

## DESIGN AND IMPLEMENTATION OF A SMART TRAINER TO STUDY THE FLOW CONTROL IN DATA LINK LAYER

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### ABSTRACT

Data Communications and Networking are two of the fastest growing segments today. The major reason for this growth is the dramatic increase in networked offices, PC based products and Internet users. Data communication and computer networking are the key fundamental courses in the most of the electronic, electrical or communication engineering study programs. Therefore the network model divides in to seven layers and the major advantage of dividing the functions in to layers is ease of study. When demonstrating each layer physically using hardware or software the students will be able to learn how the data flow between computers in the seven layers of ISO seven layers model. Out of these seven layers the data link layer acts as a major part in data communication. To maintain the flow and error control in the data link layer mainly uses three methods in a noisy channel, which are stop-and-wait, Go-Back-N and Selective Repeat Automatic Repeat Request methods. We have design and implemented a smart, easy to use and low cost trainer using microcontrollers to demonstrate the flow control method mentioned above. It is facilitate to observe the efficiency of each method and compare the differences of each type of methods by changing their parameters such as window size and also possibility to generate errors such as lost of transmitted frame and acknowledgment. Practitioners can understand the various methods of flow control in data link layer in point to point communication. Also we have developed a lab sheet specific for this trainer.

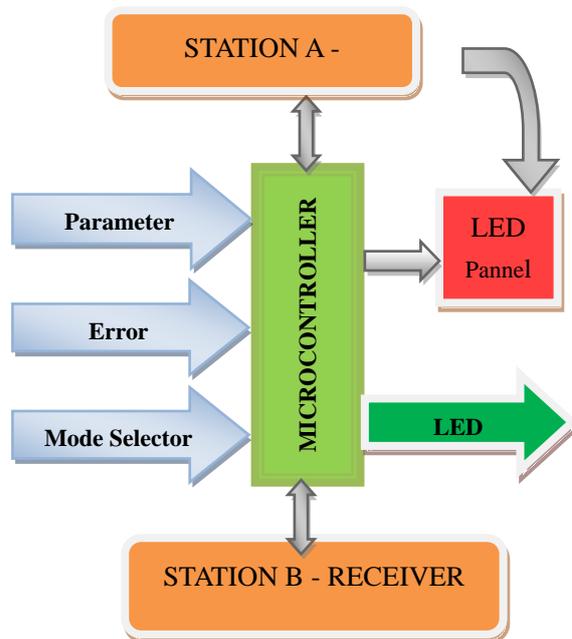
**Key words:** ARQ (Automatic Repeat Request), stop-and-wait, Go-Back-N

### 1. INTRODUCTION

One of the major advantages of dividing the functions of data communication in to seven layers is the convenience of study of each layer. When demonstrating each layer physically using hardware or software the trainee able to learn how the data flow between computers in the seven layers. Out of these seven layers the data link layer acts as a major part in data communication. To maintain the flow and error control in the data link layer mainly uses three methods in a noisy channel, which are stop-and-wait, Go-Back-N and Selective Repeat ARQ methods [1 2 3 4]. By using the trainer we

implemented the trainees can learn how the flow control achieve in data link layer using ARQ methods of Stop and Wait, Go-Back-N and Selective Repeat. Also by changing the parameters of each method of flow control the trainees can get the knowledge of how the parameters such as window size can affect to the data flow in data link layer.

