A Study on CSMA/CA for IEEE 802.11 WLAN Environment

Il-Young Moon and Sung-Joon Cho, *Member, KIMICS*

***Abstract*—**A basic access method about IEEE 802.11 MAC layer protocol using IEEE 802.11 wireless LANs is the DCF thatis based on the CSMA/CA. But, cause of IEEE 802.11 MAC layer uses original backoff algorithm (exponential backoff method), when collision occurred, the size of contention windows increases the double size Also, a time of packet transmission delay increases and efficienty is decreased by original backoff scheme. In this paper, we have analyzed TCP packet transmission time of IEEE 802.11 MAC DCF protocol for wireless LANs a proposed enhanced backoff algorithm. It is considered the transmission time of transmission control protocol (TCP) packet on the orthogonal frequency division multiplexing (OFDM) in additive white gaussian noise (AWGN) and Rician fading channel. From the results, a proposed enhanced backoff algorithm produces a better performance improvement than an original backoff in wireless LAN environment. Also, in OFDM/quadrature phase shift keying channel (QPSK), we can achieve that the transmission time in wireless channel decreases as the TCP packet size increases and based on the data collected, we can infer the correlation between packet size and the transmission time, allowing for an inference of the optimal packet size in the TCP layer.

***Index Terms*—**CSMA/CA, Wireless LANs, IEEE 802.11, TCP/IP

I. INTRODUCTION

In the increasingly competitive world of today, professional are constantly relying on wireless data communication to access up-to-date information from the network when they are out in the field or moving about in the premises. The growing popularity of IEEE 802.11 has made wireless LAN a potential candidate technology for providing high-speed wireless access services. Recently, the use of TCP/IP protocols over wireless LANs poses significant problems [1]. TCP/IP based protocols provide an excellent platform for high-speed wired LANs with constant connections. Advances in digital wireless communication have accelerated the progress of mobile computing. The growing popularity of IEEE 802.11 has made wireless LAN a potential candidate technology for providing high-speed wireless access services. Also, by supporting Mobile IP, wireless LAN can meet demands for expanded wireless access coverage while maintaining continuous connectivity from one wireless LAN to another [2].

In this paper, we studied the Institute of Electrical and Electronics Engineers (IEEE) 802.11 medium access control (MAC) protocol to enhance transport ability for wireless LANs and propose an enhanced backoff algorithm for the distribution coordination function (DCF) of MAC protocol. The DCF is designed for asynchronous data transmission by using Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).

II. WIRELESS LANS

802.11a is new specification that represents the next generation of enterprise-class wireless LANs. Among the advantages it has over current technologies are greater scalability, better interference immunity, and significantly higher speed, up to 54 Mbps and beyond, which simultaneously allows for higher bandwidth applications and more users. 802.11a MAC layer uses the same technology, as 802.11b with CSMA/CA. CSMA/CA is a basic protocol used to avoid signals colliding and canceling each other out. It works by requesting authorization to transmit for a specific amount of time prior to sending information. The sending device broadcasts a request to send (RTS) frame with information on the length of its signal. If the receiving device permits it at that moment, it broadcasts a clear to send (CTS) frame. Once the CTS goes out, the sending machine transmits its information. The IEEE 802.11 Orthogonal Frequency Division Multiplexing (OFDM) Physical layer delivers up to 54Mbps data rates in the 5GHz band[3],[4]. 802.11a uses OFDM, a new encoding scheme that offers benefits over spread spectrum in channel availability and data rate. Channel availability is significant because the more independent channels that are available, the more scalable the wireless network becomes. The high data rate is accomplished by combining many lower-speed subcarriers to create one high-speed channel. 802.11a uses OFDM to define a

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I. Y. Moon is with School of Internet Media Engineering, Korea University of Technology and Education, Chungnam Province, 330-708, Korea (Tel : +82-41-560-1493, Fax : +82-41-564-3261, E-mail : iymoon@kut.ac.kr)

