An Integrated Approach to Enhance TCP Fairness in HCCA Scheduler for 802.11e Wireless LANs

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***Abstract*—IEEE 802.11e Wireless Local Area Networks (WLANs) specifies Hybrid Coordination Function (HCF) Controlled Channel Access (HCCA) technique which provides prioritized and parameterized Quality-of-Service (QoS) support in multimedia traffic. It does not, however, attain fairness in the sharing of resources with both uplink and downlink flows. There has been extensive research on the fairness at Medium Access Control (MAC) layer whereas research concerning the fairness in transport layer (TCP) is still nascent. TCP based cross-layer optimization approach for the HCCA scheduler brings forward many challenges like unfairness problem of MAC layer and path/bandwidth asymmetry of TCP. This paper proposes an integrated approach to alleviate afore mentioned problems. Firstly, a priority based weighted fairness scheme is suggested along with an adaptive buffer management technique for TCP traffic. Secondly, an acknowledgment (ACK) delaying technique is recommended which during the uplink flows delay the TCP ACK packets so that it generates more buffer space for downlink data transmission and maintains a fair flow of uplink and downlink data transmission rates. Simulation results show that this integrated approach attains and maintains fairness in both MAC and TCP upload flows with increased throughput.**

***Index Terms*— Adaptive Buffer Size, Access Category, Access Point, Acknowledgement, Integrated approach, Transmission Opportunity, Weighted Prioritization**

I. INTRODUCTION

IEEE 802.11 WLANs, based on the Basic Service Set (BSS), play a vital role in providing ubiquitous connectivity to Internet [1]. WLANs are commonly deployed with the infrastructure BSS having the Access Point (AP), even though a group of nodes form an independent BSS without any connectivity to the wired network. The connection to the wired network here is provided by the AP [2]. Point Coordination Function (PCF) and Distributed Coordination Function (DCF), are two MAC schemes, which are specified by IEEE 802.11 standard. PCF is a channel access scheme that is centrally controlled, where, the master station reserves and manages the channel all the network clients. DCF, a channel access scheme based on distributed contention specified in IEEE 802.11. For each transmission in DCF, all nodes employ a binary exponential random backoff mechanism and the carrier sense multiple access technique with collision avoidance (CSMA/CA). Hence this access mode is relied by most of WLAN deployments for its simple, flexible nature, and cost effectiveness [3].

To provide suitable levels of QoS over IP-based wireless access networks, next-generation broadband wireless networks are used [4]. To this effect, the 802.11working group introduced the “E” group that defines additional MAC protocols for enhanced support of QoS required by the applications. 802.11e introduced HCF which defines two channel access mechanisms. They are a) Enhanced Distributed Channel Access (EDCA) – a contention-based channel access and b) HCCA – a controlled channel access. The controlled

doi:10.4304/jait.4.1.51-57

channel access is an enhanced version based on the polling scheme of 802.11e PCF. The HCCA mechanism uses a QoS-aware centralized coordinator, known as the hybrid coordinator (HC) which operates under a set of different rules from that of the PCF point coordinator (PC) [5].

IEEE 802.11e standard specified HCF enables prioritized and parameterized QoS services at the MAC layer over DCF. The EDCA and the HCCA are combined by the HCF [6]. The centralized controller HC, located at the access point is required by the HCCA. The HC is responsible for the assignment of rights for the transmission at nodes hosting applications with QoS requirements along with HCCA. It, therefore, performs dynamic bandwidth allocation within the WLAN [7].

In the QoS aware BSS (QBSS), the QoS Access Point (QAP) and the HC are juxtaposed where HC gets the first preference to access the medium. The sequence of frame exchanges is initiated by HC and the moment it detects that the Wireless Medium (WM) is idle for a period of one Point Inter Frame Space (PIFS) it allocates Transmission Opportunity (TXOP) to QoS Stations (QSTAs) including itself. It provides limited-duration Controlled Access Phase (CAP) during the contention cycle. In addition, Contention Free Period (CFP) is initiated after the beacon frame where the contention-free transfer of QoS data takes higher precedence than other non-AP QSTAs. During the CFP/CAP, the interval period between frames is one Short Interframe Space (SIFS), hence, there is an improvement in the efficiency of the channel utilization [5].

