International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN : 2278-800X, www.ijerd.com
Volume 4, Issue 10 (November 2012), PP. 19-25

Study of Quality of Service by using 802.11e

Ravi Gorripati[1], M.V. Rathnamma[2], V. VenkataRamana[3], Dr. P. Chenna Reddy[4]
[1,4]Department of Computer Science and Engineering, JNTUA College of Engineering Pulivendula, Y.S.R (Dist)., A.P., India.
[2,3]Assistant Professor, Department of Computer Science and Engineering, SSITS, Rayachoty, Y.S.R. (Dist).A.P., INDIA.

Abstract:- Wireless Local Area Networks (WLANs) are one of the fastest growing wireless access technologies. The IEEE 802.11 Standard doesn't support any QoS mechanisms. IEEE 802.11 MAC layer supports two basic access mechanisms, DCF (Distributed Coordination Function) and PCF (Point Coordination Function). The EDCA mechanism of the IEEE 802.11e standard provides QoS support through service differentiation, by using different MAC parameters for different access Categories. IEEE 802.11e uses three parameters that is TXOP, AIFS, CWmin and CWmax for providing QoS. In this paper service differentiation ability of IEEE 802.11e is evaluated. Parameters of the IEEE 802.11e are statically tuned to achieve optimum performance in different environments. Network Simulator2 (NS2) is used for simulation.

Keywords:- QoS, 802.11e, Service differentiation, EDCF, voice, video, data, background.

I. INTRODUCTION

The IEEE 802.11-based Wireless Local Area Networks (WLANs) have been widely deployed at campuses, enterprises, homes, and hotspots to provide ubiquitous wireless access. The fundamental Media Access Control(MAC)[1] scheme in the IEEE 802.11 standard is called Distributed Coordination Function (DCF), which is a random access scheme based on the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol. Practical WLANs are primarily configured to operate in the infrastructure mode, where a cluster of Mobile Stations (MSs) associated with an Access Point (AP) construct a Basic Service Set (BSS). All MSs in a BSS communicate with each other through the AP which provides access to the Internet and other associated BSSs. WLANs can also operate in the ad-hoc mode where MSs communicate with each other directly in a peer-to-peer manner if they are within the transmission range of each other. Transmission Opportunity (TXOP) TXOP scheme has been specified in the IEEE 802.11e Enhanced Distributed Channel Access (EDCA) protocol**.** This scheme can reduce the contention overhead and also provide service differentiation between various traffic classes.

II. MEDIUM ACCESS CONTROLLER

IEEE 802.11MACprotocol presents two coordination functions, Distributed coordination function (DCF) and Point coordination function (PCF).

2.1. Overview of the DCF and PCF protocols

The fundamental MAC protocol in the IEEE 802.11 standard is DCF, a random access scheme based on the CSMA/CA protocol. In DCF, a station senses the channel before attempting transmission. If the channel is detected idle for a Distributed Inter-frame Space (DIFS)[2], the station transmits the frame. Otherwise, if the channel is sensed busy (in Fig1 either initially or during the DIFS), the station defers until the channel is detected idle for a DIFS and then generates a random backoff counter before the transmission starts. In addition, a station must separate two consecutive frame transmissions by a random backoff interval, even if the channel is sensed idle for a DIFS after the successful transmission of the first frame. The value of the backoff counter is uniformly chosen in the range [0,Wi _ 1], where Wi = 2iW is the current contention window and i is the backoff stage. Wi is initially set to CWmin =W and doubled after each unsuccessful transmission until it reaches a maximum value CWmax = 2mWwhere m represents the maximum number of backoff stages. It remains at the value CWmax until it is reset to CWmin upon the successful frame transmission or if the number of unsuccessful transmission attempts reaches a retry limit. The backoff counter is decreased by one for each time slot (i.e., an interval of a fixed duration specified in the protocol) when the channel is idle, halted when the channel becomes busy and resumed when the channel is idle again for a DIFS. When its backoff counter reaches zero, then a station transmits a frame. Other stations that hear the transmission of the frame set their backoff counter to the expected period of time when the channel is busy, as indicated in the duration identity field of the frame. This mechanism called the virtual carrier sensing mechanism. If either the virtual carrier sensing or physical carrier sensing indicates that the channel is busy, the station commences the back-off procedure. Upon the successful reception of the frame, the destination station sends an ACK frame back immediately after a Short Inter-frame Space (SIFS) interval. If the source station does not receive the ACK within a specified ACK timeout interval, the frame is retransmitted according to the given backoff rules.[3] Each station maintains a retry counter that increases by one after each retransmission. The frame is discarded after an unsuccessful transmission if the retry counter reaches the retry limit.

