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Enhanced HCCA mechanism for multimedia traffics with QoS support in IEEE 802.11e networks

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ABSTRACT

In broadband wireless networks, providing Quality of Service (QoS) support for multimedia traffics is no doubt crucial to many application requirements such as real-time audio and video streaming communications. IEEE 802.11e Medium Access Control (MAC) standard proposes Hybrid Coordination Function (HCF), which is composed of HCF Controlled Channel Access (HCCA) and Enhanced Distributed Channel Access (EDCA) mechanisms for QoS support. HCCA performs a polling procedure with parameterized channel. However, a station may not always have pending data to transmit. That is, polling all the stations may waste time and therefore deteriorate the transmission performance. In this paper, we propose a modified HCCA mechanism using the beacon frame broadcasted by the AP to determine which station can transmit its pending data so as to improve the transmission performance. The simulation results show that the performance improvement of our proposed mechanism is significant for QoS support particularly under light load condition.

1. Introduction

IEEE 802.11 wireless networks (IEEE 802.11 WG, 1999) have been gaining lots of popularity and play a major role in constructing a wireless broadband computing environment. Since IEEE 802.11 is generally adopted by industry, it has become a dominant standard. The main characteristics of the 802.11 wireless networks include their simplicity, cost effectiveness, flexibility and robustness against failures due to the distributed approach of its medium access control (MAC) protocol (Chandra et al., 2000). This technology provides a ubiquitous communication and computing environment such as in offices, campuses, home, factories, etc. Basically, it can be seen as a wireless version of Ethernet, which supports best-effort service. However, nowadays, due to the explosive growth of real-time multimedia applications, there are great demands for high-speed, delay-constrained and bandwidth intensive video, audio, voice and web services. Among them, Quality of Service (QoS) support such as guaranteed bandwidth, delay, jitter and error rate are required. The original IEEE 802.11 standard is not initially designed to support QoS through Distributed Coordination Function (DCF), which does not guarantee any service level to users and applications. That is, guaranteeing the QoS requirements in an 802.11 wireless network is very challenging due to its QoS unawareness nature in the medium access control (MAC) functions (Deng and yen, 2005). Accordingly, IEEE 802.11 Task Group E established an extension to the IEEE 802.11 standard called IEEE 802.11e (IEEE 802.11 WG, 2005), which provides QoS support for time-sensitive applications (Ni et al., 2004).

Like legacy IEEE 802.11, IEEE 802.11e employs a channel access function called the hybrid coordination function (HCF), which combines contention-based channel access mechanism and a contention-free centrally controlled channel access mechanism (IEEE 802.11 WG, 2005). The former is referred to as the enhanced distributed channel access (EDCA) and the latter is known as HCF controlled channel access (HCCA). To provide QoS support, the EDCA provides differentiated and distributed access to the wireless medium with four access categories (AC). A time-sensitive traffic can reduce its transmission delay by utilizing the access category that has higher priority for contending the access channel. Previous work on evaluation of EDCA shows that the prioritized channel access mechanism is effective in that high prioritized traffic can get high throughput and lower access delay (Grilo et al., 2003; Ni, 2005). However, the QoS requirement cannot always be met especially in the heavy load conditions (Ni, 2005). In contrast to EDCA, the centrally controlled channel access of HCF is based on a polling mechanism with some QoS-specific mechanisms to allow QoS data transfers during contention-free periods. In HCCA mode, a hybrid coordinator (HC) is used to allocate transmission opportunities (TXOP) to wireless stations by

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