Using Adjacent Data Retransmission to Improve the Transmission Efficiency of Multi-hop Relay Networks

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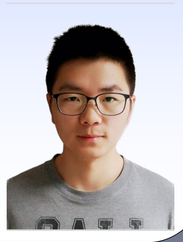

Introduction

Data transmission systems are widely used in various aspects of life, industry, research and other fields. Transmission systems have different characteristics for different application scenarios. Many of them require multi-hop transmission to extend the transmission range, such as Wireless Mesh Network (WMN), Mobile Ad-hoc Network (MANET), Wireless Sensor Networks (WSN) and so on. The biggest problem of multi-hop transmission lies in that packet loss caused by bit error ratio (BER) in multiple transmission processes increases greatly, which makes end-to-end transmission reliability and bandwidth utilization decrease. This paper analyzes the impact of BER on bandwidth utilization in multi-hop relay transmission and proposes a simple and flexible transmission mechanism that is generally applicable to multi-hop transmission scenarios.

Analysis of Multi-hop Networks

This article focuses on the general relay transmission, suitable for both wired and wireless transmission. As shown in Fig. 1, the data packet is sent from the source station SRC, passes through N relay stations P in turn, and finally reaches the DST station.

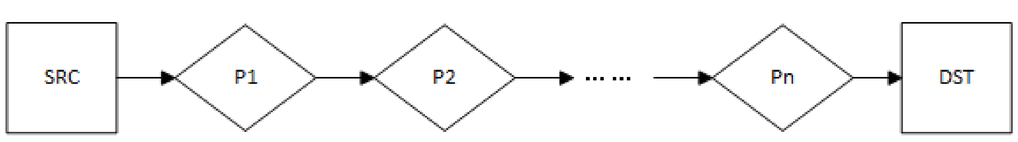

fig.1 *Multi-hop data transmission network model*

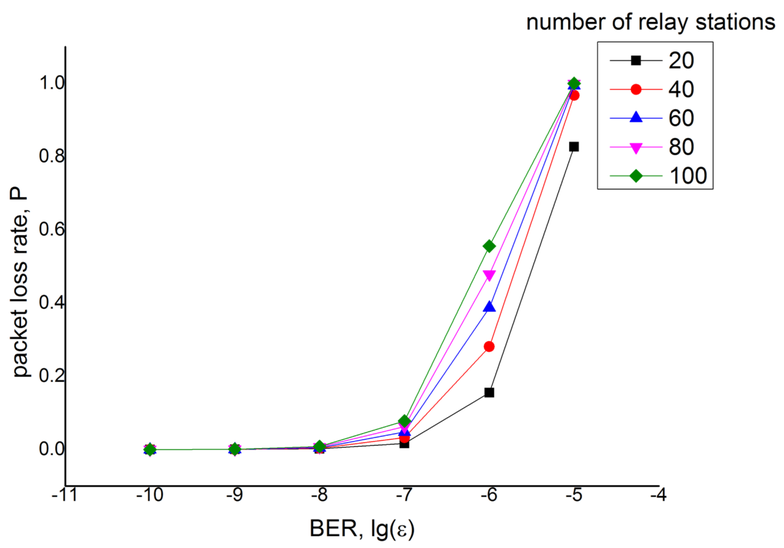

fig.2 *Relationship between BER and pack loss rate, L=1000*

It can be seen from Fig.2, when the BER is high, packet loss is very serious. When the number of relay stations increases, the packet loss rate also increases rapidly. When BER is 10^{-5}, the packet loss rate of 100 relay stations exceeds 99.98%. In this case, the data packet can no longer be transmitted from SRC to DST. Common multi-hop transmission protocol can't work.

Proposed Scheme

In order to reduce the packet loss rate of multi-hop transmission and make full use of bandwidth, we propose a transmission mechanism suitable for multi-hop transmission system. Fig. 3 shows how the transmission mechanism works.