A wireless channel, in general, is a shared medium with limited resources. To access the wireless channel, multiple mobile hosts in the WLAN contend with each other and acquire resources. Ideally, fairness can be obtained only if all mobile hosts in WLAN get equal amount of transmission opportunity and equal portion of the wireless channel. Nevertheless, this case is not possible in WLAN because of MAC design goals such as maximizing wireless channel utilization and fair resource allocation. Both are always not well matched with each other [8].

Fairness can be either absolute or relative [9].

- Absolute fairness can be achieved when every user is allocated the exact same amount of time, throughput or any other desired measure of resources. However, as different traffic types have different requirements, this is not a very effective measure.
- Relative fairness is deemed to be a better way of measuring fairness since it considers the number of individual requirements fulfilled in a specified instance. By comparing how much of individual requirements are fulfilled, the overall relative fairness is calculated.

Various fairness schemes have been used in the recent past. Some of the schemes worth mentioning are:

1. TCP fairness – As TCP does not consider history of flows or flows as a whole, it does not recognize differentiation between flows and therefore aims for absolute fairness.
2. Utility Based Fairness – This scheme defines a utility function that describes the utility a flow gets from the network with a certain capacity share. It tries to achieve maximum fairness by maximizing total utility of all users.
3. Max-min Fairness – This is a special case of utility based fairness scheme that aims to maximize the service of the entity receiving the worst service, i.e., it ensures that small flows receive all they demand while large flows have to share the remainder of the capacity equally.
4. Proportional Fairness – This scheme ensures a balance between the network throughput and users to have at least a minimal level of service by maximizing the network throughput. One example of this is Weighted Fair Queuing (WFQ).
5. Cost Based Fairness – Unlike the schemes mentioned above this scheme considers cost fairness i.e., the cost of one user's action on others. To arbitrate cost fairness the volume of congestion is required and is calculated by multiplying the congestion with bit rate of each user causing it.
6. Jain's Fairness Index - If the amount of contending users is n and ith user receives an allocation xi then Jain's fairness index f(x) is;

$$f(x) = \frac{\left[\sum_{i=1}^{n} x_i\right]^2}{n\sum_{i=1}^{n} x_i^2}$$

Though the existing literature is ripe with research on WLAN fairness at the MAC layer, the issue on TCP fairness remains to be explored yet.

Unfortunately, there exists a major unfairness among the competing flows and continued lockout of flows as a result of the cross-layer communication between 802.11 MAC layer and the TCP flow/congestion control mechanisms. A queue is maintained at the AP comprising of the upstream TCP ACKs with the downstream TCP data in WLAN multiple uplink and downlink flows. At the AP, both in forward and reverse path, the queue is accumulated due to the bandwidth asymmetry. As a result the TCP flow is weakened by the dropped packets and congestion control mechanisms of TCP. This occurs because of the assumption of equal transmission rates at both forward and reverse path.

ACK packets are returned by the TCP receivers to the source node to confirm undamaged data packet arrival at the transport layer to accomplish reliable transfer of data. During the TCP uploads, at the wireless AP, a queue of data packets is maintained by the wireless nodes to be dispatched over the wireless channel to the originating source along with the TCP ACK packets to be returned to the source node. The forward (data) and reverse (ACK) paths between the source and destination are typically assumed to have identical packet transmission rates by the TCP's operation. However, fairness in the access of the wireless channel at the station-level is imposed by the basic 802.11 MAC layer.

In other words, if n nodes contend for wireless channel access, out of the total opportunities of transmission available, each can secure a portion equal to 1/n. Thus, assuming there are n wireless nodes and one AP, each node including the AP can acquire a transmission opportunity of only 1/(n+1).

