ):

In this case n=1 and uses stop and wait technique. Sender waits for ACK after each frame transmission. The operation of this protocol is based on the ARQ(automatic repeat request)principle, which hold the next frame will be transmitted when positive ACK is received and when negative ACK is received, it retransmit the same frame. Stop and wait ARQ becomes inefficient when the propagation delay is much greater than the time tool retransmit for example let us assume that frame of 800 bits is transmitted over channel with speed 1mbps and let time for transmission if from end ACK is 30 ms. The number of bits that can be transmitted over this channel is 30,000 bits. But in stop and wait ARQ only 800 bits can be transmitted as it waits for ACK. The product of bit rate and delay is called delay bandwidth product. It helps in measuring last opportunity in transmitted bits.

2.3 A Protocol Using Go Back n:

The sender in this case does not wait for the ACK signal for
Transmission of next frame. The sender continuously transmits the frame so that the channel should be kept busy rather that wasting time in waiting for it ACK. Because in stop and protocol system does not transmit anything while it is waiting So channel remain idle for considerable time period But in this case the system does depends on only NACK(negative feedback). It symbolizes error in a particular frame. But as NACK signal will take same time to reach sender, the sender will continue to transmit. On the reception of the NACK signal, the transmitter will retransmit all the frames 3 onwards. The receivers discard all the frames it has received after 3.Example: suppose the frame is being transmitted end at frame bit 3 error occurs and NACK is transmitted at the receiver. But this takes some time to reach the transmitter. By the time up to frame 7 has all ways been transmitted. If the transmitter frame is lost or acknowledgement is lost then only error occurs. In case of damaged or lost frames the receiver transmits NACK to transmitter and the transmitter retransmits all the frames sent since the last frame acknowledged. The disadvantage of go back ARQ protocol is that its efficiency decreases in noisy channel as it does not wait for ACK after every frame transmitted. **PIGGY BACKING [2]**
MOST of the real time systems the data transmission needs to be bi-directional which is popularly called as full duplex system. Now this two way transmission can be achieved in two ways: a) the method in which two separate channels are involved for both forward and reversed transfer. But in this case acknowledgement are involved which waste the bandwidth of the reverse entirely. This whole system is the basis of the sliding window protocol's) But there is a better solution to achieve fullduplexing with same capacity channels for both ways (forward and reversed) transmission. In this technique, suppose two A and B users transmits data frame then data frames from A and B is intermixed with ACK and from B to A. when the receivers receives the data frame it does not transfer ACK signal immediately but wait until the network layer of receiver moves to next data packet then ACK is attached to this outgoing data packet to be transmitted to A.
this technique in which the acknowledgement is delayed temporarily is called piggy backing. Though it provides additional complexity but involves better use of channel bandwidth. The only thing we have to consider is that data link layer may take too long to transmit.

3.1 Improvement of the Throughput Efficiency:

If the delays remain unchanged the throughput efficiency will decrease. So to compensate this it will be necessary to use longer blocks for higher data rates. But it must be kept in mind that the longer blocks will have a greater probability of error. So the optimum block length is must for any particular system so throughput efficiency depends upon the type of system used. The half duplex system have poor efficiency which can be increased by adapting the continuous mode of transmission instead of block by block transmission. This system will avoided time but needs more storage or buffering.

4. SIMPLE PROCEDURE OF SLIDING WINDOW COMMUNICATION:

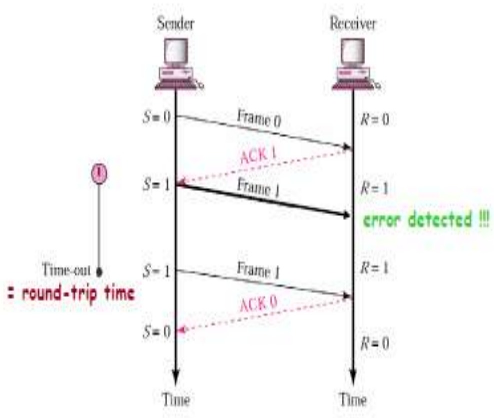
· In the beginning the sending window and the receiving window are empty.· Sender start sending data frames and receiver waits for frames from network.· Whenever sender gets new packet from network layer the next higher sequence number according to sending window is given and the upper edge is advanced by one.· After transmitting one frame and starting the timer, the sender will transmit next data until sending window is filled.· in mean time sender wait for ACK.

