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Title: Resolving Collisions in IEEE 802.11 by means of Contention Window Reservation Scheduling

In Wireless Local Area Network (WLAN), nodes communicate through a shared wireless channel. When multiple nodes try to transmit packets on a shared communication channel, collisions can occur. This will cause throughput degradation and delay to packets delivery. To avoid collisions, an effective medium access mechanism is needed, which controls and manages access to the shared channel. The most popular medium access mechanism used in wireless LANs is currently the IEEE 802.11b/g which is also known as the legacy IEEE 802.11 [1] MAC protocol. However, this protocol was designed for data communication and does not provide satisfactory services for real-time traffic [2]. It adopts the carrier sense mechanism of the Ethernet and implements it in WLANs with minor changes to avoid collisions. Although this protocol is robust, it is not well optimised. Packet loss and delay due to packet collisions is high. To enhance the legacy IEEE 802.11 protocol, the IEEE 802.11e MAC protocol was introduced. The 802.11e provides prioritization of real-time traffic and improves quality of service (QoS) [3]. However, both the legacy and the enhancement protocol adopt the random binary exponential backoff mechanism to avoid packet collisions. This mechanism successfully reduces collisions but as the number of nodes in the network increases, rate of packet collisions also increases. As a result of packet collision, network performance degrades and QoS deteriorates. Lost packets due to packet collisions need to be resent and contention window backoff values doubled.

There have been several schemes proposed to mitigate collisions in WLAN contention mode [4][5]. Although an improvement over the legacy 802.11 is shown in these schemes, most benefits are limited due to increase overhead as a result of adding extra information in the MAC header. In [5], early backoff announcement is implemented where a station announces its future backoff information to avoid collisions. This information needs to be broadcast to all wireless nodes, and thus must be added into the MAC header. Alternatively, in [4] a multiple input-output approach is adopted, whereby an access point (AP) needs to have more than one receiving antenna, which in turn increases complexity at the physical layer.

In this presentation, a contention window reservation scheduling (CWRS) mechanism that resolves collisions in WLAN will be presented. In this mechanism, the contention window is scheduled so that no wireless node has the same contention window value at the same instance. With this mechanism, it is possible to achieve collision free transmission in the wireless contention mode which results in higher throughput and significantly lower packet delay. The proposed mechanism also provides easy migration from the legacy 802.11 as changes only involve the backoff mechanism, and other parameters of this protocol remain unchanged.

[1] IEEE, “Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications”, ANSI/IEEE STD 802.11, 20 August 1999.

[2] Todor Cooklev, “Wireless Communication Standards - A study of IEEE 802.11, 802.15, and 802.16”, IEEE Standards Wireless networks Series, IEEE Press, 2004.

[3] IEEE, “Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, Amendmend 8: Medium Access Control (MAC) Quality of Service Enhancements”, 11 November 2005.

[4] Hu Jin et al, “A MIMO-Based Collision Mitigation Scheme in Uplink WLANs”, IEEE Communications Letters, Vol. 12, No. 6, June 2008.

[5] Jaehyuk Choi et al, “ EBA: An Enhancement of the IEEE 802.11 DCF via Distributed Reservation”, IEEE Transactions on Mobile Computing, Vol.4, No 4, July/August 2005.