S. J. Cho is with the School of Electronics, Telecomm. and Computer Eng., Hankuk Aviation Univ., Koyang-Si, Kyounggi-Do, 412-791, Korea (Tel : +82-2-3158-1518, Fax : +82-2-3158-1935, E-mail : sjcho@mail.hangkong.ac.kr)

total of 8 non-overlapping 20 MHz channels across the 2 lower bands; each of these channels is divided into 52 subcarriers, each approximately 300 KHz wide[5]. Figure 1 shows the end-to-end link control over 802.11-based wireless LANs.

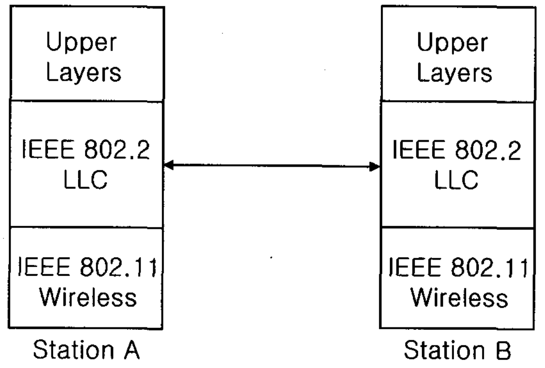

Fig. 1 End-to-End over 802.11-based WLANs.

III. PROPOSAL TO IMPROVE TRANSPORT ABILITY FOR WLAN

802.11 networks use CSMA/CA protocol for sharing the wireless medium. The CSMA/CA protocol avoids the probability of collisions among stations sharing the medium by using a random backoff time if the station's physical or logical sensing mechanism indicates a busy medium. The period of time immediately following a busy medium is when the highest probability of collisions occurs, especially under high utilization. The reason for this is that many stations may be waiting for the medium to become idle and will attempt to transmit at the same time. Once the medium is idle, a random backoff time defers a station for transmitting a frame, minimizing the chance that stations will collide.

In this paper, proposed enhanced backoff algorithm enhances data transmission ability than original method by retransmit scheme for random backoff time in DCF protocol. The procedure for the proposed method is summarized in following step:

1) A station with a new packet ready for transmission senses whether or not the medium is busy
2) If the medium is detected idle, the station starts packet transmission.
3) Otherwise, the station continues to monitor the medium busy or idle status.
4) After finding the medium idle, the station starts to treat medium time in units of slot time.
5) If the second carrier sense find medium idle = NO or collision = YES, the station send it enhanced backoff function.
6) And then, it is sent to the start by enhanced backoff function.
7) Except for the second carrier sense, all of them send original random backoff time function.

The reason why using enhanced backoff scheme only at the second carrier sense, it prevent unnecessary backoff time delay. This random backoff time mechanism does a good job of avoiding collision. However, stations on the networks with high utilization have experience substantial delays while waiting to transmit frames. Figure 2 depicts flowchart of proposed enhanced backoff scheme.