With the TCP uploads, an equal percentage of packet transmissions is assigned to each wireless node by the 802.11 MAC allowing n/(n+1)TCP data packets and only 1/(n+1) TCP ACK packets which is equal to the percentage of medium access of the AP. This, however, results in significant asymmetry in both forward and reverse paths at the transport layer in the case of large number of stations [10]. The organization of the paper is as follows: Section II gives the problem identification and proposed solution. Section III discusses related work. Section IV describes proposed solution. In section V simulation results and discussions are presented and finally conclusions are presented in the section VI.

II. Problem Identification & Proposed Solution

The cross-layer optimization approach set in TCP for the HCCA scheduler causes difficulties such as:

1 To resolve the uplink/downlink unfairness issue in the 802.11e WLAN by allocating fair resources at the MAC layer
2 To resolve the TCP path and bandwidth asymmetry problem by providing an alternate TCP ACK mechanism

To alleviate the above mentioned issues, a four-stage integrated technique is proposed in this paper which takes into consideration the weighted values providing fixed buffer sizes. The current approach is applied in the enhanced HCCA scheduler that was developed in the author's previous work [11].

III. Related Work

Nakjung Choi et al. [12] have elaborated the issue of unfairness occurring in the IEEE 802.11e Direct-Link Setup (DLS) mode concerning both external and local TCP connections. They put forward a Half Direct-Link Setup (H-DLS) to address the issue of fairness in sharing the bandwidth by each TCP connection whether originating externally or locally. H-DLS helps to segregate the TCP data and ACK packets path in local TCP connections. It also treats TCP ACK packets alike so that fairness could be attained among both external and local TCP connections.

Feyza Keceli et al. [13] have discussed the issue of unfairness in the uplink and the downlink flows in the IEEE 802.11e infrastructure BSS using EDCA default parameters. To calculate the EDCA parameters an analytical model is proposed. This achieves a fixed utilization ratio between uplink flows and downlink flows. They follow this up with a model assisted measurement algorithm that adapts dynamic parameters and considers the exchanges between the bi-directional communication structure of TCP and the MAC layer algorithm.

Naeem Khademi et al. [14] have put forward Threshold-Based Least Attained Service-Selective Acknowledgement Filtering (TLAS-SAF) which is a unique queue management policy. The TLAS-SAF is the combination of the TLAS and selective packet marking ACK filtering queue management mechanisms which provides both size and direction based fairness in wide area networks. This sustains the long-lived flows while providing better service for the short-lived. A minimum guaranteed threshold of service is set for every network flow and for all packets falling below the set threshold it behaves similar to LAS and as SPM-AF upon reaching the threshold. Both size and direction based fairness in wide area networks is considered in this work by the authors.

Feyza Keceli et al. [10] have demonstrated the unfairness problem of transport layer in the IEEE 802.11 WLANs. A link layer access control block for the AP was suggested to provide fairness in the TCP transmission rates using BSS infrastructure. To prioritize the TCP downlink data packet transmission of TCP ACK uplink flows packets, a congestion control and filtering algorithm is used, which is then evaluated using the measured average downlink data transmission rate.

Siwaruk Siwamogsatham [15] has proposed a novel, simple and effective technique to rectify the uplink/downlink unfairness problem in an infrastructure WLAN. This technique employs multiple independent backoff timers in each client station which are assigned and organized by AP. Each queue contains downlink traffic of each client station. Once the backoff timer expires, packets are transmitted. The AP randomly selects a timer and assigns the timer in case of multiple backoff timers expiring at the same time. Their mechanism is very simple as backoff timers are assigned based on contention window sizes and does not require any major changes in the AP firmware.

