An Analysis of Scheduling Scheme for QoS Guaranteed Interactive Multimedia over High Speed Wireless Campus Networks

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\textbf{Abstract} — Interactive Multimedia (IMM) applications have observed quick growth in the world of computer and communication technologies. Voice, video conferencing, graphics services are considered as IMM applications, at low cost with more flexibility in a high speed Wireless Local Area Network (WLAN) that can be defined as a high speed Wireless Campus Network (WCN). The networks’ traffic flow determines the participating users work as a sender or receiver during the voice or video conversation. The IMM applications have to be kept the least data loss and maximum throughput over WCN. Packets scheduling and channel allocation mechanism are the challenging issues for improving IMM transmission and it is still an unresolved problem over WCN. This paper reviews on different exist scheduling mechanisms and channel allocation algorithms of IMM related to various applications and highlights the current issues. A new priority based scheduling scheme and dynamic channel allocation mechanisms have been proposed in this paper. It is expected that the proposed mechanisms ensure the minimum requirement of the IMM applications which will deliver QoS with the least handoff delay and minimize the call dropping probabilities for IMM applications though WCNs.

\textbf{Keywords} — Scheduling Algorithm, Real Time, WCN, Multimedia Applications and IMM Transmission

I. INTRODUCTION

The advancement of IMM applications is the major driving forces behind the rapid evaluation of next generation wireless networks. Wireless networking has acquired boundless acceptance, because it consents users to affix and exchange information flexible with no cabling cost. It has been envisioned that the high speed Wireless Local Area Network (WLAN) that can be defined as a high speed Wireless Campus Network (WCN) where traffic is to be varying and wide diversified \cite{1}. In 1997, The Institute of Electrical and Electronics engineers (IEEE), approved the IEEE 802.11 standard for WCNs. The WCNs specifications define a set of standards for physical layers (PHYs) and MAC (Medium Access Control) layers. The arduous scheme of IEEE 802.11 specifications investigated to acquire several goals such as specify computer LANs supported wireless products’ class, lead to serve existing mobile client applications and to abate cost by incentive emulation among wireless products vendors \cite{2}. The IEEE 802.11 specification transmits and allows radio spectrum over the air medium between an access point (AP) and wireless users. It has founded as a restrictive technology for wide area wireless communication because it delivers PHY and MAC functionality for fixed wireless networking environment. In the local area, pedestrian and vehicular speeds maintain the portable and mobility stations. It also has specific various features like time-bounded supply service, service continuity within elaborate areas via Ethernet, 1 and 2 Mbps transmission rates for various applications, Support the most exist applications, Multicast (including broadcast) services, network administration services and authentication services. There are lots of different standard exist in the IEEE 802.11 family such as IEEE 802.11, IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11e and so on \cite{3}. IEEE 802.11 provides 1 to 2 Mbps dispatch and employs to wireless LANs in the 2.4 GHz frequency band using either Direct Sequence Spread Spectrum (DSSS) or Frequency Hopping Spread Spectrum (FHSS). Whereas, IEEE 802.11a is the extension version of the IEEE 802.11 which uses for WCNs and provides up to 54 Mbps in the 5 GHz frequency band using an Orthogonal Frequency Division Multiplexing Encoding Method (OFDMEM) instead of FHSS or DSSS. On the other hand, IEEE 802.11b and IEEE 802.11g both are employ for WCNs and provide same frequency band 2.4GHz but the transmission rates are dissimilar 11Mbps (with a turn back to 5.5, 2 and 1 Mbps) and more than 20Mbps respectively and a comprehensive analysis can be found in \cite{4}. Moreover, the IEEE 802.11e is specifying a set of Quality of Service (QoS) improvements for multimedia applications to change the MAC layer over WCNs The WCN can be set up into two different modes. First one is the Ad Hoc
Network and other one is the Infrastructure Network mode. The ad hoc network is also known as peer-to-peer network where very simply arrange a set of wireless stations that directly connected with each other without using any access point and connection to a wired network [5]. On the other hand, the infrastructure network has at least one Access Point (AP) which is connected with in two sub networks using wired network. Both networks are shown in Fig. 1. In WCNs, Quality of Service (QoS) requirements of different IMM traffic flows are satisfied by sharing the common radio channel which provides the MAC protocol [6]. The MAC protocol aims to provide varieties requirements of multimedia traffic flows for wide range of traffic classes. It has two basic access modes one is Distributed Coordination Function (DCF) which distribute the frames through the MAC protocol.

