ABSTRACT

An enhanced version of IEEE 802.11 Wireless Local Area Network (WLAN) standard, namely IEEE 802.11e is currently used to offer Quality of Service (QoS) support for time-sensitive applications.

Firstly, when compared to Constant Bit Rate (CBR) traffic which has regular arrival rates, Variable Bit Rate (VBR) traffic greatly varies due to the fluctuations in the peak arrival rate. Hence, QoS provisioning with fixed service rate will not be suitable for bursty traffic. In other words, Hybrid coordination function Controlled Channel Access (HCCA) based Transmission Opportunity (TXOP) allocation schemes with fixed service rate is not suitable for VBR traffic. Moreover, IEEE 802.11e WLAN faces severe contention issues when the number of uplink and downlink flow increases. So, the Medium Access Control (MAC) protocol should handle the contention issues of both User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) flows, separately.

To overcome these problems, this thesis proposes a Traffic differentiation and QoS provisioning technique based on Differentiated Services (DiffServ) architecture for IEEE 802.11e WLAN. When a new data flow arrives, it is initially provisioned with QoS using DiffServ engine. The output is fed to the traffic differentiator that differentiates the traffic frames as UDP or TCP flow. If the distinguished traffic frame is UDP, Contention Window (CW) is adjusted according to the number of active uplink and downlink flows. If the distinguished traffic frame belongs to TCP, CW is adjusted according to the number of idle slots between two consecutive transmissions.

Secondly, a careful calculation of scheduling parameters such as Service Interval (SI), TXOP Duration or TXOP ordering is necessary for properly allocating resources to a data flow. SI must be chosen close to the optimal value when the data rate of the traffic stream is too large. In order to achieve the desired QoS requirements, unpredictability of the traffic and dynamic assigning of TXOPs for bursty media flow should be considered. Due to the data rate variations, the wastage of resources affects the schedulers that do not implement any recovery policy. When the instant data rate drops, the unused portion of TXOP is lost.

To provide solutions to these issues, this thesis presents an Enhanced traffic aware scheduling protocol. Here, a queue length notification scheme is used for efficient transmission of queue length and data rate information to QoS Access Point (QAP). Based on the queue length information, TXOP is estimated. In case the data rate is high, Overboost scheduler algorithm is used which efficiently deals with traffic streams by transferring excess data to the Enhanced Distributed Channel Access (EDCA). Moreover, to recover the lost TXOP, an Unused Time Shifting Scheduling (UTSS) algorithm is used.

Thirdly, the EDCA of the IEEE 802.11e standard is beneficial for prioritizing the traffic. In EDCA, packet access qualifications are considered only for intra-node traffic streams and are not provided for different user stations in the network. In other words, two active stations that are transmitting data packets simultaneously within same Access Category (AC) are not differentiated by the standard mechanism. Also, in IEEE 802.11e WLAN, the existing user-differentiation technique in EDCA protocol is affected by the collision rate and battery capacity of the different stations.

In order to solve these issues, this thesis proposes a Fuzzy based adaptive user-weight classification scheme for EDCA in IEEE 802.11e WLAN. Here, the inter-node priority for each traffic class is assigned to each station. To estimate the inter-node priority, fuzzy logic is applied considering the traffic access category, number of transmitted packets, collision rate and residual energy level parameters for each traffic class. Based on the outcome of the fuzzy rules, inter-node priority is determined and the node weights are updated dynamically.

The performance of the three proposed approaches are evaluated in terms of bandwidth allocation (Mb/sec), bandwidth utilization (Mb/sec), end-to-end delay (sec), packet drop and residual energy (Joules). Simulation results show that the proposed approaches achieve better bandwidth utilization for CBR and VBR traffic with reduced end-to-end delay and packet drop. The results also show that residual energy and bandwidth allocation are maximized.