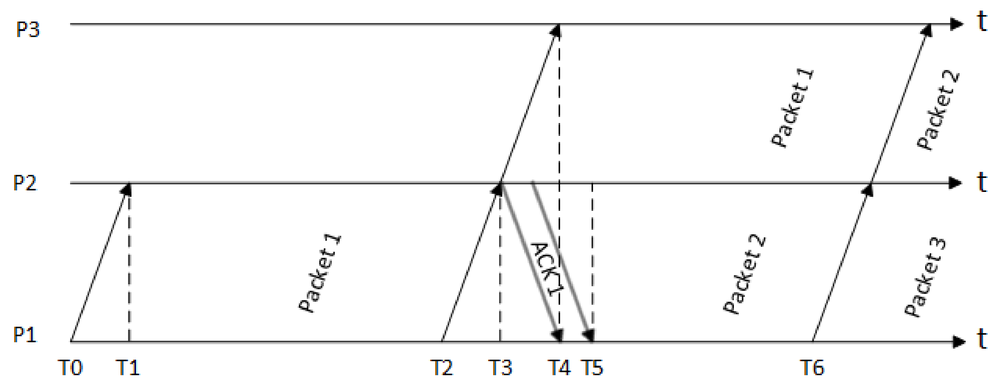

fig.3 *flow chart of our proposed scheme*

As shown in Fig. 3, P1, P2 and P3 represent three adjacent relay stations. The data packet is transmitted from P1 to P3 direction. P2 will send ACK to P1 as soon as it receives a packet correctly. If not receive ACK in time, P1 will resend packet to P2.

ACK is a signal that means the packet has arrived correctly. It can be a specific type of frame in the protocol in witch case the ACKs will occupy some data bandwidth from P3 to P1 direction. Moreover, due to the different state of the protocol stack, the time for giving an ACK is uncertain. Therefore, it is difficult to set an appropriate retransmission timeout.

We replace the complete ACK frame with a special physical layer code. The code is given by the encoder as soon as the decoder receive a frame correctly. This logic can be easily implemented in programmable devices. As long as the codec speed is given, the retransmission timeout can be accurately calculated.

Simulation

In order to reduce the packet loss rate of multi-hop transmission and make full use of bandwidth, we propose a transmission mechanism suitable for multi-hop transmission system. Fig. 3 shows how the transmission mechanism works.

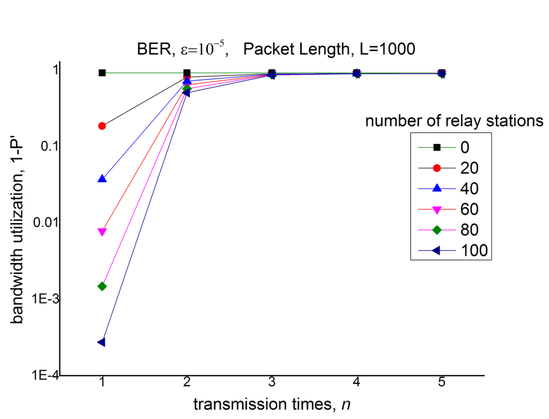

fig.4 *Simulation results of the relationship between transmission times and bandwidth utilization*

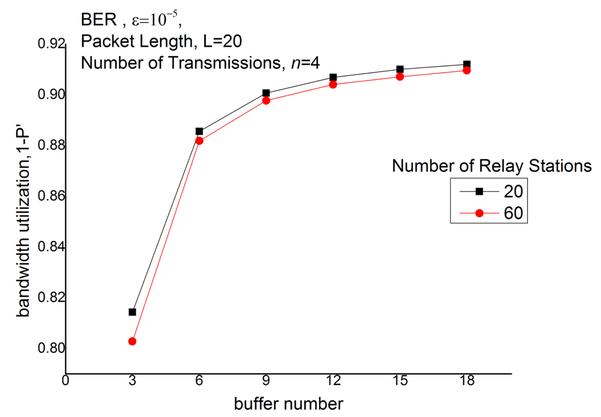

fig.5 *Simulation results of the relationship between buffer number and bandwidth utilization*

Conclusion

The proposed transmission mechanism for multi-hop relay networks can make full use of link bandwidth at high BER. We replace the complete ACK frame with a special physical layer code .The simulation result shows this schemes works well in a large numer cascading situations and it also has the advantages of simplicity, and small hardware requirements.