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Automatic Repeat Request (Arq) Protocols

Abubakar Bello Bada
Dept. of Computer Science Federal University Birnin-Kebbi Kebbi State, Nigeria.

----------ABSTRACT----------
Automatic Repeat Request (ARQ) protocols provide a widely recognized avenue for guaranteeing reliable transmission of data. The protocols are used in error control system to ensure the reliability of the transferred data. There are three types of these protocols, namely Stop and wait (SW), Go-Back-N (GBN), and Selective Repeat (SR). This paper takes a look at how theywork their advantages and disadvantages. It also takes a look at a recent ARQ protocol which attracts significant research of recent due to emergence of high speed data packet access; it is Hybrid ARQ (HARQ).
Keywords*: ARQ, SW, GBN, SR, HARQ.*

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I. INTRODUCTION

In the process of transmission, frames may be lost, the mechanism of detecting and correcting this loss is known as error correction.Automatic repeat request (ARQ) is a technique for ensuring accurate data delivery to the user in spite of the error occurrence [2]. ARQ provides reliable transmission of information. The two main transmission errors include, frame injury and frame loss. ARQ and Forward Error Correction (FEC) are being used as control protocols to fix these errors [2]. They use time-out retransmission, negating and retransmission mechanism, positive acknowledgement and error detection to solve the errors. ARQ is applied both in wired and wireless networks and it provides this error detection and recovery based on feedback messages and retransmission. In recent times ARQ is combined with channel codes at physical layer which result in a protocol known as Hybrid ARQ protocol [3]. This hybrid ARQ improves the overall system performance by improving error correction, time delay performance and channel adaptability. Reliability of the transmission can be improved by adding error control at the transport layer. ARQ can detect lost packet at the sender site using a timer which starts when the packet is sent.

II. ARQ PROTOCOLS

A. Stop And Wait Arq (Sw)

In stop and wait ARQ the protocol is connection oriented. The main idea in this protocol is that a frame is sent by the sender to the receiver, the sender then waits for a confirmation of receipt or acknowledgement (positive acknowledgement), andupon reception of this acknowledgement another frame for the next packet is sent. If upon sending the frame a negative acknowledgement is received, then the sender will resend the frame [1].
In a situation whereby a receiver received a frame correctly and sends an acknowledgement for that to the sender but the acknowledgement is lost or reaches after time-out. Then the next frame to be received will contain the same data as the previous frame[2]. To tell the receiver the packet layer to which the frame belongs, a serial number (SN) is used to uniquely identify network layer packets.
Stop and wait ARQ is easy to implement but it is a low efficiency mechanism because the channel utilization is low. Many data transmission use it even though it is not as efficient as others [1].

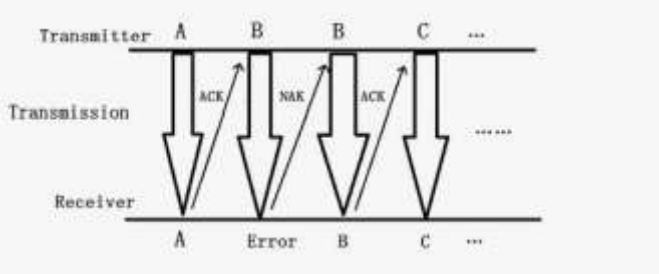

Figure 1: Mechanism of Stop and Wait. [1]

B. Go Back N Arq (Gbn)

One of the limitations of stop and wait ARQ is low utilization of the transmitter;Go-Back-N tries to overcome that limitation by keeping the channel busy while the transmitter awaits acknowledgment [4].

The idea behind Go-Back-N ARQ is that the sender sends the first frame and continues sending frames as it awaits the acknowledgement of the first frame from the receiver. If the first frame is received correctly and its acknowledgement is sent and received correctly also, then the system is done with it. While at the same time this is going on, the handling of subsequent frames is going on [2].

During transmission if a certain frame encountered an error, the receiver ignores that frame and any other frame that comes after it [1]. On completion of transmission, the transmitter has to retransmit the frames starting from the one that encountered an error, Hence the nameGO-BACK-N. The N stands for the number of the frame that encountered error [1].

