ijesm www.ijesm.com International Journal of Engineering, Science and Metallurgy

(General article)

Performance of Wireless LAN in DCF and EDCF using OPNET

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Accepted 18 July 2012, Available online 1Sept 2012

Abstract

The wireless local area network is a flexible data communications system implemented as an extension to, a wired LAN. Using radio frequency technology, wireless LANs transmit and receive data over the air, minimizing the need for wired connections. Thus, wireless LANs combine data connectivity with user mobility. Quality of service (Qos) is major research issue in the development of wireless LAN. So Qos need to be improved as the advancements in wireless technology goes on In this paper, effects of various access mechanisms on the performance of WLAN have been analyzed and compared using network simulators. The network simulators provide an ease in estimating the performance of networks. Among the various network simulators available, OPNET gains an edge in analyzing the performance of the networks through simulations. The metrics like throughput, delay and retransmission attempts have been used for performance analysis of the wireless computer networks using simulation through OPNET Modeler 14.0(1)

Keywords: *IEEE 802.11, BSS, Qos, OPNET, Wired LAN*

1. Introduction

Wireless local area networks (WLANs) are being developed to provide high bandwidth to users in a limited geographical area.. Physical and environmental necessity is another driving factor in favor of WLANs. WLAN has two types of network elements: stations (STAs) and access points APs). A STA is defined as the device that is equipped with a component that can communicate via a WLAN standard. A STA is called an AP if it is connected to a wired network and offers infrastructure service to mobile STAs. Networks composed of a combination of these actors are categorized as Independent Basic Service Set (IBSS) or Infrastructure Basic Service Set (Infrastructure BSS).

A. Independent Basic Service Set

IBSS type of network is also referred to as an ad-hoc network. An ad-hoc network is a network where there is no infrastructure. In such a network, stations communicate directly to each other and they spontaneously establish a distributed communication mechanism. As shown in Figure 1, the IBSS network is not connected with the wired domain. IBSS is initiated if a station is in the vicinity of another. One of the STA selects itself as the starter and sends beacon signals indicating the service id of the IBSS. The routing algorithm in IBSS is handled by ad-hoc routing protocols which reside in the network layer.

B. Infrastructure Basic Service Set

In contrast to ad-hoc networks, Infrastructure BSS contains a gateway to the wired domain and enables communication between a station of a BSS and a station of other BSSs and other LANs as seen in Figure 1. The gateway is called access point (AP) in the IEEE 802.11 standard. APs communicate with each other via either cable or radio to interconnect BSSs

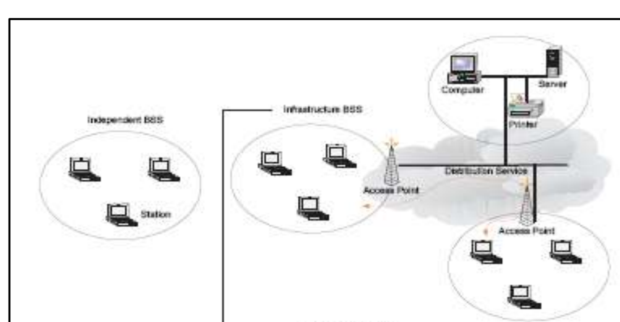

Fig 1: WLAN Topology

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This paper has been organized as follows: Part I deals with Introduction, Part II deals with mechanisms, Part III deals with the brief description of IEEE 802.11e , Part IV deals with the experimental set up and results of simulation and in Part V the paper has been concluded.

2. Access mechanisms

IEEE802.11 [2] Media Access Control (MAC) defined two access mechanism: **distributed coordination function (DCF) and point coordination function (PCF)**. Both PCF and DCF mode of IEEE 802.11 do not perform equally well under all traffic scenarios. Their behavior varies depending upon current network size and traffic load. It is useful to use the DCF mode for low traffic and small network size, and the PCF mode for high traffic loads and to reduce contention in large size network.DCF is used as a fundamental access method to MAC layer protocol in IEEE802.11 standard, it is based on carrier sense multiple access with collision avoidance (CSMA/CA) of binary system exponential back-off arithmetic. Many literatures have put forward improvement on it, including the scheme of adjusting contention window, improving back-off arithmetic and so on as in [3,4], but it still could not solve the problem of poor provision in real time ability of DCF. However, PCF access method provides good real time operation, it adopts the polling mode to assign the use of channel, and thus it is without collision. This mode could apply in the situation which delays demanding, such as voice and multimedia and so on. PCF provides contention-free frame transmission, this mode only work in infrastructure-based network with AP server as a point coordinator to implement the polling function. IEEE 802.11 standard allow WLAN to use polling mode and contention mode to access channel .Authors illustrated that combination of DCF/PCF can combine the advantages of two different access mechanisms. Besides all the advantages offered by WLAN like flexibility, less need or no need of planning and robustness as compared with wired LAN, it also suffers from some disadvantages. These are limited range of connectivity (within 100-150 ft of the base station (indoors) and about 100-300 meters (outdoors) to get connected), lower Qos (Lower bandwidth due to limitations in radio transmission and higher error rates due to interference) and need of safety and security. Among all these factors **Qos** is the major research issue now a days and continuous work is being carried out to improve Quality of service in Wireless LAN.

