An Analysis of the throughput performance of some continuous A.R.Q. Schemes

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Abstract

In the basic continuous ARQ schemes (Go-Back-N or Selective Repeat ARQ), each block is continuously transmitted without interruptions. Only when the transmitter receives NAK from the receiver side, the transmitter stops sending current data block and retransmit the erroneous block (Naked block).

When channel error rate increases and become sufficiently high, there exists a point at which each block of message is transmitted, on average, more than once. Under such conditions, it will be more efficient to send continuously two or more copies(generally l copies) of each block from the first transmission over noisy channel. A request for repeat will be made again only when none of l duplicates are received correctly.

By this way, the proposed scheme yields a better throughput efficiency and holds nearly constant throughput as compared to others continuous A.R.Q schemes under wide error rate variations ($0 < P < 0.3$).

I. Introduction

A common technique to handle transmission errors over noisy channel is the use of error detection and retransmission A.R.Q. scheme. Various A.R.Q. schemes composing of basic A.R.Q. scheme exist, one is stop-and-wait A.R.Q. scheme and the other is continuous schemes in which data blocks are sent from the

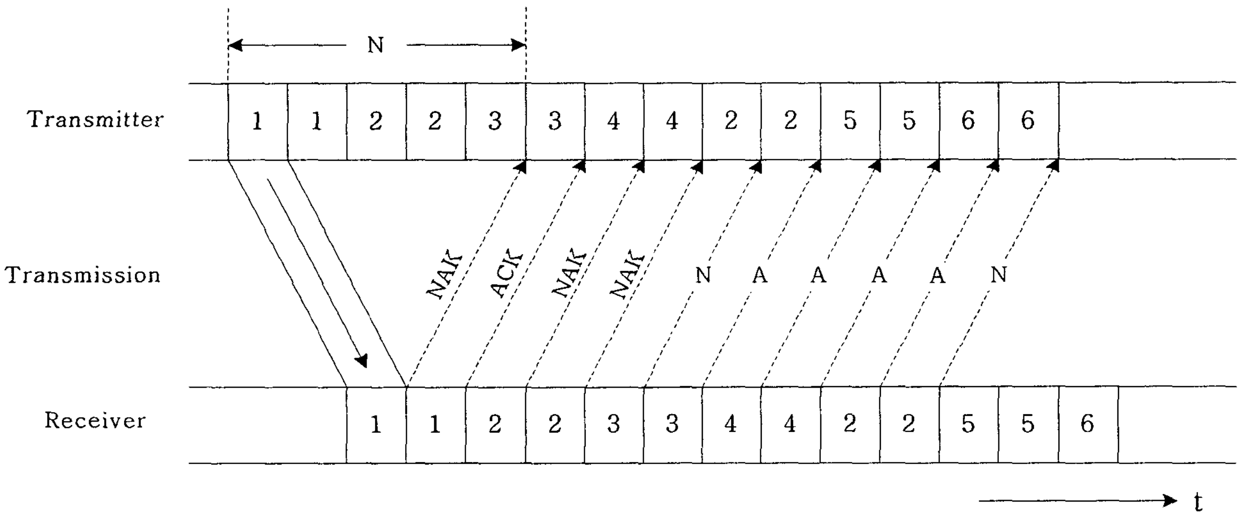

Fig. 1 Proposed A.R.Q. scheme

transmitter to the receiver without interruptions. The best known continuous schemes are the selective-repeat scheme and the go-back-N scheme. The best throughput efficiency is realized by the basic selective- repeat scheme.

In this paper, we present a variant for the basic selective-repeat scheme to be used for channels with high error rate and long propagation delay.

In the basic selective-repeat A.R.Q. scheme, the block is continuously transmitted without interruptions. Only when the transmitter receives NAK from the receiver side, the transmitter stops sending new data blocks and retransmit only the erroneous data block. And then, receiver must reorder in sequence the serial numbers of the arrived data blocks. The probability of several retransmissions of a erroneous block depends entirely on the channel environment. If channel error rate increases and becomes sufficiently high, there exist a point at which each data block is transmitted, on average, more than once.

Under such environment, it will be more efficient to transmit continuously two or more copies(generally l copies) of each block from the first transmission (Fig. 1). If l copies of each data block are all Naked, transmitter send one more time l copies of each block which are stored at the transmitter buffer. If only one copy among l duplications of each data block is Acked, it is considered that the data block is correctly received.

II. The derivation of throughput equation of the proposed scheme

Assuming that the ACK message is received error-free and undetected block error probability (P_u) is very small compared to the block error rate (P), the throughput (η_{BS}) equation of basic selective-repeat A.R.Q. scheme is given by [1];

$$\eta_{BS} = \frac{k}{n \cdot \frac{1}{1-P}} \qquad \text{...............................(1)}$$

where η_{BS} ; the basic S.R. throughput equation

k ; the no. of information bits per block

n ; block length in bits

P ; block error probability

At the Fig. 1, we example the case that 2 copies of each block is transmitted from the first transmission. Generally, the no. (l) of copies of each block can be made variable and is dependent only on channel error rate. This means that the no. (l) of copies of each block will be increased or decreased according to channel error probability.