However, the DCF do not have the least delay guarantee to transmit the real time application because there are no priorities or other mechanisms. Thus, IMM applications are not satisfied with this protocol. Another is Point Coordination Function (PCF) that employs the packet-switched connection oriented services that are very effective for IMM applications. However, an AP must maintain a polling list to poll the station which needs to implement, that means end-to-end QoS requirements are not satisfied until if any access control method is implemented in this scheme. IMM applications and services through WCNs are challenging issue in the present world because of constraints and heterogeneities like- limited bandwidth, severe QoS requirements, various protocols and standards and so on. IMM applications are revolutionary technologies behind the distance learning system which offer voice, video conferencing, graphics services at low cost with more flexibility in a high speed WCN[7]. These types of applications require high bandwidth, better throughput, efficient performance, least delay and minimum data loss. The optimum requirements of QoS are listed to select the primary path of the network [8]. Packet scheduling is an effective mechanism for improving the performance of the IMM over wireless campus networks based on the IEEE 802.11 standard [9]. Since the demand for transmitting delay sensitive data over WCNs is inevitable for IMM applications, various works [6], [10-15] have been investigated. This paper reviews on different exist scheduling mechanisms and channel allocation algorithms that are related to various applications and highlights the current issues. It also highlights the proposed mechanism which can be used to improve the real time applications especially for IMM applications over WCN.

This paper is organized as follows: section-II presents the literature review of various real time scheduling algorithms, the open issues are discussed in section-III, the proposed mechanism of the network deals in section-IV and this paper is concluded in the last section.

II. LITERATURE REVIEW

The main purpose of the IMM application over WLANs is organized properly the traffic flow on the networks. The real time IMM applications related traffic scheduling and channel allocation mechanisms are reviewed in the following different subsections. A summary of the different scheduling and channel allocation algorithms are displayed in Table I.

A. Efficient Fair Scheduler (EFS)

The authors introduced a new packet based scheduling algorithm which is least delay constraint for real time applications under very high traffic loads [16]. EF scheduler was overcome the sharing of unfair resource and assigned to the other traffic which is low priority. The proposed scheduler was combination of Deficit Round Robin Scheduler (DRRS), packet classifier and traffic shaper. The validity of EFS has been verified by using both analytical discussion and an experimental study of simulation under different traffic loads. The achievement of EFS is that, it improves end-to-end QoS by using analytical and simulation environment. However, EFS algorithm is used only for wired network based DRR scheduler and not appropriate for WLANs environment.

B. Token-Based Scheduler (TBS)

TBS is the packet based scheduling algorithm and only one token is recycling over the WLANs [17]. In every node, packet transmission depends on the token which node occupy the token then it able to transmit the
packets and the maximum channel occupancy time is assigned by the node. Based on the packets size and transmission rate the node can send one or multiple packets. The packet recycling process maintains the Markov chain. The proposed TBS offered quantitative service differentiation which provides more facilities and flexibly to the service provider of the network for class management service. Furthermore, it significant improves the channel utilization by preventing collisions and polling overhead with the connection and polling based schemes respectively. However, the proposed scheme is difficult to guarantee QoS for each class because it not ensures to consider CAC mechanism. If it uses the CAC then might be lost the channel efficiency over the WLANs.

C. Deficit Round Robin Scheduler (DRRS)

The queues of the simple round robin servicing could be done in constant time. However, the deficit round robin scheduler service is the quite modification version of the former one still now. It was arranged the queues based on stochastic fair queues [18] and the simple round robin service is used to serve the queues with assigning a quantum size for each queue. In the traditional round robin, if the cause of too large packet size, a queue fails to send packet then the reminder previous quantum is added with the next quantum for the next round. Hence, the deficits, the previous quantum are kept track off. The mechanism of DRRS is illustrated in the Figs. 2 and 3.

D. Voice Priority Queue Scheduler (VPQS)

The authors introduced in [19], the VPQS is a priority packet based traffic scheduling for real time applications over WLANs. It has scalability, link-sharing ability of bandwidth and the ability to tolerate the status of traffic flows changing. It mainly divided into two traffic flow such as VoIP traffic flow (VF) and Non-VoIP traffic flow (NVF).

