OBTAINING THE EFFECTS OF WMM IN CONGESTED 802.11 NETWORKS

Erdem UÇAR **Gökhan AKIN** **Sınmaz KETENCİ**

Trakya University, 22100 Edirne, Turkey *Istanbul Technical University, 34469 İstanbul, Turkey*

Abstract

To obtain QoS in the Wireless Networks, two standards have been developed as 802.11e by IEEE and WMM by Wi-Fi Alliance. These standards don't provide visible performance improvements to the delay sensitive traffic in normal conditions. In this study, the effect of these standards has been tested in terms of traffic delay in congested networks.

Keywords: 802.11e, WMM, QoS, Delay, Jitter

INTRODUCTION

The communication media is shared in wireless Networks and collision is absolute in result. Since the receiving and the transmitting station in wireless Network use the same frequency, they work at half-duplex mode.

To run a wireless network at the full duplex mode, the data transmission and receiving process must be done in different way. But the IEEE 802.11 standards don't permit for this even if this is possible in theory. As the daily needs increase for wireless network, IEEE 802.11 standards become insufficient for realization of the multiple communications applications.

With the newly developed technologies under the recent conditions, the QoS is obtained. And so a trouble free communications is gained. In this paper collision avoidance technique, innovations introduced to MAC (media access control) sub-layer by IEEE 802.11e standards, application logic of QoS in wireless networks and tests done within this study on the performance of these applications have been discussed.

1.CSMA/CA ALGORITHM

The Signals that sent at the same time by two wireless network stations are interfere with each other and generates collision, so in result the sent data is received as noise or error in the network. There is no absolute way to understand that either if the collision is created or not. Even the data sending station will not aware of it. Because its receivers will be closed at that moment. As a simple feedback, a receiver sends an acknowledgment (ack) frame to its each frame sent by transmitter in response. Even the ack frames are collision investigation tolls at basic level; they can't prevent collision at the source.

IEEE 802.11 standards use CSMA/CA method to minimize the collisions. Like the CSMA/CD method in wired network, this method avoids from collision instead of finding it. The client waits till the communication medium becomes free. To start the communication client waits for an extra random period of time more after it realizes the line is free already. Than the communication starts after this extra waiting period.

2. DISTRIBUTED COORDINATION FUNCTION (DCF)

There are two possibilities for a frame sending station. Transmitting station waits for a while, if any other station doesn't send any frame in this period of time, it'll start sending the frame. And then the receiving station sends back an ack frame informing that it received the frame without any collision. A station may send its own frame, after it waits for the completion of the transmission of other equipment and waiting for the random period of time more. (1)

The necessary waiting period of every station that wants to send the data is as much as the sum of DIFS (Distributed Coordination Function Interframe Space) and Backoff Period of time which randomly selected. All that period of operation is called DCF (Distributed Coordination Function). Figure.1 shows the B, C and D stations while station A is sending the data.

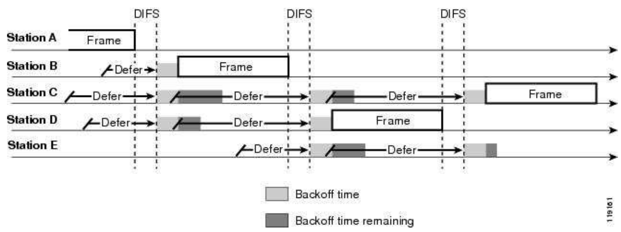

Fig. 1. DCF Operation (2)

The size of random backoff is controlled by the Contention Window (CW) used by DCF. The CW value established by the equipment at the beginning is given to CW. Later a DCF using station applies the following steps to send a data frame:

I. Picks a value in between zero and the minimum Contention Window (CWmin) value, to calculate the random backoff.
II. Waits for DIFS period, when the communication medium is free.

III. Waits while the medium is free, as long as the multiplication of random backoff value and the slot period (20 µSec.).

IV. If another station with the smaller backoff period starts to communicate in this period, the initial station reduces the random backoff number as much as the slot period value that it waited.

V. In case of the medium is empty again, in addition to the DIFS period, it waits for a period of time, calculated with this new random number. It sends the frame at the end of this period if the medium is free.

VI. A new CW is calculated if the frame couldn't be sent due to the fullness of the medium, even if the backoff value is zero. And according to this value the DCF period is repeated. The CW value which will be used in this period is calculated by "2*(CW + 1)" formula. The CW value cannot be greater than the CWmax.

3. ENHANCED DISTRIBUTED COORDINATION FUNCTION (EDCF)

The EDCF has been started to be used with IEEE 802.11e standards as a developed version of DCF. The most important part of this development is the adjustment of CWmin and CWmax. Random values based on the traffic classification. In spite of waiting of equal DIFS, all the traffics used with EDCF and DCF, alter in conjunction with traffic classification of CWmin value used to create the random backoff level. EDCF uses AIFS instead of DIFS. The difference of AIFS than DIFS is that the AIFS is at a different value for each access category. AIFS values for access categories are announced by access points via beacon frames. The traffic with higher priority has smaller CWmin value while the best-effort traffic in mostly has longer CWmin value which creates longer random value. Each station determines the top boundary level of sending period (TXOP). TXOP is the time interval in which the station has the right of transfer and it is expressed by the starting time of transfer and the maximum period. (3)

Each frame from higher layer arrives MAC with its own priority value. Those priority values are mapped into the access category values carried in the MAC frame header. According to IEEE 802.1d bridge specification the relative priority of 0 is placed between 2 and 3. (4)

Priority, Access categories, definitions, CWmin and CWmax values are shown in the tables below.