The throughput efficiency (η) is defined as the ratio of information bits delivered to the total transmitted for any given block before the transmitter begins to transmit the next block. As each set composed of l copies of each block is transmitted from the first transmission, the throughput equation of the proposed scheme is given as follows;

$$\eta_p = \frac{\eta_0}{l \cdot \frac{1}{1-P^l}} \qquad \text{.............................(2)}$$

where $\eta_0 = \frac{k}{n}$

l ; the number of copies of each data block

Note that η_0 is a theoretical upper bound for the throughput efficiency of any A.R.Q. scheme.

III. The performances evaluation of three different continuous A.R.Q schemes.

The throughput efficiencies of the basic

Go-Back-N A.R.Q. and Sastry's modified G.B.N. A.R.Q. are given by

$$\eta_{B.G.} = \frac{\eta_0}{1+N\cdot\frac{P}{1-P}} \quad \text{.............................(3)}$$

$$\eta_S = \frac{\eta_0}{1+P\left[\frac{1}{1-P}+2(N-1)\right]} \quad \text{..........(4)}$$

where N ; the round trip delay of a system

For reference, the figures (2) and (3) contain a curve for the throughput efficiency, $\eta_{B.S.} = \eta_0(1-P)$ of basic selective-repeat scheme. The figures (2) and (3) show us that the throughput efficiency of the basic G.B.N. scheme and Sastry's modified G.B.N. scheme decrease very sharply as block error rate becomes higher and round trip delay become longer.

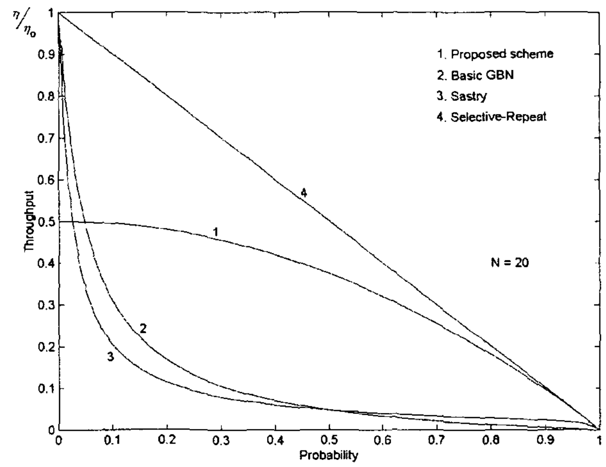

Fig. 2 Comparison of Throughput efficiency(l=2, N=20)

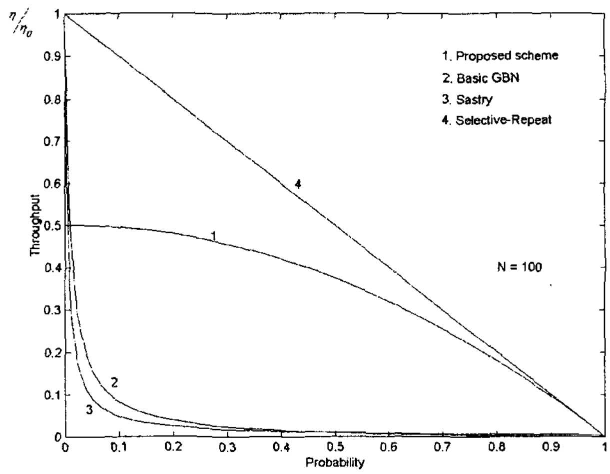

Fig. 3 Comparison of Throughput efficiency(l=2, N=100)

We can see that as the round trip delay (N) becomes longer from 20 to 100, the degree of throughput decrease becomes sharper. But the proposed scheme holds nearly constant throughput efficiency at the wide range of error rate variations (0 < P < 0.3) as compared to other continuous schemes.

It means that the channel's transmission capacity is comparatively stable in spite of wide error rate variations (0 < P < 0.3). This characteristic of nearly constant throughput efficiency of the proposed scheme can contribute to the stability of data flow through the noisy channel of data network.

IV. Conclusion

Under the conditions of wide error rate variations (0 < P < 0.3) and large round trip delay (N) of a system, the proposed scheme holds nearly constant throughput efficiency as compared to other continuous scheme (Fig. 2 and 3). From the view point of this characteristic, we can derive the conclusion that the channel's transmission capacity is comparatively stable in spite of wide range of error variations. This characteristic of nearly constant throughput of the proposed scheme can contribute to the stability of data flow through the noisy channel of network.

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