As illustrated in Fig. 4, users input is received by the classifier of Enqueue and separated in VoIP and Non-VoIP flow. The Voice over IP (VoIP) traffic flow is received by the token bucket then the VPQ scheduler
receives the flow from token bucket and passes to the VoIP Buffer finally dequeue the traffic flow for the end users. In contrast, at the non-VoIP traffic flow without token bucket and VPQ scheduler reaches in Non-VoIP buffer place then de-queue the non-VoIP traffic flow for the end users.

The proposed scheme was provided higher throughput and fairness for VoIP traffic flows to improve the networks efficiency by using VPQ scheduler. The NS-2 simulator used to implement and analyze the VoIP traffic. The main advantage of VPQS is a voice priority based algorithm which guarantees more efficiency by providing significant throughput and fairness for real time applications. However, it is not suitable for fixed bandwidth reservation wireless channel because it allows variable rate of data or packets size over WLANs.

E. Token and Self- Policing Based Scheduling (TSPBS)

The TSPBS is a priority packet based scheduling algorithm which works in distributed manner [20]. Voice applications are considered as a first priority, video and data is the second and third priority respectively. There is no centralized controller for passing token from one to others. The present token holder decides to pass to the next holder. When a backlogged node contains the token, it piggybacks in its video, voice or data packet transmission and transfer it to the next. When the data token holder has empty or a voice token node changes from ON-state to OFF-state, the holder directly passes to the next node. The proposed scheme solved the packet scheduling problem to guarantee the QoS to use priority based packet scheduling during significant traffic loading over WLANs with IEEE 802.11e standard. Moreover, it prevented bursty video nodes from the medium overloading and the Transmission Opportunities (TXOPs) controlled the idle time. The MATLAB simulator evaluated the average voice packet delay against the number of video nodes, channel utilization with the system traffic load and the fairness index against traffic load. The TSPBS able to guarantee to enter the high priority traffic flows during high traffic token from the high loading medium over WLANs. However, it provided limited service differentiation because the absence of service class management and it did not address the hidden -node problem which might be affected the proposed scheme.

F. Class Based Queue Scheduler (CBQS)

The CBQS is not only the priority based packets scheduler but also it is a resource manager of hierarchical link-sharing [21]. Link-sharing resource is integrated with different CBQ traffic classes, where every CBQ class has the bandwidth allocation and the priority. The CBQ scheduling algorithm might be implemented with the number of packet scheduling schemes within the priority levels such as Deficit Round Robin (DRR), Weighted Fair Queue (WFQ) and so on.

G. Transmit-permission policy and adaptive bandwidth allocation scheme (TPPABAS)

The authors proposed priority based scheduling mechanism with polling scheme which changes the MAC
layer access modes such as DCF and PCF to solve the access control problem in IEEE 802.11 networks and the transmission and bandwidth allocation policy satisfy the time-bounded traffic flows to allocate the channels dynamically and divide the bandwidth into three fixed channel for different traffic flows [6].

<table>
<thead>
<tr>
<th>Authors name and publication year</th>
<th>Schedulers name</th>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmed et al. (2007) [16]</td>
<td>EFS</td>
<td>It is packet based traffic scheduler and improves end-to-end QoS by using analytical and simulation environment.</td>
<td>EFS algorithm is used only for wired network based DRR scheduler and not appropriate for WLANs environment.</td>
</tr>
<tr>
<td>Ping Wang and Weihua Zhu (2007) [17]</td>
<td>TBS</td>
<td>TBS offered quantitative service differentiation which provides more facilities and flexibility to the service provider of the network for class management service.</td>
<td>The proposed scheme is difficult to guarantee QoS for each class because it not ensures to consider CAC mechanism.</td>
</tr>
<tr>
<td>Shreedhar And Varghese (1996) [18]</td>
<td>DRRS</td>
<td>DRRS is a frame-based packet scheduling scheme which overcome the drawbacks of simple Round Robin Scheduling (RRS) algorithm.</td>
<td>The delay bound is very longer and it depends on the ration bandwidth sharing. DRRS just focuses on the fairness but cannot support the scheduler efficiency.</td>
</tr>
<tr>
<td>Nisar et al. (2011) [19]</td>
<td>VPQS</td>
<td>VPQS is a voice priority based algorithm which guarantees more efficiency by providing significant throughput and fairness for real time applications over WLANs.</td>
<td>It is not suitable for fixed bandwidth reservation wireless channel because it allows variable rate of data or packets size over WLANs.</td>
</tr>
<tr>
<td>Polychoron Koutsakis (2011) [20]</td>
<td>TSPB S</td>
<td>TSPBS able to guarantee to enter the high priority traffic flows during high traffic loads from low priority traffic flows and protected bursty video nodes from the high loading medium over WLANs.</td>
<td>Provided limited Service differentiation because the absence of service class management and not address the hidden – node problem.</td>
</tr>
<tr>
<td>Floyd and Speer (1998) [21]</td>
<td>CBQS</td>
<td>CBQS solved the data traffic, resource management echanism and link-sharing for packet switched networks.</td>
<td>Not appropriate for real time and multimedia applications the cause of bursty traffic misconduct.</td>
</tr>
<tr>
<td>Der-Junn Deng and Hsu-Chun Yen (2005)[6]</td>
<td>TPPABAS</td>
<td>The TPPABAS modify the MAC layer access control mechanism to provide QoS of real time applications with delay constraints and the bandwidth management strategy in IEEE 802.11 standard.</td>
<td>It could not utilize the bandwidth properly because it allocated the total bandwidth of the channel into three different bandwidth dedicated channels for various traffic flows.</td>
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</table>