Young-Woo Nam et al. [16] have put forward an effective scheme to improve the fairness problem. This Dynamic TXOP Control (DTC) scheme adjusts the TXOP limit based on the local information such as the channel utilization at QAP and current network load at stations without any feedback information. Under this scheme, QAP uses channel utilization to calculate TXOP limit value and then transmits to each station through a beacon frame. Following this, a station calculates the final TXOP limit value based on its own queue utilization information. DTC scheme adaptively allocates TXOP limit value depending on the network state by using channel utilization and queue utilization measurements and is suitable for multimedia applications.

R E Ahmed [17] has come up with a new hybrid channel allocation algorithm in which the base station sends a multi-level hot-spot notification to the central pool which is located at Mobile Switching Station (MSM), and author has demonstrated that the call using a "borrowed" channel may retain it depending upon its hot-spot level

In Madhar Saheb Shaik et al. [11] both the packet loss rate and current channel condition information are used to adjust the application data rate. At the end of previous Transmission TXOP, the packet loss rate and the queue size are estimated when the Tolerable Loss Limit (TLL) is included by the sender with the Traffic Specification (TSPEC) by calculating the Bit Error Rate (BER) based on the specified channel conditions. This scheme uses the history of packet loss rate k, and the length of the queue to compute the TXOP additionally required for each Traffic Stream (TS) of QSTA.

IV. Proposed Four-Stage Fairness Enhancement Scheme

Stage I - Weighted Prioritization Technique

A weighted prioritization technique is proposed which uses an adaptive buffering scheme that helps to improve the fairness of the HCCA.

This approach is obtained from D.J. Leith et.al [18, 19] which works for prioritization on AP for using sufficient bandwidth allocation for TCP ACKs. The access of the given Access Categories (AC) at the AP basically uses the 802.11e Arbitration Inter-Frame Space (AIFS) and Contention Window (CW) parameters to prioritize TCP ACKs. A precise prioritization of TCP ACKs at the AP is generated with a small value of AIFS and CW. The values taken basically are;

- A lower AIFS value
- A lower CW
- A higher TXOP limit, or
- Any joint combination of these

Stage II - Weighted Fair Assessment Technique

The parameters above determine the effectiveness of prioritization technique to increase fairness. A weighted fair assessment technique has been provided to resolve the uplink/downlink unfair access problem in the 802.11e infrastructure.

Such a weighted technique provides a fixed proportion of utilization among uplink and downlink stations of the AC without disturbing the prioritization amongst AC's. This can improve the stability of parameter tuning, which are linearly normalized according to the most recent contention parameters and the corresponding measured number of flows. The effective number of downlink stations (Edl) is given by

$$Edl = \frac{(CW_{U\,\min}{}^{*})(\beta_d)}{(CW_{D\,\min}{}^{*})(\beta d^{*})} \tag{1}$$

where * represents the recent values for contention parameters and the corresponding measured number of flows. The value of the effective number of downlink stations are used in the set of possible $CW_{U\,\min}$ values for the AP which is calculated as;

$$CW_{D\,\min} = \frac{CW_{U\,\min}{}^{*}\,TXOP_U}{Edl * U * TXOP_D} \tag{2}$$

The channel access ratio between uplink and downlink within an AC varies almost linearly with respect to the selection of CWmin and TXOP values in asymptotical conditions (saturation). There are three crucial advantages by employing this scheme;

- Feasible with different transport layer protocol characteristics
- The coexistence of nodes with different bandwidth requirements
- Varying network conditions over time

The scheme enforces losses due to fixed AP buffer which can radically affect the performance of the scheme. Other factors that influence this scheme are the channel contention as well as inter-service time at a station that varies with time. These factors provide the probability of buffer blockage and higher traffic blockage. An adaptive buffer sizing scheme is presented in section 4.3 to address the performance failure.