Priority	Access Categories	Definitions	CWMin	CWMax	AIFS[s]
1	0	Best Effort	15	1023	72 µs
2	0	Best Effort			
0	0	Best Effort			
3	1	Video Probe	15	1023	37 µs
4	2	Video	7	15	28 µs
5	2	Video			
6	3	Voice	3	7	28 µs
7	3	Voice			

Table 1. Enhanced Distributed Channel Access Values for IEEE 802.11g (for 802.11e)

The priority value of traffic is described in the ToS field of IP packet header by client. The EDCF operation is expressed, depending on this value in below.

I. All other stations wait for a random period while the X station transmitting a frame.

II. Voice 1 and Voice 2 stations pick less CWmin value since they transmit voice frames, so their random waiting periods become shortened. On the contrary of this, since the Best Effort 1 and the Best Effort 2 stations pick higher CWmin value, they define longer random period.

III. Since the Voice 1 has the minimum random period, it realizes the first transmission. Other stations wait while the Voice 1 transmitting frame. The newly joined Voice 3 station waits also for a random period.

IV. Each station waits for AIFSD period after Voice 1 station completed the transfer and they reduce their random duration. Voice 2 random periods starts transmitting as the first station finishing the random period.

V. When the Voice 2 station completes its transmission, the station waiting as long as AIFSD period, decrease their waiting period and the Best Effort 2 as first completing this period starts to transmit. But the Voice 3 station having higher priority cannot send the frame in this small period. The reason of this is the greater small random period selected by Voice 3 station entered the network later, than the waiting period lessened by the Best Effort 2 station by time.

VI. After Best Effort 2 station, all other stations wait as long as AIFSD period and they decrease random period. Voice 3 that completes this transfers the frame. So the operation continues in this way.

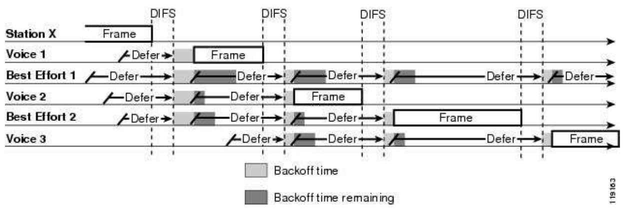

Fig. 2. EDCF Operation

4. WIRELESS QOS AND WIRELESS MULTIMEDIA (WMM)

In wireless networks access point devices accept the present classification values (ToS) which are marked by wired LAN devices. This QoS values can be set by applying to the Virtual LANs or physical interfaces. QoS values coming from wired networks can be shaped by LAN devices but in wireless networks, access point devices trust the clients QoS settings most of the time. (5)

Wireless Multimedia (WMM) that is realized by Wi-Fi organization, for obtaining service quality (QoS) is used together with IEEE 802.11e standard. WMM investigates the traffic in 4 categories as voice, video, Best-Effort and Background and sets the data priority according to their categories. It is an enhanced version of collision avoiding technique used in wireless networks.WMM defines the waiting period of sources according to the access categories and waiting period becomes shorter for the frames with higher priority.

5. ANALYZING WMM PERFORMANCE IN TERMS OF DELAY

For real time applications, the priority management is provided in the 802.11 networks by using WWM. In this way, even in congested Networks, the negative effects on the delay sensitive traffics are decreased. The improvement, indicated by the WWM has been tested by "D-ITG (Distributed Internet Traffic Generator)" software in this study. This software is distributed as open source by the "Universita' delgi Studi di Napoli Fesderico II" for the purpose of use in the scientific investigations. Various types of data communications can be simulated and many measurements can be made by this software. D-ITG supports both IPv4 and IPv6 traffic generation and it is capable to generate traffic at network, transport, and application layer. (6)

This study focuses on WMM effects under congested network circumstances in terms of delay. Simulated UDP traffic patterns' IP precedence (ToS) values have been set to 5 and the payload size was 512 bytes. Same traffic patterns have been used with and without WMM applied and results examined.

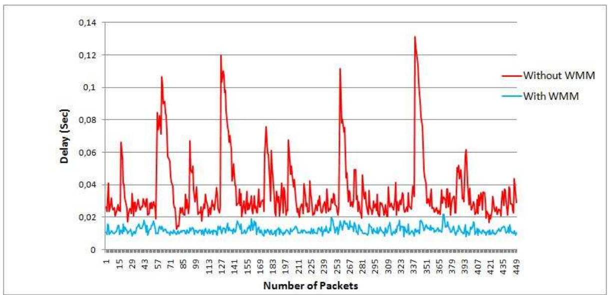

Fig. 3. Delay rates with and without WMM

The delay period in the graphic is shown by seconds. The traffic delay rates with WMM enabled is shown in blue colored line while the delay rates without WWM is shown in red color line in graphic. The delay rates are lower when the WWM is active. Also the variation in delay (jitter) is seen very low.

CONCLUSION

As a result it is seen that the delay and jitter problems of sensitive traffic in congested networks are decreased by 802.11e and WMM. (figure.3) But It's not clear if most of the users have special priority. With another study, this situation can be examined. In normal conditions under the effect of these developed standards, the wireless networks are approached to a better level for meeting increasing demands and multimedia (video, voice) application needs.

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