If active ACK is received then sender fetches next packet and overwrite the previous packet on buffer. If damaged ACK or timer goes off then duplicate should be sent.· When a valid frame arrives, its sequence number is checked to see if it is the next one. If it the next one then it is accepted and passed to network layer and ACK will be generated.· But if it does not happen so then it will be discarded and is not passed to network layer.[3]

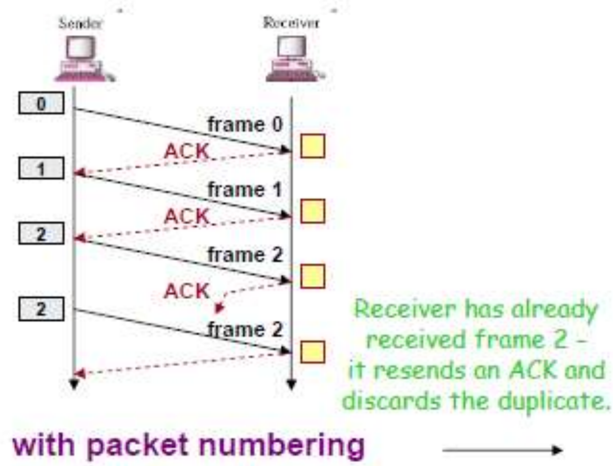
II. METHODOLOGY

Stop-and-Wait ARQ:

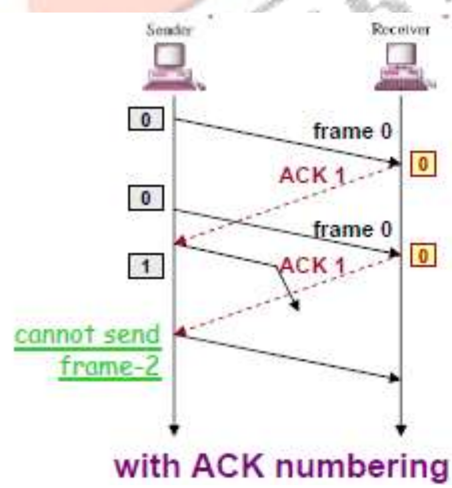
Three things can happen. 1. The frame arrives safe and sound at the receiver site; the receiver sends an acknowledgment. The acknowledgment arrives at the sender site, causing the sender to send the next frame numbered x + 1. 2. The frame arrives safe and sound at the receiver site; the receiver sends an acknowledgment, but the acknowledgment is corrupted or lost. The sender resends the frame (numbered x) after the time-out. Note that the frame here is a duplicate. The receiver can recognize this fact because it expects frame x + I but frame x was received. 3. The frame is corrupted or never arrives at the receiver site; the sender resends the frame (numbered x) after the time-out. simplest flow and error control mechanism sender sends an information frame to receiver sender, then, stops and waits for an ACK if no ACK arrives within time-out, sender will resend the frame, and again stop and wait time-out period > roundtrip time abnormalities (and how to fix them) lost acknowledgment delayed acknowledgment.



Lost Acknowledgment frame received correctly, but ACK undergoes errors / loss after time-out period, sender resends frame receiver receives the same frame twice frames must be numbered so that receiver can recognize and discard duplicate frames sequence # are included in packet header



Delayed Acknowledgment (Premature Timeout) ACKs can be delayed due to problems with links or network congestion time-out expires early, sender resends frame when delayed ACK arrives, sender assumes that given ACK is for the last frame sent ACKs must be numbered to prevent gaps in delivered packet sequence



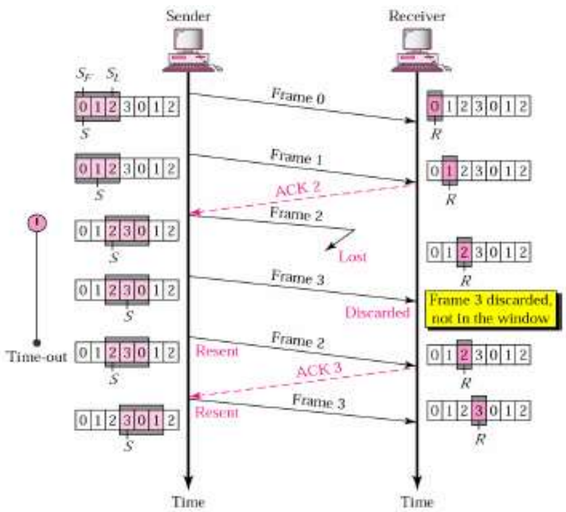
$$t_0 = 2 \cdot t_{prop} + 2 \cdot t_{proc} + t_{frame} + t_{ACK} = 2 \cdot t_{prop} + 2 \cdot t_{proc} + \frac{n_f}{R} + \frac{n_{ACK}}{R}$$

$$R_{eff} = \frac{\text{number of info bits delivered to destination}}{\text{total time required to deliver info bits}} = \frac{n_f - n_{header}}{t_0}$$

$$\eta_{SW} = \frac{R_{eff}}{R} = \frac{1 - \frac{n_{header}}{n_f}}{1 + \frac{n_{ACK}}{n_f} + \frac{2\cdot(t_{prop}+t_{proc})R}{n_f}}$$

Go-Back-N ARQ:

The send window allows us to have as many frames in transition as there are slots in the send window. Go-Back-N ARQ-overcomes inefficiency of Stop-and-Wait ARQ –sender continues sending enough frames to keep channel busy while waiting for ACKs a window of Ws outstanding frames is allowed m-bit sequence numbers are used for both – frames and ACKs, and $W_s = 2^m-1$



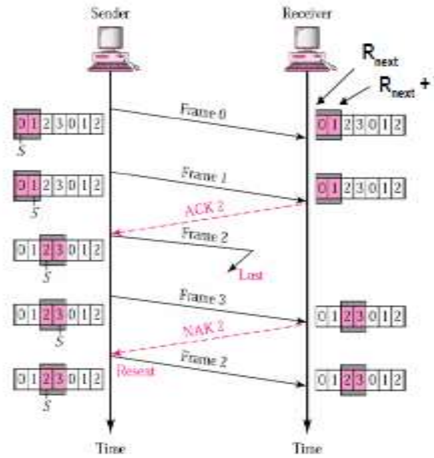
$$t_{GBN} = (1-P_f)\cdot t_{frame} + P_f\cdot\left(t_{frame} + \frac{1}{1-P_f}\cdot W_s\right) = t_{frame} + \frac{P_f}{1-P_f}\cdot W_s\cdot t_{frame}$$

$$\eta_{GBN} = \frac{\frac{n_f - n_{header}}{t_{GBN}}}{R} = \frac{1-\frac{n_{header}}{n_f}}{1+(W_s-1)P_f}(1-P_f)$$

Selective Repeat ARQ • Go-Back-N is NOT suitable for 'noisy links' – in case of a lost/damaged frame a whole window of frames need to be resent excessive retransmissions use up the bandwidth and slow down transmission Selective Repeat ARQ overcomes the limitations of Go-Back-N by adding 2 new features

(1) receiver window > 1 frame, so that out-of-order but error-free frames can be accepted

(2) retransmission mechanism is modified – only individual frames are retransmitted Selective Repeat ARQ is used in TCP.[3]



$$t_{SR} = \frac{t_{frame}}{1-P_f} = \frac{n_f}{R\cdot(1-P_f)}$$

$$\eta_{SR} = \frac{R_{eff}}{R} = \frac{\frac{n_f - n_{header}}{t_{SR}}}{R} = \left(1-\frac{n_{header}}{n_f}\right)\cdot(1-P_f)$$

III. RESULTS AND DISCUSSION

Example [Stop-and-Wait vs. Go-Back-N]

n_f = 1250 bytes = 10000 bits

$n_{ACK} = n_{header}$ = 25 bytes = 200 bits

Compare S&W with GBN efficiency for random bit errors with pb = 0, 10^{-6}, 10^{-5}, 10^{-4} and bandwidth-delay product R*2*(tprop+tproc) = 1 Mbps * 100 ms = 100000 bits = 10 frames → use Ws = 11.

Efficiency	p_b=0	$p_b=10^{-6}$	$p_b=10^{-5}$	$p_b=10^{-4}$
S & W	8.9 %	8.8 %	8.0 %	3.3 %
GBN	98 %	88.2 %	45.4 %	4.9 %

Go-Back-N provides significant improvement over Stop-and-Wait for large delay bandwidth product

Go-Back-N becomes inefficient as error rate increases

Performance Comparison

assume n_{ACK} and n_{header} are negligible relative to n_f, and

$(2(t_{prop} + t_{proc})R)/n_f = L = W_s - 1$

Efficiencies of three ARQ techniques are

$\eta_{SW} = (1/(1 + L)) * (1 - P_f)$

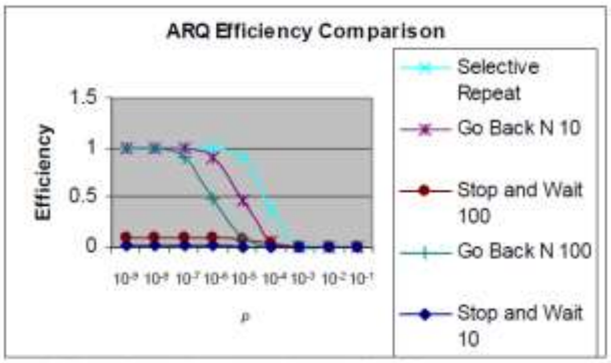
$\eta_{GBN} = (1/(1 + LP_f)) * (1 - P_f)$

$\eta_{SR} = (1 - P_f)$

$\eta_{SW} < \eta_{GBN} < \eta_{SR}$

for $0 < P_f < 1$, Selective Repeat provides best performance

for $P_f \rightarrow 0$ Go-Back-N as good as Selective Repeat



Delay-Bandwidth product = 10, 100

IV. CONCLUSION

In this paper discussed about the sliding window protocol regarding their ARQ mechanisms stop and wait protocol propagation delay is more and go-back-n protocol is moderate and selective repeat protocol is better. Selective repeat protocol shown better transmission efficiency than other protocols we can analyse the comparison of three transmission protocols

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