Stage III - TCP Acknowledgment Delaying Technique

In wireless networks, the AP can measure the Inter-service time (T_{is}) for each flow which is the time between the arrival of the packet and the transmission time which requires less computation time. The equation for calculating T_{is} can be given as;

$$T_{is} = x\, T_{is} + (1\text{-}x)\,(Te - Ts) \tag{3}$$

where *Ts* is the time of packet arrival at the top of the queue of the network interface and *Te* the time of packets transmitted successfully, which are indicated by receiving correct corresponding MAC ACK. The value of x is taken as $x \cong 0.999$.

ACK packet-filtering technique takes the aggregate of TCP ACK packets in the ACK packet delaying phase and filters ACK TCP uplink flows packets as well as generates additional space for downlink data packets.

Let us assume, $ACK_{num,i}$ as the cumulative ACKs for flow *i,* where $T_{lack,i}$, is the total elapsed time from the last ACK packet sent to the MAC queue for flow *i* and δ a constant weighing factor and η a variable weighing factor of function $ACK_{num,i.}$

With the proposed filtering algorithm the uplink flow *i* of the ACK packet is deferred for a period δ. The uplink ACK packets are scheduled so that it does not surpass the per flow average of TCP downlink packet rate. Accordingly, the buffering time of minimum ACK packets can be represented as;

$$\eta.ACK_{num,i}.T_{is} - T_{lack,i.}$$

$T_{lack,i}$ is subtracted from $\eta.ACK_{num,i}.T_{is}$ to compute the difference in duration among two *ACKs* sent successively to the MAC buffer which is represented by $ACK_{num,i}$. T_{is}. Each TCP ACK packet cumulatively acknowledges

$ACK_{num,i}$ data packets. This cumulative acknowledgement results in uplink/ downlink fairness of TCP access.

The delay D_i, representing the duration that the relaying ACK packet is kept in the queue, before it is scheduled for transmission can be defined now as;

$$D_i = \max (\delta . T_{is} , \eta . ACK_{num,i} . T_{is} - T_{lack,i}) \qquad (4)$$

Thus, TCP ACK *i* is delayed before scheduling for D_i in order to ensure transmission of more TCP down link data packets by eliminating unfairness problem.

In case of a new ACK packet reaching before the timer D_i, the earlier streamed ACK packet is replaced by the new ACK packet. The TCP header is accessed by the link layer to retrieve the $ACK_{num,i}$ value and the timer D_i is restarted with the new value. Once the timer D_i expires, TCP ACK packets are scheduled for transmission and $ACK_{num,i}$ and $T_{lack,i}$ values are reset to zero.

In the proposed scheme the ACK packet for a particular interval is delayed to determine whether another ACK is arriving and the filtering approach employed does not schedule the ACK for transmission if the ACK packet is assumed to increase the rate of uplink data transmission compared to the rate of downlink data transmission. In this way the fairness between uplink/downlink transmissions is maintained.

Stage IV - TCP based Adaptive Buffer Sizing Technique

A buffer sizing scheme is adopted to overcome the packet loss enhancing the above technique to achieve fairness. The buffer size Q is represented as;

$$Q = \min \left(\frac{T}{T_{is}}, Q\max\right) \qquad (5)$$

where Qmax is fixed at 400 packets as a default value, T is the target queuing delay and T_{is} is the inter- service delay which is given in (3)

This in turn decreases and increases the size of the buffer in line with the falls and rises of rate of service respectively, to maintain an approximate constant delay of T seconds in the queue. To accommodate the fluctuation in the mean service rate, the buffer size is effectively regulated to remain equal to the Bandwidth-Delay Product (BDP). The equation (5) can be further expanded, with respect to short-term service rate fluctuations, as;

$$Q = \min\left(\frac{T}{T_{is}} + \phi, Q\max\right) \qquad (6)$$

where ϕ is an over-provisioning amount to accommodate the short-term service rate fluctuations.

Collectively, all these techniques along with an alternate TCP ACK mechanism therefore provide a fair resource allocation at the MAC layer to resolve the uplink and downlink unfairness problem in the 802.11e WLAN.