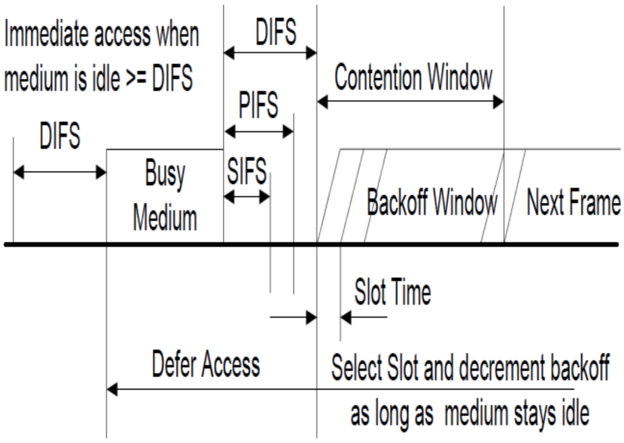

Fig 1: IEEE 802.11 DCF Channel Access

PCF, a polling-based mechanism, provides contention-free frame transmission in an infrastructure network by using Point Coordination (PC), usually residing in the AP, to determine which station presently obtains the channel access. DCF is performed during the Contention Period (CP) and PCF is performed during the Contention Free Period (CFP). When a PC is operating in a Basic Service Set (BSS), the access mechanisms (the DCF and the PCF) alternate with a CFP followed by a CP.

2.2. Overview of IEEE 802.11e

The IEEE 802.11 standard is a technology whose purpose is to provide wireless access to local area networks. Stations using this technology access the wireless medium using either the Point Coordination Function (PCF) or the Distributed Coordination Function (DCF). In particular, the Distributed Coordination Function (DCF)[4] uses a listen-before-talk scheme named carrier sense multiple access (CSMA) with collision avoidance (CA). It is used by stations in a BSS during the CP and also by stations in an IBSS operating in ad hoc mode. Although the CSMA/CA mechanism shows good adaptation to different numbers of transmitters, it offers no mechanisms to perform traffic differentiation, making QoS support practically unfeasible. The IEEE 802.11e working group was created to add QoS support to the original IEEE 802.11 standard, and in 2005 a new international standard was released. The IEEE 802.11e working group was created to add QoS support to the original IEEE 802.11 standard, and in 2005 a new international standard was released. This standard introduces the hybrid coordination function (HCF) which defines two new medium access mechanisms to replace PCF and DCF. These are the HCF controlled channel access (HCCA) and the Enhanced Distributed Channel Access (EDCA).[5]Concerning 802.11e enabled stations forming an ad-hoc network, these must implement the EDCA algorithm. The 802.11e QoS support is achieved through the introduction of different access categories (ACs), and their associated backoff entities. Contrarily to the legacy IEEE 802.11 stations, where all packets have the same priority and are assigned 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.

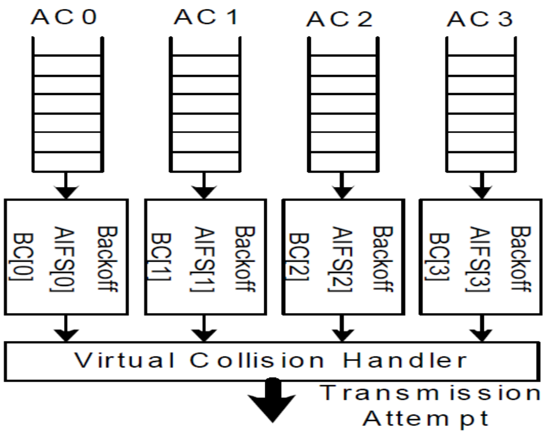

Fig 2: EDCF Four access categories (ACs)

The different access categories available in IEEE 802.11e stations are: voice (AC_VO), video (AC_VI), best effort (AC_BE) and background (AC_BK). Each backoff entity has an independent packet queue assigned to it, as well as a different parameter set. In IEEE 802.11 legacy stations, this parameter set was fixed, and so the inter-frame space was set to DIFS and the CWmin and CWmax values were set to 15 and 1023, respectively (for IEEE 802.11a/g). With IEEE 802.11e the inter-frame space is arbitrary and depends on the access category itself (AIFS[AC]). We also have AC-dependent minimum and maximum values for the contention window (CWmin[AC] and CWmax[AC]). Additionally, IEEE 802.11e introduces an important 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 frames consecutively without contention with other stations. This mechanism, also known as contention-free bursting (CFB), increases global throughput through a higher channel occupation. An EDCA–TXOP (in contrast to an HCCA–TXOP)[6] is limited by the value of TXOP Limit, which is a parameter defined for the entire QBSS and that also depends on the AC (TXOP Limit[AC]).