The advantage of this protocol is there is higher transmission efficiency because as long as negative acknowledgement is not received the sender will continue sending until the send window is exhausted [1]. But there is a need of complex storage at the receiving end to save all the sent data as such it is better used in systems with low data transfer rate and short round trip time [5].

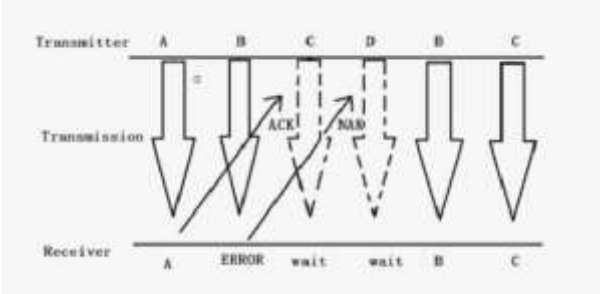

Figure 2: Mechanism of Go-back-N. [1]

C. Selective Repeat Arq (Sr)

Go-Back-N ARQ is not efficient in situations where there are high error rates because it has to retransmit the erroneous frame and all the other frames after it [1]. Because of that,Selective RepeatARQ came up, which is based on the idea of retransmitting selective packets [2]. The selective packets in this situation are the lost packets or unacknowledged packets. When there is packet loss or a packet is yet to be acknowledged as successfully received and time-out occurs the sender retransmits such packets [7].

This protocol is the most effective of the ARQ protocols. It improves channel utilization and it is usually used in situations where the equipment is the most complex and requires the receiving end with infinite buffer register [1].

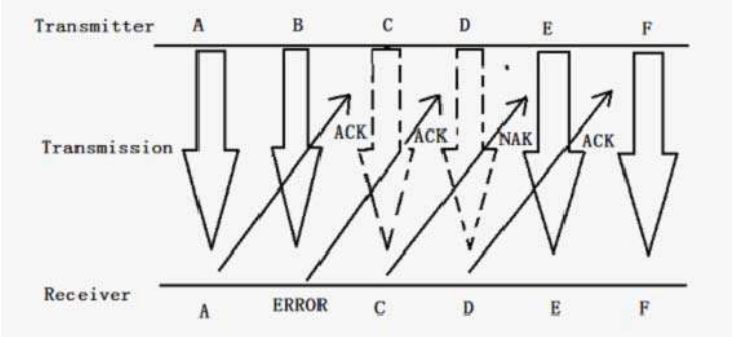

Figure 3: Mechanism of Selective Request. [1]

III. NEW ARQ PROTOCOL

A. Hybrid Arq (Harq)

When ARQ is combined with Forward Error Correction (FEC), the technique produced is known as Hybrid ARQ. In this technique a message is encoded using FEC and then partitioned into several blocks [5]. This blocks are then transmitted one after the other until the receiver decodes the message successfully [5].

In this protocol the overall system performance is enhanced because of the improvement in its error detection, time delay performance e.t.c. it has become an important part of the wireless technology evolution [7].

Compared to other ARQ protocols it has improved the channel performance of the system and it is more complex and efficient compared to them [6]. HARQ will play an important role in future network technologies.

There are 3 types of HARQ, this include:

1. Type I: in this HARQ there is always error detection code besides FEC encoded data [3]. The FEC code is first decoded at the receiver and if the errors are still there then a retransmission if that packet is requested and the erroneous packet is discarded.
2. Type II: in this HARQ, the erroneous packet is not discarded but retransmitted in combination with some incremental redundancy provided by the transmitter for subsequent decoding [4]. It is otherwise called incremental redundancy.
3. Type III: this type is like type II but a bit more special because each packet is self-decodable [3].

IV. CONCLUSION

Selective Repeat is always considered the best of the three main types of ARQ protocols because there is time and transmission utilization. Unlike Stop and wait which though has both flow and error controls is inefficient because of the time it waste waiting for acknowledgement. The Go-Back-N is a better version of Stop and Wait which utilizes pipelining but also waste time when erroneous frame is encountered.

By combining FEC and ARQ, HARQ achieves a better throughput by avoiding the decoding complexity of FEC and time delay of ARQ. This makes it more suitable of high-speed wireless access system.

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