V. SIMULATION RESULTS

A. Simulation Model and Parameters

The proposed fairness mechanism is simulated using NS2 [19]. It has been implemented over the author's earlier designed enhanced HCCA scheduler [11] for 802.11e WLAN. The channel capacity of mobile hosts is set at the same value of 11Mbps. In the simulation, 10 QSTAs and the base station (BS) are deployed in a 1000 meter x 1000 meter region for a simulation time of 50 seconds. All nodes have the same transmission range of 250 meters. The TCP upload traffics are sent from wireless stations. Finally, both the proposed TCP fairness mechanism for HCCA scheduler (TF-HCCA) and the TCP fairness scheme of EDCF (TF-EDCF) are compared [18].

B. Performance Metrics

The following metrics are used to evaluate the performance:

Throughput: Throughput is taken as the average measured throughput at AP represented in Mbits per second

Buffer Size: It is the adaptive buffer size at the AP

Delay: It is the average end-to-end delay occurred for transmitting the TCP Upload flows.

Packets *Received*: It is the average received throughput at AP represented in packets.

C. Results

Initially the TCP upload flows of the stations are varied as 2, 4, 6, 7, 8, 9 and 10 and the throughput and buffer size of AP are measured.

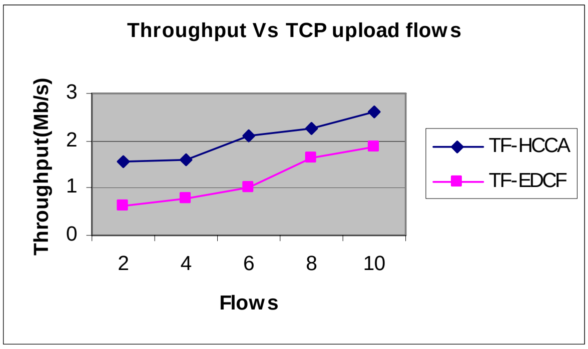

Figure 1: Throughput Vs Upload Flows

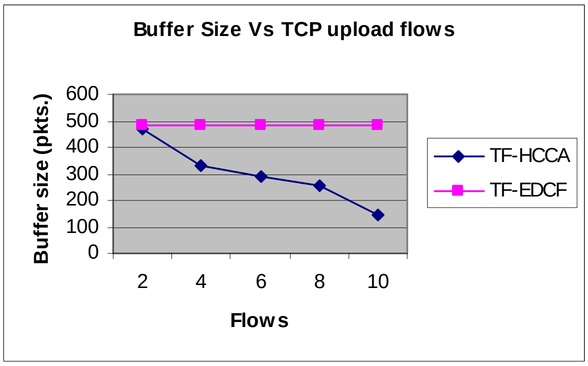

Figure 2: Buffer Size Vs Upload Flows

Fig. 1 and 4, represents the measured throughput and packets received for both the schemes at the AP. These figures indicate that there is a linear increase in throughput and number of packers received corresponding to the increase in the upload flows which is clearly in favour of the proposed TF-HCCA scheme

