Contention-Free Station Communication Matching Algorithm in Multi-Hop Power Management for Wireless Ad-Hoc Networks

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ABSTRACT

Many single-hop power management mechanisms have been proposed in previous studies. Compared to the multi-hop power management mechanisms, the design of the single-hop power management mechanism in a wireless network is relatively simple. However, existing methods are difficult to balance the transmission utilization and energy efficiency. This paper proposes the Contention-Free Station Communication Matching (CFSCM) algorithm for multi-hop power management. CFSCM is based on list-based scheduling with Time-Division Multiple Access (TDMA). CFSCM appropriately schedules the data transmission of nodes and power management. In addition, CFSCM adopts multiple channels to improve the performance of data transmission. Simulation results show that the proposed method can significantly improve transmission utilization and avoid the hidden terminal problems.

Keywords: *Exposed Terminal Problem, Hidden Terminal Problem, List-Based Scheduling, Multi-Channels, Multi-Hop, Time-Division Multiple Access, Transmission Efficiency*

1. INTRODUCTION

With different requirement of people, a variety of network protocols have been developed. The most popular protocols is IEEE 802.11 (Chen, 2006; Gast, 2005). It can be used to build local area network (LAN) for Enterprises and families. The requirement of network communication is not just speed or quality. Now, people hope the life time of hardware equipment can be longer. Moreover, the rising consciousness of environmental protection makes the issue

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of energy conservation in network protocol more serious in recent year. Wireless network can be classified into single-hop and multi-hop whether it needs relays to transmit data. In single-hop network, nodes can directly receive wireless signal from each other. In contrast, packets need to travel through multiple relays to reach destination in multi-hop network. Most of ad hoc networks are multi-hop. Therefore, the transmission range of ad hoc network has no limit. Power management of single-hop is simple on the power management of wireless network issue. The reason is that single-hop just consider transmitter and receiver (Bhardwaj, Divya, & Sofat, 2007; Khan & Boncelet, 2006; Moo-Yeong, Bum-Gon, Ju Yong, & Min Young, 2010). In contrast, it needs to consider the power management after multi-hop and communication process of multiple stations. Therefore, the operation of multi-hop power management will become more complicated, and its references (Nait-Abdesselam, Bensaou, Soete, & Ka-Lok, 2007; Peng, Xinming, Zhenzhong, & Yi, 2008; Wei, Heidemann, & Estrin, 2002, 2004) (Hanh & Takizawa, 2010) are less than single-hop.

In general, stations in ad hoc network are always idle when they don't need to transmit messages. It will cause extra energy waste. In addition, collision and repeat request will also waste energy in the transmission process.

For those reasons, power management is a challenge in multi-hop ad hoc network. Hidden Terminal Problem will affect power-saving mode of the station.

In order to solve the problem, IEEE 802.11 adopts RTS (Request To Send) / CTS (Clear To Send) mechanism and uses Network Allocate Vector (NAV) to limit transmission from station. Thereby, IEEE 802.11 can stop the transmission from adjacent stations and avoids collisions with stations which are transmitting signals.

However, adjacent stations which are set up NAV can use multi-channel to transmit signals to each other with no collisions and interferences. Therefore, the method that IEEE 802.11 used will reduce transmission performance and the energy can't be utilized effectively. This paper will focus on the problem of energy conservation in ad hoc network and proposes Contention-Free Station Communication Matching (CFSCM) algorithm.

CFSCM is an energy-saving and scheduling mechanism for stations which is similar to Time-Division Multiple Access (TDMA). CFSCM modifies the original TDMA and uses flexible time scheduling to improve network performance. It improves the process of communication for all stations and thereby avoids wasting energy. In addition, CFSCM uses two channels to exchange data. Furthermore, it can improve the throughput of transmission.

The remainder of this paper is organized as follows: Section 2 presents a review of the related literature; Section 3 introduces the proposed Contention-Free Station Communication Matching (CFSCM) algorithm; Section 4 describes the simulation and analysis; and, finally, Section 5 offers a conclusion.

2. RELATED WORKS

2.1. Time Division Multiple Access (TDMA)

There were a lot of studies (Bhardwaj et al., 2007; Ephremides & Truong, 1990; Khan & Boncelet, 2006; Lee, Noh, & Lim, 2014; Leonovich & Huei-Wen, 2010) based on TDMA in the past. Their mechanisms are focus on allocation for awake time and doze time and scheduling for every station in the list by the unit of Time Slots. The advantage of TDMA is appropriate time allocation. Every Time Slots have different schedule. According to traditional methods, the permission to use the medium of Time Slots can only be assigned to a station. In this period, the other stations are in the passive state. Therefore, it can reduce Probability of collisions and solve some Hidden Terminal Problems. But, the solution makes inefficiency. If we can enable multiple stations simultaneously, without interfering with each other's communications, it will improve the overall efficiency of network transmission.

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