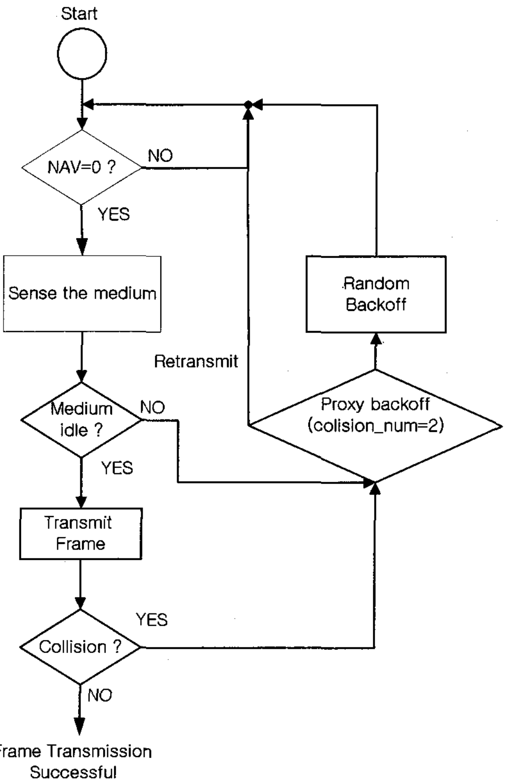

Fig. 2 Flowchart of a Proposed IEEE 802.11 MAC protocol

IV. SIMULATION OF TRANSMISSION TIME

To evaluate the performance of the proposed scheme, by changing Eb/No in wireless channel, we acquire transmission time of packet and and analyze BER performance of OFDM/QPSK using a enhanced backoff scheme in AWGN channel and Rician. Also, it is studied the transmission time of TCP packet compared a enhanced backoff scheme with an original backoff. For achieving transmission time of TCP packet for wireless LAN, total message transmission time is simulated that a size of total message of upper layer TCP is at 5000 bytes and that Eb/No is 4 dB in AWGN channel and 4 dB, KR = 9 dB in Rician. In addition, TCP packet size is analyzed fragmenting from 100 to 2000 bytes. In figure, the parameter Eb/No set at 4 dB to comparea enhanced backoff scheme with an original backoff in AWGN channel and Rician. In figure 3, when the TCP packet size increases from 100 to 2000 bytes, packet transmission time of both enhanced backoff scheme and original backoff is less than the transmission time of an initial TCP packet 100 bytes. In figure 4, the parameter

Eb/No set at 4 dB, KR = 9 dB(Rician) to compare a enhanced backoff scheme with an original backoff in AWGN channel and the simulation result is approximately the same as figure 3.

From these results of figure 3 and 4, a proposed enhanced backoff scheme produces a better performance than an original backoff in wireless LAN environment. In addition, when we evaluate figure 3 and 4, we get that the TCP packet size should increase in order for the transmission time in wireless channel to decrease. To obtain a suitable TCP packet size, we also considered the BER in a wireless channel. In the case of optimal TCP packet size (about 500 byte) in AWGN channel and Rician, the TCP packet transmission time - considering trade-off between total message transmission time and TCP packet size - is about 345 ms (Eb/No = 4 dB) in AWGN channel and 315 ms (Eb/No = 4 dB, KR = 9 dB) in Rician.

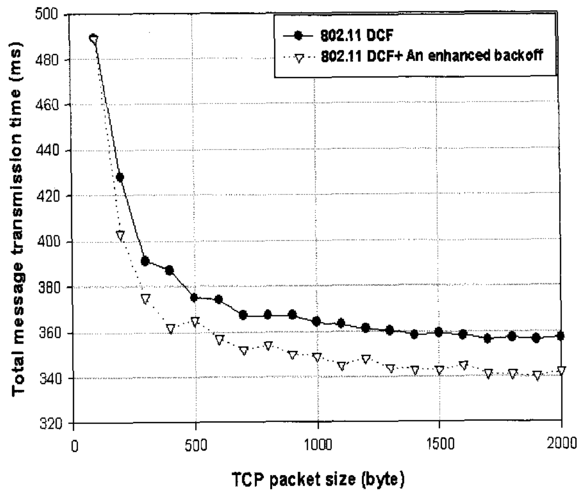

Fig. 4 Total message transmission time (Eb/No = 4 dB, KR = 9 dB, Rician)

V. CONCLUSION

This paper has analyzed TCP packet transmission time enhanced backoff scheme. It is considered the transmission time of TCP packet on the OFDM/QPSK in AWGN wireless channel and in Rician. Also, we analyzed the TCP packet transmission time by changing Eb/No. A enhanced backoff scheme algorithm decreases TCP packet transmission time than on original backoff.