3. Overview of IEEE 802.11E

The IEEE 802.11e [7] is an improvement to the original IEEE 802.11 standard in order to support Quality of Service (QoS) at the MAC level. To achieve this, packets received from upper levels are handled in a different manner depending on their QoS requirements, meaning that IEEE 802.11e supports service differentiation. Similarly, the MAC layer also offers a differentiated treatment to packets with different QoS requirements when passing them to upper stack layers. Here the table is showing the priorities of various access categories.

Table 1 Access categories mapping to user priority

Priority	UP	AC	Designation
Lowest	1	0	Background
	2	0	Standard
	0	1	Best Effort
	3	1	Excellent Effort
	4	2	Streaming Multimedia
	5	2	Interactive Multimedia
	6	3	Interactive Voice
Highest	7	3	Reserved

UP = User Priority; AC = Access Category

Hybrid Coordination Function (HCF), defines two new medium access mechanisms to replace the legacy Point Coordination Function (PCF) and Distributed Coordination Function (DCF). These are the HCF Controlled Channel Access (HCCA) and the Enhanced Distributed Channel Access (EDCA). Concerning IEEE 802.11e enabled stations forming WLAN network, these must implement the EDCA. At the Application layer, frames are assigned a priority value ranging from 0 to 7, referred as User Priority (UP). This is achieved using the first three precedence bits of the [Type of Service] (ToS) field in an IPv4 datagram header or the [Traffic class] field in an IPv6 datagram header. Depending on this UP, when a frame arrives at the MAC layer, it is classified into one of the four Access Categories (AC); the mapping between the different Ups and these four ACs is illustrated in Table 1.Contrarily to the legacy IEEE 802.11 stations, where all MAC Service Data Units (MSDU) have the same priority and are as-signed to a single backoff entity, IEEE 802.11e stations have four backoff entities (one for each AC) so that packets are sorted according to their priority.

Table 2 presents the default MAC parameter values for the different ACs (referred as EDCA parameters) for an IEEE 802.11a/g radio. For IEEE 802.11 legacy stations this parameter set was fixed, and so the CWmin and CWmax were set to 15 and 1023, respectively (for IEEE

802.11a); also, the time interval between frames - interframe space (IFS) – was set to a constant value: DIFS. With IEEE 802.11e, as the values of EDCA parameters depend on the AC itself, they are referred to

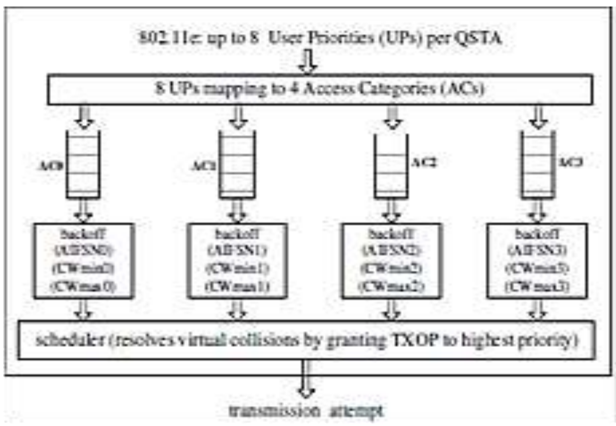

Fig 2: EDCF proposed by IEEE 802.11E

as CWmin [AC], CWmax [AC], AIFSN [AC] and TXOP limit[AC].The purpose of using different contention parameters for different access categories is to give a low-priority class a longer waiting time than a high-priority class IEEE 802.11e introduces a new feature referred to as transmission opportunity (TXOP). A TXOP is defined by a start time and duration; during this time interval a station can deliver multiple MPDUs. This mechanism, also known as Contention-Free Bursting (CFB), increases global throughput through a higher channel occupation. From Table 2 we can notice that smaller values for the CWmin, CWmax, and AIFSN parameters are associated in a higher priority when

Table 2: EDCA parameter values

AC	Cw min	Cw.max	AIFSN	TXOP (ms)
Background	15	1023	7	0
Best Effort	15	1023	3	0
Video	7	15	2	3.008
Voice	3	7	2	1.504

accessing the channel; relative to the TXOP limit, higher values result in larger shares of capacity and, therefore, higher priority.