Priority	Access Category(AC)	Designation
Lowest 1	0	Background
2	0	Background
0	2	Best Effort
3	2	Best Effort
4	2	Video
5	2	Video
6	3	Voice
Highest 7	3	Voice

Table 1: User priority to Access Category mapping

Table 1 presents the default MAC parameter values for the different ACs. Notice that smaller values for the AIFSN, CWmin and CWmax parameters result in a higher priority when accessing the channel; relative to the TXOP Limit,[11] higher values result in larger shares of capacity and, therefore, higher priority.

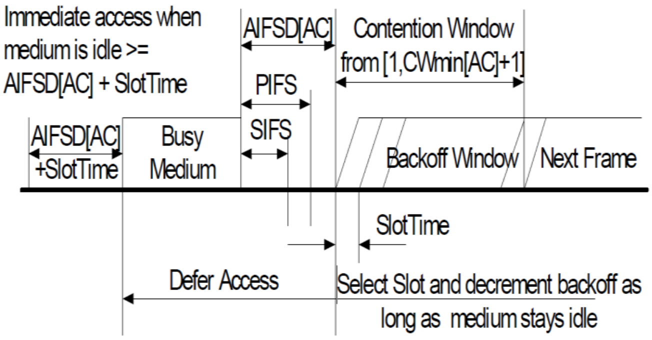

Fig 3: IEEE 802.11e EDCF channel access

Where SIFS is the shortest inter-frame space possible and a Slot Time is the duration of a slot. As defined by the standard, the AIFSN [AC] parameter must never be less than 2 to avoid interference with normal AP operation. For applications to take advantage of the IEEE 802.11e technology, datagram should have their IP Type of Service (TOS)[7] header field set according to the desired user priority. When delivered to an IEEE 802.11e enabled wireless card driver, those datagram will be handled according to the priority defined, as explained in the IEEE 802.11e standard.

III. PERFORMANCE ANALYSIS

The following metrics are used for performance analysis:

a. Normalized throughput, for each access category is defined as the fraction of time in which the channel is used to transmit all data frames successfully.
b. Mean frame access delay, is defined as the time interval between the instant that the data frame arrives to the queue and the time when the data frame is successfully acknowledged by the receiver. That is, the delay includes queuing and medium access delays at the source MAC, successfully reception of the data frame by the receiver and successfully reception of the ACK frame, and all the unsuccessful transmissions of the frame.
c. Number of packets dropped while transmitting the data based on priority.

IV. SIMULATION SETUP

Network simulator-2 (NS2) is used to evaluate the performance of IEEE 802.11e EDCA mechanism. We simulate with eight stations among these four stations are sending four user priority data (voice, video, data and background) and remaining four stations are acting as receivers.[9] We choose 802.11b as the PHY layer, and the PHY data rate is set to 1 Mb/s and using AODV routing algorithm. The simulation parameters are shown in the table 2.

Table 2: Default values of IEEE 802.11e parameters

AC	CWmin [AC]	CWmax [AC]	AIFS [AC]	TXOP [AC]
AC_BK (0)	31	1023	7	0
AC_BE (1)	31	1023	3	0
AC_VI (2)	((CWmin +1)/2)-1	CWmin	2	0.003008
AC_VO (3)	((CWmin +1)/4)-1	((CWmin +1)/2)-1	2	0.001504

4.1. Simulation Analysis of EDCF

In case of 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. Different applications were configured for different access categories.

4.1.a. Normalized Throughput of Different Access Categories

In Fig. 4 we can see Throughput of Access category 3 is higher than the Access category 0, 1 and 2. Throughput for Access category 2 lies in between 3 and 1. It means that Throughput for applications like Voice over IP and Video conferencing, EDCF provides maximum Throughput by providing them more priority over the other services like simple data transfers (HTTP).