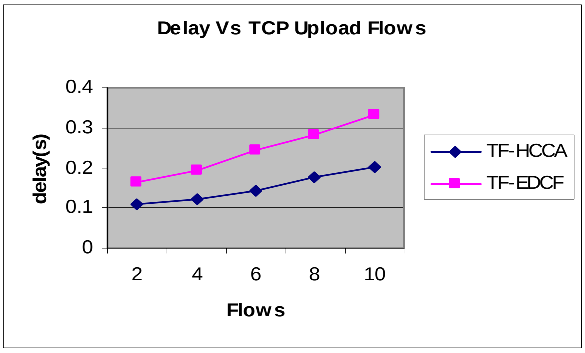

Figure 3: Delay Vs Upload Flows

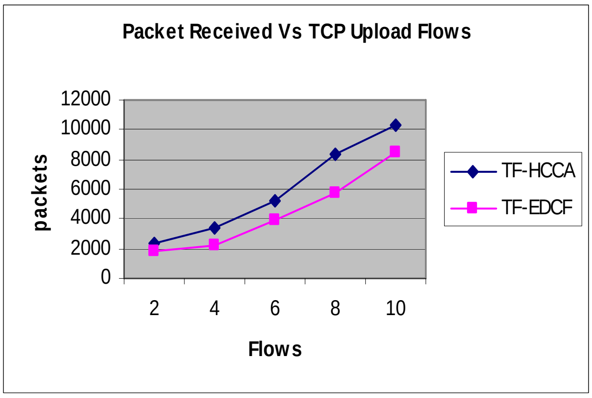

Figure 4: Packet Received Vs Upload Flows

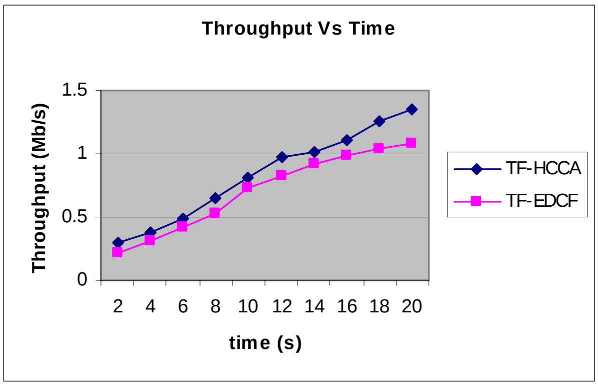

Figure 5: Throughput Vs Time

Fig. 2 shows the buffer size of AP against the increase of upload flows for both the schemes. In TF-EDCF scheme, the buffer size remains constant for all the flows as it has fixed buffer. However, the buffer size is adaptively adjusted in the TF-HCCA scheme when the flows are increased which increases the efficiency of buffer occupancy when compared to TF-EDCF.

Fig. 3 represents the average end-to-end delay of both the schemes. A clear increase in the delay can be observed as the upload flows increase in the case of TF-EDCF whereas there is a reduced delay in the case of TF-HCCA scheme.
Subsequently, the throughput for various time intervals is measured.

Fig. 5 illustrates the measured throughput at the AP for both the schemes. It can be seen that there is a clear linear increase in the throughput with the increase in time. This demonstrates that TF-HCCA scheme attains significant improvement in the throughput when compared to TF-EDCF.

VI. Conclusion

The fairness issue in IEEE 802.11e has received plenty of attention. However, a major part of that work was concerned with fairness at the MAC layer and the issue of TCP fairness yet needs to be attended to. TCP based cross-layer optimization approach for the HCCA scheduler encounters many challenges like unfairness problem of MAC layer resource and TCP path and bandwidth asymmetry problems. In this paper, an integrated approach is proposed to alleviate these problems. This approach is designed in four stages. In the first stage a mechanism for prioritization on AP is devised for using sufficient bandwidth allocation for TCP ACKs. In the second stage, a weighted fair assessment technique is provided to attain fair and efficient access provisioning. An ACK delaying technique to delay the TCP ACK packets of uplink flows to generate additional buffer space for downlink data transmission is dealt with in the third stage. This procedure ensures that the data transmission rate of uplink and downlink flows is maintained fairly. Finally, in the fourth stage of this technique an adaptive buffer size for AP is used instead of traditional fixed buffer size in order to avoid the effects of statistical multiplexing and buffer backlog. Thus this integrated approach maintains fairness in both MAC and TCP layers. As simulation results show the proposed approach attains better fairness for TCP upload flows with increased throughput.

Acknowledgment

This work is part of the first author's PhD work, which is supported under the Staff Development Program of Caledonian College of Engineering, Oman and National Institute of Technology, Durgapur, India.