From the results, in OFDM/QPSK channel, we can obtain that the transmission time in wireless channel decreases as the TCP packet size increases. As a result, based on the data collected, we can infer the correlation between packet size and the transmission time, allowing for an inference of the optimal packet size in the TCP layer. This paper will be able to give a hint on improvement of quality of service (QoS) and performance improvement of wireless LAN system.

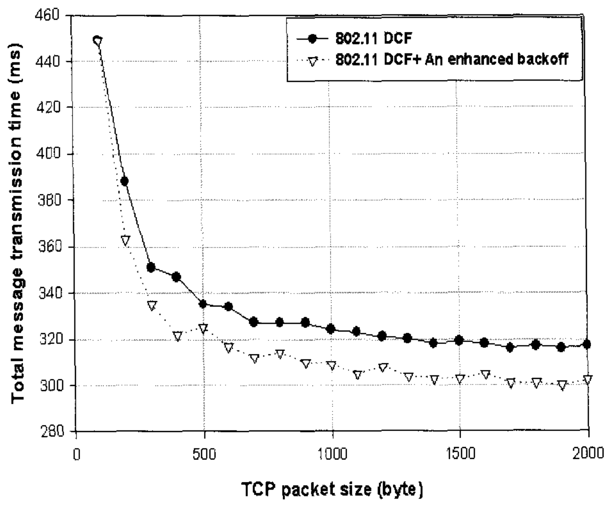

Fig. 3 Total message transmission time (Eb/No = 4 dB)

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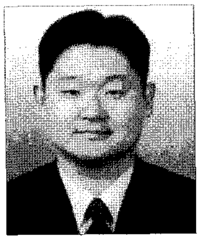
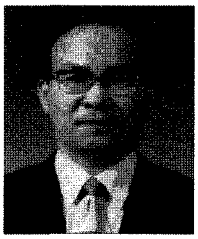


Il-Young Moon
Member KIMICS Received the B. S., M. S. and Ph. D. degrees in telecommunication and information engineering from Hankuk Aviation University, Kyounggi-Do, Korea in 2000 and 2002 and 2005 respectively. He is currently a fulltime lecturer of School of Internet Media Engineering, Korea University of Technology and Education, Seoul, Korea. His research interests are in the areas of mobile IP, wireless LANs, wireless TCP, Ad hoc Network. He is a member of Korean Institute of Communication Sciences, a member of Korea Institute of Electronics Engineers, a member of Korea Navigation Institute, and a member of Korea Institute of Maritime Information & Communication Sciences.



Sung-Joon Cho
Member KIMICS Received the B. S. degree in tele-communication engineering from Hankuk Aviation University, Kyounggi-Do, Korea in 1969, the M. S. degree in the telecommunication engineering from Hanyang University, Seoul, Korea in 1975 and the Ph. D. degree in telecommunication engineering from Osaka University, Osaka, Japan in 1981. Since 1972, he has been a professor in the School of Electronics, Telecommunication and Computer Engineering, Hankuk Aviation University, Kyounggi-Do, Korea. In Hankuk Aviation University, he was a dean of Student Affairs Division from 1989 to 1990, a dean of Academic Affairs Division from 1991 to 1992 and in 1996, a chief of Research Institute for Electronics, Information and Telecommunication from 1993 to 1996, a dean of Graduate School Aviation Industry from 1996 to 1998, and a dean of Graduate School from 1999 to 2002. He received the medal of Science Research in 1984, 1994, 1995, and 2002. His research interests are in the areas of wireless communication, mobile communication, and electromagnetic interference. He is a member of Korean Institute of Communication Sciences where he was a vice president in 1998, a member of Korea Electromagnetic Engineering Society where he was a vice president from 1996 to 2001, a member of Korea Navigation Institute where he was a president from 2001 to 2002, a member of Korea Institute of Maritime Information & Communication Sciences, a member of IEEE, and a member of IEICE(Japan).