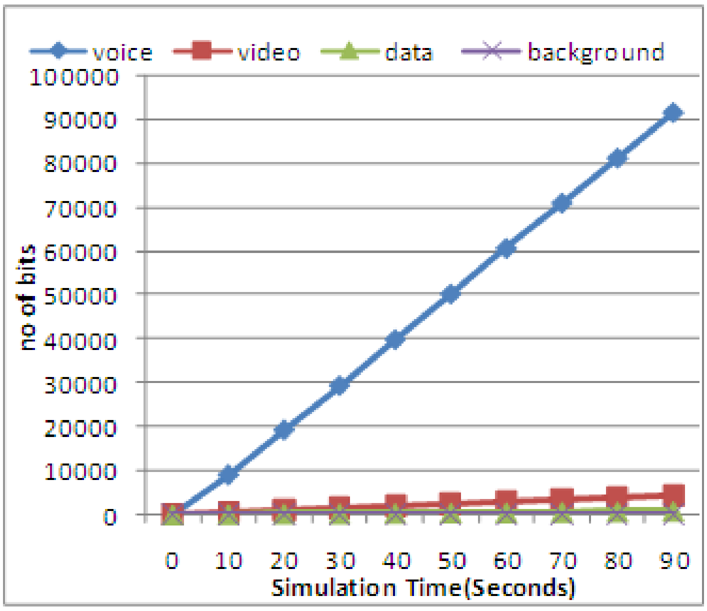

Fig 4: Normalized Throughput for Different access categories

4.1.b. Mean Frame Access Delay for Different Access Categories

In Fig. 5 we can see Mean frame Access Delay for Access category 3 is comparatively less among all Access categories. Delay for Access category 0 lies in between AC(1) and AC(2). It means that the medium is assigned to the application according to the priority. Thus, EDCF provides lesser Medium Access Delay for delay sensitive applications. Observe the fig 5, the EDCA contains the constant access delay for voice and video. Coming to data access delay gradually increased and at the same time background data delay also gradually increased.

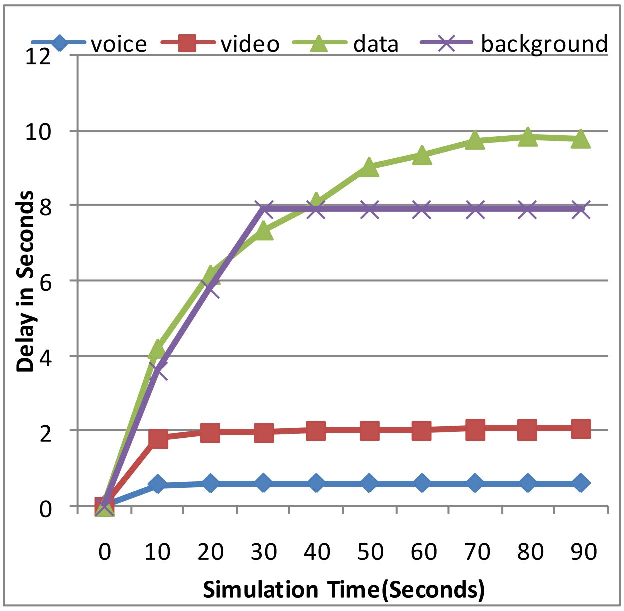

Fig 5: Mean Frame access delay for different access categories

V. DCF & EDCF COMPARISION

5.1. Normalized Throughput

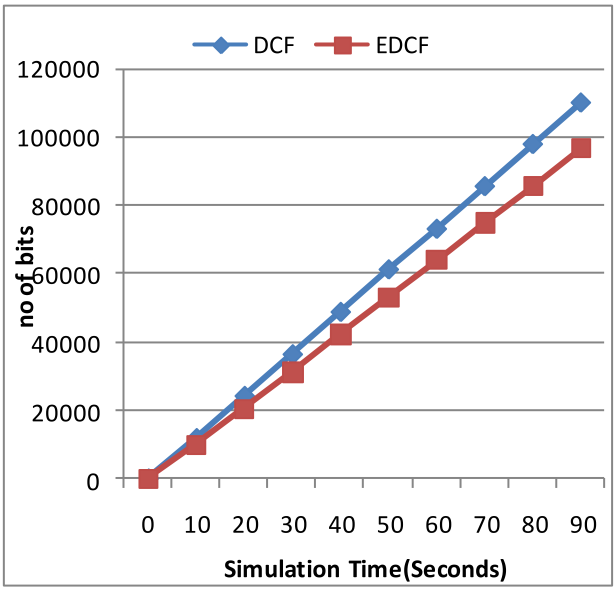

Fig 6: Normalized Throughput of DCF vs EDCF

By observing we observe that the throughput of DCF is significantly different from EDCF. From Graph analysis, one fact is clearly visible, that line of DCF is marginally higher than that of EDCF. We can conclude that DCF's overall Throughput is little more than the EDCF. We can easily imagine that the traffic is well served with the DCF while many frames are dropped with the EDCF due to prioritization.