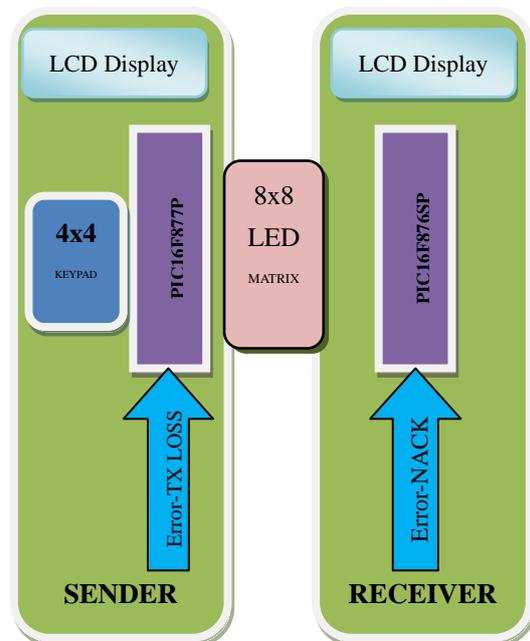
## 2. METHODOLOGY



**Figure 1: Methodology Diagram**

To demonstrate flow control in data link layer, data is taken from network layer of station A and send it to station B. Station A needs to have a keypad with LCD display to enter text and the memory to store the data. According to the design it can have any window size of  $m$ , where  $m$  is the number of frames per window and have  $n$  number of bits per each frame. The number of bits per frame ( $n$ ) depends upon the input data, frame sequence number, address of the receiving station and the error control. It needs to have a LED panel of  $m \times n$  matrix to show the outstanding frames. The send frames are stored in the memory of station B to check the errors. If the received frames are correct send an acknowledgment to the station A, which can be indicated by an LED. If the received frames are in error a negative acknowledgement is send to station A, which can be indicated by an LED. The station B needs to have a LCD display to see the data send by the station A. The error generator can be used to generate errors, such as loss of transmit frame, loss of acknowledgment, time

outs and the received data error in frames in station B. Using the mode selector switch we can select the mode either the stop-and-wait ARQ method or Go-Back-N ARQ method or Selective Repeat ARQ. The parameter changer can be used to change the parameters of the flow control such as window size ( $m$ ), no of bits per frame ( $n$ ) and transmission time. The figure 2 shows the basic blocks of the demonstration board, which the operation is as follows. To demonstrate flow control in data link layer, get data from network layer of Sender and send it to Receiver. Sender need to have a 16 button keypad (4x4) with LCD display to enter text and the memory to store the data.



**Figure 2: Basic Block Diagram**

According to the design it can select maximum window size as  $m=8$ , where  $m$  is the number of frames per window and maximum bits per frame as  $n=8$ . The number of bits per frame ( $n$ ) depends upon the input data and frame sequence number. It needs to have a LED panel of  $8 \times 8$  matrix to show the outstanding frames. The send frames are stored in the memory (PIC 16F876SP) of Receiver to check the errors. If the received

frames are correct send an acknowledgment to the sender, which can be visualized at the LCD display. The error generator can be used if the received frames are in error send a negative acknowledgement to sender, which can be visualized at the LCD display. The receiver needs to have a LCD display to see the data send by the sender. To generate errors, such as loss of transmit frame and negative acknowledgment. The loss of transmit frame generated at the sender's side and the negative acknowledgment generated at the receivers side. Initially it can select the type of ARQ method used and the number of windows  $m$ . Depending on the window size it will change the length of frame. All the received acknowledgements either ACK or NACK are displayed at the sender's LCD. Time to send a frame ( $T$ ) between sender and receiver can be denoted as shown in figure 1.

$$T = 2t_p + t_f + t_{pr} + t_a \quad (01)$$

- $t_p$ - propagation time
- $t_f$  - time to transmit a frame
- $t_{pr}$  - processing time at each station to react to an incoming event
- $t_a$  - time to transmit an acknowledgement

It need to assume the  $t_p$ ,  $t_{pr}$  and  $t_a$  are constants and  $t_f$  vary depending on the size of frame [2].

After enter the characters of the display the system will calculate the  $T$  and display it on the LCD, then the student can measure the efficiency ( $U$ ) of the system [1 2];

$$U = \frac{t_{frame}}{T} \quad (02)$$

### 3. RESULTS

This was tested and verified according to the laboratory practice sheet. We got the expected observations mostly tally with relevant theories behind.

## 4. HARDWARE AND SOFTWARE SPECIFICATIONS

### Features

- Hardware based demonstration
- Three ARQ methods in data link layer
- Error generator in both transmitter and receiver
  - Transmitter side error – Loss of transmit frame
  - Receiver side error – Loss of ACK (not available for Selective-Repeat-Request)
- Display the time to send data
- Led matrix (8x8) to display the outstanding frames
- 16\*2 LCD display in both transmitter and receiver.

### Technical Specifications

- Serial Communication - USART
- Baud Rate 1.5 byte/second
- Communication length 10cm
- Power 5v DC

### LAB Experiment

- Study of flow control in three ARQ methods;
  - Stop-And-Wait ARQ
  - Go-Back-N ARQ
  - Selective Repeat ARQ
- Generate Time out and Negative acknowledgement (NACK) errors to compare the efficiency

## 5. CONCLUSION

The trainer for flow control in data link layer is mainly focused on flow control but can expand the development up to error control also. This will demonstrate only point to point communication, with using some physical media can develop to point to multi point also. The microcontroller has a complex program because of having many functions to do in flow control such as error generation, parameter changer,

mode selection etc. It is very easily develop by using software rather than using a microcontroller. When considering the components, special electronic components are not needed other than the microcontroller so components can be obtained in the local market. can be developed with some error correction and detection mechanism in future.

## 6. REFERENCES

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