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PSSB: Priority enforced slow-start backoff algorithm for multimedia transmission in wireless ad-hoc networks

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ABSTRACT

The binary exponential backoff (BEB) algorithm is the fundamental access method, which provides collision avoidance in wireless ad-hoc networks. However, BEB algorithm poses several performance issues. For example, the high collision rate problem, unfair channel access and throughput degradation have been several widely known issues. Besides, frames in BEB do not have priorities, making it unsuitable for multimedia communications. With a little bad luck, a station might have to wait arbitrarily long to send a frame. In this paper, we introduce the priority enforced slow-start backoff algorithm (PSSB) for multimedia transmission for wireless ad-hoc networks, which employs a distributed adaptive contention window control mechanism to mitigate intensive collisions in congested scenario and support priority traffic for multimedia transmission. Furthermore, the proposed scheme could alleviate the fairness problem in partially connected network topology by employing feedback information from wireless stations. Simulations are conducted to evaluate the performance of the proposed scheme. The results show that the proposed scheme outperforms the BEB algorithm in many aspects in wireless ad hoc networks.

1. Introduction

In the last decade, the tremendous development and rapidly growing application of wireless access technologies, such as Wireless LANs and WiMAX, has facilitated the ubiquitous and pervasive Internet access. One of the critical performance metrics in wireless network is the achievable network throughput and the support of multimedia communications, which heavily depends on the efficiency in sharing the common radio channel. For the majority of wireless network protocols, binary exponential backoff (BEB) algorithm (Bianchi, 2000; Ni et al., 2005; Li et al., 2004) is employed as a mandatory stability strategy to share the medium.

Although BEB scheme is the de-facto standard contention resolution algorithm in wireless networks, its shortcomings in certain network configuration conditions have been widely know and actively addressed by many researchers. First, this strategy might incur a high collision probability and the channel utilization could be degraded in congested scenario. This is because it selects a small initial value of backoff window by a naive assumption of a low level of congestion in the system. Second, this strategy might lead to the "fairness problem" in partially connected ad hoc wireless networks because BEB scheme always favors the last successfully transmitted station (Xu and Saadawi, 2001; Chen and Chao, 2001; Yen et al., 2009). Third, non-collision frame loss, i.e., link error-related loss, is another key factor diminishing the performance of BEB scheme, since it does not take into account the occurrence of non-collision losses. Unfortunately, wireless transmission links are noisy and highly unreliable. Path loss, channel noise, fading and interference may cause significant bit errors. If the sender is unable to distinguish the causes of frame loss, it is difficult to make the correct decision. Finally, frames in BEB do not have priorities, and there is no other mechanism to guarantee an access delay bound to the stations. To put it another way, multimedia applications like voice and live video transmission may suffer with this protocol.

In the literatures there have been adequate excellent discussions on the issues on BEB and its performance analysis. Most existing contention window control mechanisms can be classified into two categories, namely semi-dynamic (Song et al., 2005; Bharghavan et al., 1994) and quasi-dynamic (Bianchi et al., 1996; Bononi et al., 2004; Kwon et al., 2004; Wang et al., 2004; Deng et al., 2008a; Deng et al., 2008b) approaches, according to the theory used for contention window controlling. In general, quasi-dynamic approaches tend to achieve better performance than semi-dynamic approaches because they can operate according to the observed actual channel conditions. However, in addition to the difficulties in acquiring sufficient knowledge of the system, these type of approximations tend to be very computationally complex, and subject to significant errors, especially in high traffic load situations. Furthermore, all quasi-dynamic schemes suffer

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