5.2. Mean Frame Access Delay

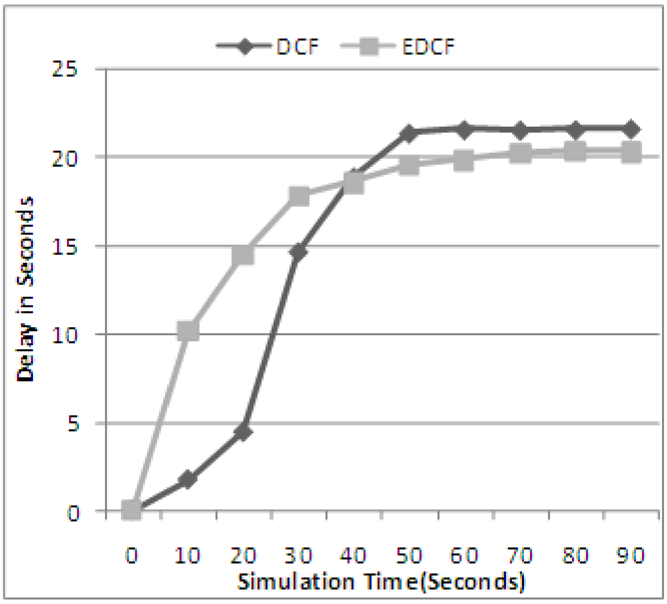

Fig 7: Mean Frame Access Delay of DCF vs EDCF

In Fig 7, for the first 30 seconds of simulation the Mean frame access Delay of DCF is lesser than the EDCF after that both protocols increases at equal pace, and then EDCF suffers somewhat lesser Access Delay than DCF. The increase in the Mean frame Access Delay for both protocols is due to increase in the number of nodes competing to gain access of medium.

5.3. Data Dropped

In Fig. 8, observing the first 30 seconds of simulation, data drop in DCF and EDCF is same and then after that, DCF suffers a sudden high Data Drop due to collisions, but Data Drop in EDCF increases gradually. The reason of varying Data Drop gradually in EDCF is the service differentiation which provides priority based scheme to handle different kind of data.

From the results, we conclude that the EDCF can provide differentiated channel accesses for different traffic types. With the observed throughput and delay, we expect that the EDCF can support real-time applications with voice and video traffic with a reasonable quality of service in certain environments.

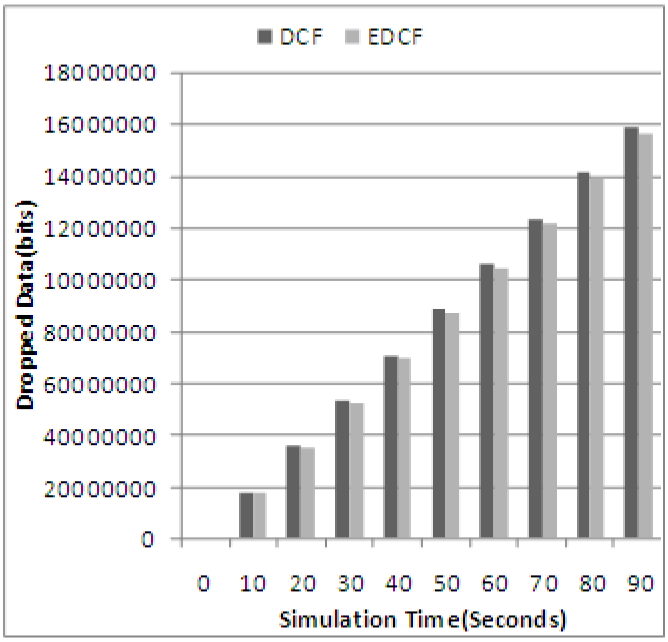

Fig 8: Dropped data of DCF vs EDCF

VI. CONCLUSION

EDCA provisions service differentiation by configuring different traffic classes with different contention window sizes, AIFSN and TXOP values. Based on the simulation, we compared the legacy 802.11 DCF and the 802.11e EDCF to show that the EDCF can provide differentiated channel access among different priority traffic. The results obtained from simulation shows that Enhanced Distribution Coordination Function (EDCF) provides efficient mechanism for service differentiation and hence provides quality of service to the Wireless LAN. However, this improvement comes at a cost of a decrease in quality of the lower priority traffic up to the point of starvation. Higher priority traffic benefited, while lower priority traffic suffered. In terms of overall performance DCF performs marginally well than EDCF. This happens due to reason that in EDCF mechanism, each AC function acts like a virtual station for medium access, so more collision will be expected for EDCF scenario. But in terms of Quality of Service for delay sensitive applications (like Video conferencing) EDCF outperforms DCF.

