Study of Network Coding-Aware MAC Protocol for Wireless Multihop Networks

NYAN LIN*, Krittanai SRIVIRIYAKUL**, Rithea NGETH*, Yasuo TAN*, and Yuto LIM*

* Japan Advanced Institute of Science and Technology (JAIST), School of Information Science
** Chulalongkorn University, Department of Computer Engineering

1. Introduction

Network coding is a popular coding technique for the data packets at the intermediate nodes in the wireless multihop network that can increase the throughput performance. In this paper, we present the advantages of applying network coding at a 3-node chain topology to reduce the energy consumption for transmitting the data packets. We also applies the 2-hop Path Selection Protocol (2PSP) that allows an intermediate node to relay the data packets to obtain the higher transmission rate [1] to increase the throughput and save more energy. The goal of this paper is to investigate the energy consumption of the network coding aware medium access control (MAC) protocol, i.e., carrier sense multiple access with collision avoidance (CSMA/CA) and 2PSP.

2. Research Motivation

Figure 1(a) shows 4 transmissions are needed to complete a successful data exchange between A and B. In order to improve the energy consumption and throughput, an exclusive OR (XOR) coding can be applied at intermediate node R, which broadcasts the coded packet $a \bigoplus b$ upon receiving the packets a and b from node A and B, respectively as shown in Fig. 1(b). A and B can recover the packets b and a by using XOR function upon receiving the coded packet, respectively. Therefore, data transmission in between A and B can be completed within 3 transmissions and the energy for one data transmission can be saved.

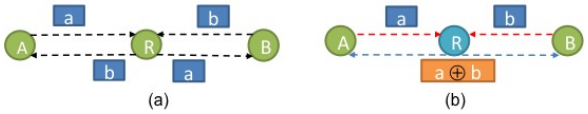

Figure 1. Data transmission with network coding technique

3. CA-2PSP Scheme

We add the network coding function into the 2PSP and introduce a coding aware 2PSP (CA-2PSP) scheme. Fig. 2 depicts a relay node R sends a Ready to Relay (RTR) upon receiving the Relay Request-To-Send (RRTS) and Relay Clear-To-Send (RCTS) messages from A and B, respectively. Since the relay node R is inside the transmission range of both A and B, it can select the higher transmission rates and performs the XOR function of two receiving data flows from A and B. By this approach, the CA-2PSP can save more energy for data transmission by choosing the higher transmission rates.

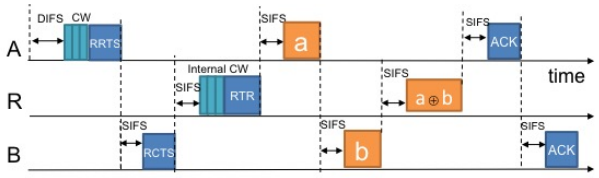

Figure 2. The handshaking sequence of CA-2PSP

4. Numerical Simulation

We use the IEEE 802.11a specification to evaluate the proposed CA-2PSP. The simulation results are averaged of 100 times with different source-destination pairs in one single topology scenario. 100 nodes are randomly placed in a 160 x 160 m^2 coverage network. The number of flows for each unique source is increased to 80 data flows with the condition that two or more data flows might have the same destination. Simulation results reveal that 22% of energy saving by applying the proposed CA-2PSP scheme when the number of data flows is 80 as illustrated in Fig. 3.

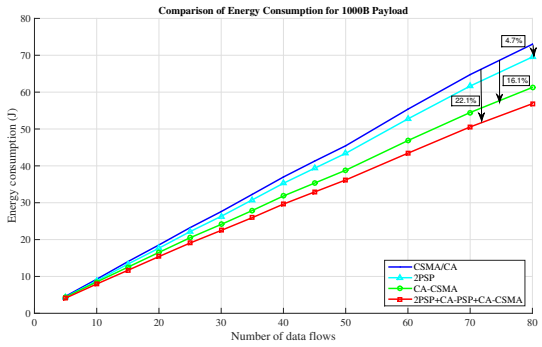

Figure 3. Comparison of energy consumption for CSMA/CA, 2PSP, CA-CSMA, and CA-2PSP

5. Conclusion

We concluded that the network coding is always beneficial to save energy consumption in the wireless multihop networks. Our future work will focus on examining the throughput of CA-2PSP.

References

[1] A.O. Lim and S. Yoshida, "A 2-Hop path selection protocol (2PSP) in multi-rate ad hoc wireless networks," IEICE Trans. Commun. vol.E90-B, no.1, Jan. 2007.