A Novel Framework for Medium Access Control in Ultra-Wideband Ad Hoc Networks

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Abstract. Ultra-wideband (UWB) communication is becoming an important technology for future Wireless Personal Area Networks (WPANs). A critical challenge in UWB system design is that a receiver usually needs tens of micro-seconds or even tens of milliseconds to synchronize with transmitted signals, known as timing acquisition problem. Such a long synchronization time will cause significant overhead, since the data rate of UWB systems is expected to be very high. In this paper, we address the timing acquisition problem at the medium access control (MAC) layer, and propose a general framework for medium access control in UWB systems; in this framework, a transmitting node can aggregate multiple upper-layer packets into a larger burst frame at the MAC layer. Furthermore, we design an MAC protocol based on the framework. Compared to sending each upper-layer packet individually, which is a typical situation in exiting MAC protocols, the proposed MAC can drastically reduce the synchronization overhead. Simulation results show that the proposed MAC can significantly improve the performance of UWB networks, in terms of both throughput and end-to-end delay.

Keywords. ultra-wideband (UWB), MAC, timing acquisition, throughput, delay

1 Introduction

According to Federal Communications Commission (FCC), an *Ultra-wideband* (UWB) system is defined as any radio system that has a 10-dB bandwidth larger than 20 percent of its center frequency, or has a 10-dB bandwidth equal to or larger than 500 MHz [1]. To enable the deployment of UWB systems, FCC allocated an unlicensed frequency band $3.1 - 10.6$ GHz for indoor or hand-held UWB communication systems [1].

In the past few years, UWB communication has received considerable attention in both academia and industry. Compared to traditional narrow band systems, UWB can provide high data rate (> 100 Mb/s) with very low-power emission (less than -41 dBm/MHz) in a short range. In addition, UWB can also support multiple access. These features make UWB particularly suitable for *wireless personal area network* (WPAN) applications. Currently, IEEE

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