4. Experimental set up and results

In this work WLAN has been implemented in EDCF and DCF mode for set of tunning parameters and compared.

Comparison of DCF and EDCF

All four traffic classes were fed into the MAC layer from higher layer, which are corresponding to AC (0), AC (1), AC (2) and AC (3) respectively to check how efficient the new protocol is to provide service differentiation required for real time application. (Note that DCF does not support service differentiation, so no provision of Access category).To implements this, in the application profile for EDCF protocol different applications were configured for different access category. The various applications chosen for analysis and comparison are given in table 3.

Table 3: Applications configured in simulation

ACCESS CATEGORY	APPLICATION CONFIGURED	DESIGNATION
AC(0)	HTTP (LIGHT)	BACKGROUND
AC(1)	REMOTE LOGIN (HEAVY)	BEST EFFORT
AC(2)	VIDEO CONFERENCING	INTERACTIVE MULTIMEDIA
AC(3)	VOIP	INTERACTIVE VOICE

Fig 3. Shows the simulation set up for comparison of DCF and EDCF mode of WLAN topology. The performance of both the protocols is compared and the results were analyzed in terms of Throughput, Media Access Delay and Retransmission Attempts

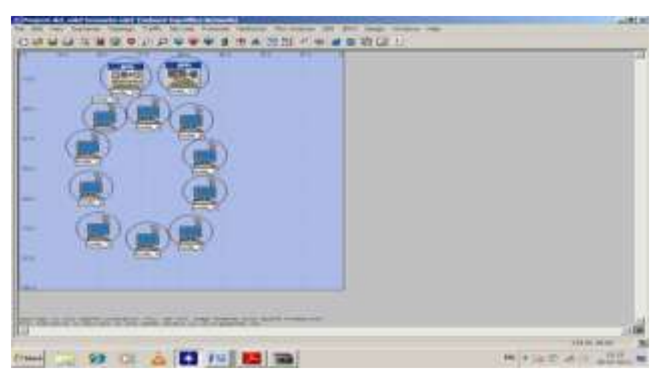

Fig 3: Simulation Set up for comparison

- Throughput- It is observed from fig 4. that in the first 30 seconds of simulation, Throughput of both DCF and EDCF is high, but then after that, it decreases with time and stabilizes for both protocols .Throughput of EDCF is slightly less than DCF mode.

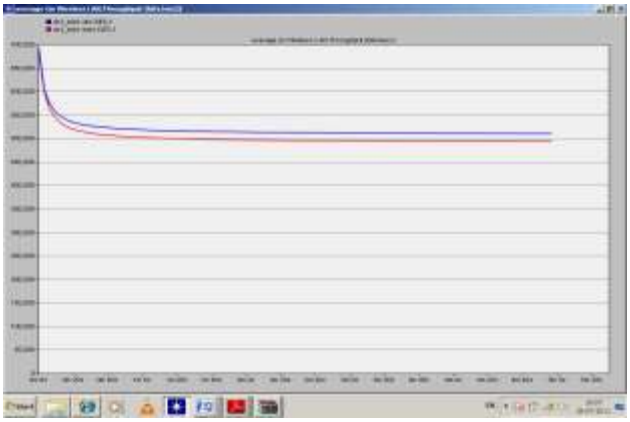

Fig 4: Throughput comparison of DCF and EDCF

- Retransmission attempts- .As shown in fig 5. In the first 30 seconds of simulation, Retransmission Attempts for both DCF and EDCF are less, but then after that, it decreases with time and stabilizes for both protocols. Retransmission Attempts in first 30 seconds are less due to less number of back off's assigned to wireless stations. There is a small noticeable difference between curves of Retransmission Attempts of DCF and EDCF protocol. That small difference implies that the overall Retransmission Attempts made in DCF protocols are a bit lesser than EDCF protocol.