The evaluation of proposed mechanism was based on simulation and theoretical analysis. The results showed that the reduction of handoff probabilities for real time applications and good performance of the WLANs in the IEEE 802.11 standard. However, the proposed mechanism could not utilize the bandwidth properly because the total bandwidth of the channels was allocated into three different bandwidth dedicated channels for various traffic flows.

III. OPEN ISSUES

The real time traffic scheduling and channel allocation mechanisms mainly used to provide the guaranteed QoS and offer multiple sessions through the same node link for transmitting real time data. These types of mechanism share bandwidth of the networks and transmit the traffic flows over the networks. There are various real time traffic schedulers and issues have been addressed over the WLANs based on the IEEE 802.11 standard.

- Sufficiency of bandwidth in real time traffic with delay constraints.
- Requirement of bandwidth resources and channel efficiency for real time traffic classes to deliver QoS guarantee through WLANs.
- Load balancing to deliver QoS over WLANs.
- The cost effective IMM traffic delivery through WLANs.
- Network scalability and manageability of IMM traffic scheduling algorithm when the nodes sharing channels increase over the WLANs.
- Requirement of MAC layer access control mechanism and channel allocation policy for maximum bandwidth utilization and delivering IMM applications over the WLANs.

IV. PROPOSED MECHANISM

The real time applications need to deliver traffic flows over the channel with the least delay. The MAC layer access control mechanism and the channel allocation and reservation policy are the effective way to satisfy IMM traffic flows through the WCNs. Many researchers are working on this area in various specific topics. The MAC layer priority based access control mechanism, channel allocation and reservation policy have been considered to ensure delivery of IMM traffic flows with the least delay. The proposed mechanism implements in the MAC layer protocol because the MAC protocol has two basic access modes one is Distributed Coordination Function (DCF) which distribute the frames through the MAC protocol.

The DCF do not have the least delay guarantee to transmit real time applications because there are no priority based or other access mechanisms for delay constraints IMM traffic flows. Thus, IMM applications are not satisfied with this exist scheme. The other access mode is Point Coordination Function (PCF) that employs
the packet-switched connection oriented services that are very effective for IMM applications. An AP must maintain a polling list to poll the station which is needed to implement in PCF access mode, because the end-to-end QoS requirements are not satisfied without it. Furthermore, the implementation of channel allocation and reservation schemes are needed to utilize the maximum bandwidth for delivering IMM applications in MAC protocol which minimizes the handoff and call dropping probabilities during the real time data transmission.

![Flow Chart](image)

**IV. CONCLUSION**

A new scheduling and channel allocation mechanisms have been proposed that ensure QoS for IMM applications over WCNs. The proposed scheduling and channel allocation policies give priority of delay sensitive real time traffic flows and allocate channel dynamically with fulfill the minimum required bandwidth of IMM traffic flows to transmit them. It is expected that, a new scheduling and channel allocation schemes will deliver QoS with the least handoff delay and minimize the call dropping probabilities for IMM applications though WCNs. The further research will highlight the performance of the proposed mechanism over the WCNs.

**ACKNOWLEDGEMENT**

The authors would like to express their sincere gratitude to the Research Management Centre (RMC) of IIUM for funding this project under RAGS 12-0013-00013.

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