REFERENCES

[1]. Sandeep Kaur, Dr. Jyotsna Sengupta, "Performance Evaluation of IEEE 802.11e", IJCST Oct . - Dec. 2011.

[2]. Stefan Mangold, Sunghyun Choi, Peter May, Ole Klein, Guido Hiertz, Lothar Stibor, "IEEE 802.11e Wireless LAN for Quality of Service" IEEE 2010.

[3]. Dongho Lee, Kwangsung Ju, and Kwangsue Chung, "Dynamic Traffic Prioritization and TXOP Allocation in 802.11e Based Multihop Wireless Networks, IJCSNS 2012.

[4]. M. Barry, A. T. Campell, A. Veres, "Distributed Control Algorithms for Service. Differentiation in Wireless Packet Networks", Proc. IEEE INFOCOM 2001

[5]. Liljana Gavrilovska, Ramjee Prasad, "Ad hoc networking towards seamless communications", Published by Springer, 2006

[6]. Colette Consani, "Work In Progress: Quality of Service of IEEE 802.11e"

[7]. S. Choi, K. G. Shin, "A cellular local area network with QoS guarantees for heterogeneous traffic", Proceedings IEEE INFOCOM'97, pp. 1032-1039, Kobe, Japan, April 1997.

[8]. IEEE 802.11e/D11.0, 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)", October 2004

[9]. Heegard, C. and Coffey, J. and Gummadi, S. and Murphy, P. A. and Provencio, R. and Rossin, E. J.and Schrum, S. and Shoemake, M. B., "High-Performance Wireless Ethernet", *IEEE Comm.Magazine*, vol. 39, no. 11, Nov. 2001.

[10]. G. Bianchi, "Performance Analysis of the IEEE 802.11 Distributed Coordination Function," *IEEE J. Select. AreasCommun.,* vol. 18, no. 3, March 2000, pp. 535-547.

[11]. F. Cali, M. Conti, E. Gregori, "Dynamic Tuning of the IEEE 802.11 Protocol to Achieve a Theoretical Throughtput Limit,"*IEEE/ACM Trans. Networking,* vol. 8, no. 6, December 2000, pp. 785-799.

[12]. Casetti, C. Chiasserini, C. "Improving Fairness and Throughput for Voice Traffic in 802.11e EDCA". Personal, Indoor and Mobile Radio Communications, 2004. PIMRC 2004. 15th IEEE International Symposium. September, 2004. Volume 1. Pages 525-530.

Authors Profile

Ravi Gorripati received the B.Tech degree in Computer Science and Engineering from JNT University, Anantapur in 2010. Currently he is pursuing M.Tech degree in Computer Science and Engineering at JNTUA College of Engineering, Pulevendula. His research interests include MANET, wireless sensor networks, and Cloud Computing.

M.V.Rathnamma obtained his Master's degree in Computer Science Engineering form JNTUA, Anantapur, pursuing Ph.D. degree in JNTUA and at present working as an Asst. Professor in Department of Computer Science Engineering, SSITS, Rayachoti, Y.S.R.(Dist), A.P. Her areas of interest include Computer Networks, Mobile Adhoc Networks, trust management in MANETS and other latest trends in technology. She has more than 04 years of experience in teaching and research in the area of Computer Science and Engineering.

V.VenkataRamana obtained his Master's degree in Computer Science Engineering form JNTUH, University, pursuing Ph.D. degree in JNTUA, University and at present working as an Associate Professor in Department of Computer Science Engineering, SSITS, Rayachoti, Y.S.R (Dist), A.P. His areas of interest include Computer Networks, Mobile Adhoc Networks, Bio-Inspired Networks and other latest trends in technology. He has more than 09 years of experience in teaching and research in the area of Computer Science and Engineering.

Dr. P. Chenna Reddy did his B.Tech from S.V. University College of Engineering, Tirupati, M.Tech & Ph.D from JNTU, Hyderabad. He is currently working as Associate Professor at JNTUA College of Engineering, Pulivendula. He has 15 years of teaching experience. He has published several papers in reputed journals and conferences. His areas of interest are Computer Networks and related fields. He is currently working on Bio-inspired networking.