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- **Popularization of Ubiquitous Computing** - foraging for computing / communication resources on the move (e.g. vehicular technology), smart / 'aware' environments, security and privacy in these contexts; human-centric computing; possible legal and social implications.
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- **Social and Demographic Changes** - provide IT solutions that can help policy makers plan and manage issues such as rapid urbanization, mass internal migration (from rural to urban environments), graying populations, etc.
- **IT in Education and Entertainment** - complete end-to-end IT solutions for students of different abilities to learn better; best practices in e-learning; personalized tutoring systems. IT solutions for storage, indexing, retrieval and distribution of multimedia data for the film and music industry; virtual / augmented reality for entertainment purposes; restoration and management of old film/music archives.
- **Law and Order** - using IT to coordinate different law enforcement agencies' efforts so as to give them an edge over criminals and terrorists; effective and secure sharing of intelligence across national and international agencies; using IT to combat corrupt practices and commercial crimes such as frauds, rogue/unauthorized trading activities and accounting irregularities; traffic flow management and crowd control.

The main focus of the journal is on technical aspects (e.g. data mining, parallel computing, artificial intelligence, image processing (e.g. satellite imagery), video sequence analysis (e.g. surveillance video), predictive models, etc.), although a small element of social implications/issues could be allowed to put the technical aspects into perspective. In particular, we encourage a multidisciplinary / convergent approach based on the following broadly based branches of computer science for the application areas highlighted above:

Special Issue Guidelines

Special issues feature specifically aimed and targeted topics of interest contributed by authors responding to a particular Call for Papers or by invitation, edited by guest editor(s). We encourage you to submit proposals for creating special issues in areas that are of interest to the Journal. Preference will be given to proposals that cover some unique aspect of the technology and ones that include subjects that are timely and useful to the readers of the Journal. A Special Issue is typically made of 10 to 15 papers, with each paper 8 to 12 pages of length.

The following information should be included as part of the proposal:

- Proposed title for the Special Issue
- Description of the topic area to be focused upon and justification
- Review process for the selection and rejection of papers.
- Name, contact, position, affiliation, and biography of the Guest Editor(s)
- List of potential reviewers
- Potential authors to the issue
- Tentative time-table for the call for papers and reviews

If a proposal is accepted, the guest editor will be responsible for:

- Preparing the "Call for Papers" to be included on the Journal's Web site.
- Distribution of the Call for Papers broadly to various mailing lists and sites.
- Getting submissions, arranging review process, making decisions, and carrying out all correspondence with the authors. Authors should be informed the Instructions for Authors.
- Providing us the completed and approved final versions of the papers formatted in the Journal's style, together with all authors' contact information.
- Writing a one- or two-page introductory editorial to be published in the Special Issue.

Special Issue for a Conference/Workshop

A special issue for a Conference/Workshop is usually released in association with the committee members of the Conference/Workshop like general chairs and/or program chairs who are appointed as the Guest Editors of the Special Issue. Special Issue for a Conference/Workshop is typically made of 10 to 15 papers, with each paper 8 to 12 pages of length.

Guest Editors are involved in the following steps in guest-editing a Special Issue based on a Conference/Workshop:

- Selecting a Title for the Special Issue, e.g. "Special Issue: Selected Best Papers of XYZ Conference".
- Sending us a formal "Letter of Intent" for the Special Issue.
- Creating a "Call for Papers" for the Special Issue, posting it on the conference web site, and publicizing it to the conference attendees. Information about the Journal and Academy Publisher can be included in the Call for Papers.
- Establishing criteria for paper selection/rejections. The papers can be nominated based on multiple criteria, e.g. rank in review process plus the evaluation from the Session Chairs and the feedback from the Conference attendees.
- Selecting and inviting submissions, arranging review process, making decisions, and carrying out all correspondence with the authors. Authors should be informed the Author Instructions. Usually, the Proceedings manuscripts should be expanded and enhanced.
- Providing us the completed and approved final versions of the papers formatted in the Journal's style, together with all authors' contact information.
- Writing a one- or two-page introductory editorial to be published in the Special Issue.

More information is available on the web site at http://www.academypublisher.com/jait/.