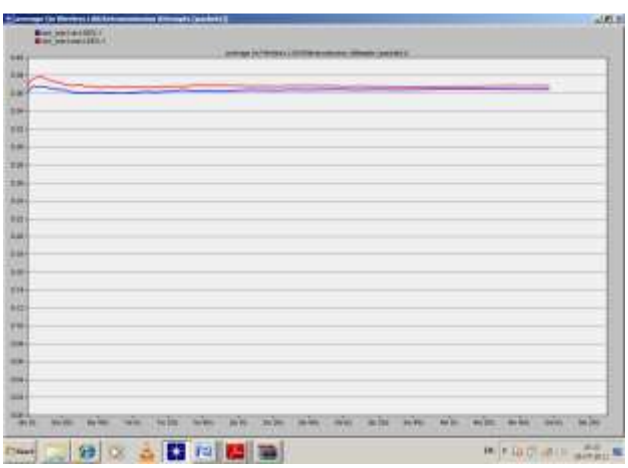

Fig 5: Retransmission attempts for DCF and EDCF

- Media Access Delay- from Fig 6, for the first minute of simulation the Medium Access Delay for both protocols increases at equal pace, and then after that, DCF suffers somewhat lesser Access Delay than EDCF. The increase in the Medium Access Delay for both protocols is due to increase in the number of nodes competing to gain access of medium.

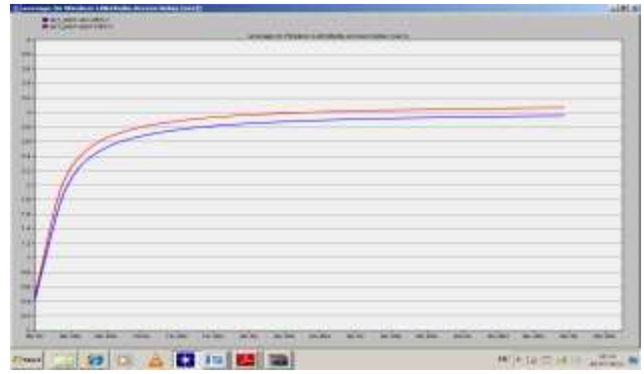

Fig 6: Media Access delay comparison of DCF and EDCF

Conclusion

The impact of DCF mode of Wireless LAN topology has been analyzed and compared with EDCF which is Enhanced DCF using OPNET Modeler. DCF is basic access mechanism in WLAN which do not offer service differentiation to different types of traffic. So higher priority traffic like video streaming and voice applications suffer with large delay. EDCF on the other hand offers service differentiation on the basis of priorities and provide performance improvement over DCF mode. The performance of EDCF can further be improved by proper tunings of various parameters like physical characteristics, transmitted power, Fragmentation Threshold etc.

References

1. OPNET Modeler. http://www.opnet.com/.
2. IEEE Standards for Information Technology – ANSI/IEEE Std 802.11 – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. On line, 1999
3. IEEE Standards for Information Technology– IEEE Std 802.11e – Draft Supplement to Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Medium Access Control (MAC) Quality of Service Enhancements. online, 2005
4. Zhang Xinfeng, "The analysis of IEEE802.11 MAC delay performance", Communication World, Shang Hai, pp. 69-72, 2007
5. Li Feng, Wang Qiuguang, "The simulation research of wireless local area network's MAC with DCF Way," JOURNAL HARBIN UNIV. SCI. &TECH, Harbin, Vol. 11, pp. 1-3 ,Oct 2006\
6. Wang Shunman, Tao Ran, Chen Shuoying, Wu Changqi, Wireless local area network, CHINA MACHINE PRESS, Beijing, 2005\
7. WANG Xiu-fang , DU Hong ,WEI Yu-heng , JU Li-li, "Modeling and Simulation of Wireless Local Area Network MAC Access Mechanism in Oil Field",IEEE, pp.2148-51, 2007
8. IEEE 802.11e WG, Draft Supplement to Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY)specifications: Medium Access Control (MAC) Enhancements for Quality of Service (QoS), IEEE Std 802.11e/D3.3.2, November 2002
9. Choi Sunghyun, Del, Sai, Mangold S. "IEEE 802.11 e contention-based channel access (EDCF) performance evaluation", IEEE International Conference on In Communications, vol. 2, pp. 1151-1156, 2003
10. Gu D. and Zhang J., "QoS enhancement in IEEE 802.11 wireless local area networks", IEEE Communications Magazine, vol. 41, no. 6, pp. 120 -124, June 2003