Title of Ph.D Thesis : *A Unified Approach to Analyze Multiple Access Protocols for Buffered Finite Users*

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ABSTRACT

Multiple Access Control (MAC) protocols play a vital role in determining the performance of wireless local area networks (WLANs). With developments at the physical layer, new MAC protocols are required to make efficient use of the bandwidth available. Newly conceived applications for these technologies, and the ever-increasing demands that they place on the MAC protocols, also requires constant effort in this area. These factors ensure that MAC protocol development is currently relevant and will continue to be well into the future. As such, it is important that design methodologies for these systems are well understood.

MAC protocols have unique requirements due to their position in the network stack. By definition they must interact closely with the physical layer, meaning strict observance of often-tight timing requirements. A conflicting demand is brought by increased pressure for low-level functionality to support facilities such as Quality of Service (QoS) and security. While a variety of MAC protocols have been proposed recently for wireless LANs, the problem of efficient bandwidth utilization, higher throughput, lower mean delay, and fairness has not been fully solved yet. For example, IEEE 802.11 protocol does not perform well and the bandwidth utilization drops below 50% of the total bandwidth under heavy traffic load conditions.

In the study of various performance parameters for IEEE 802.11 networks, it has never been a case, where any single performance metric has been used by the WLANs to indicate the QoS to the user. Moreover, the WLANs itself does not provide guaranteed end-to-end Quality of Service. Thus, the study revealed that there was a need to develop a unified performance model which takes care of inter-dependence amongst various network performance factors for IEEE 802.11 networks while assessing the QoS in the WLAN setups. Further, the top five layers on the OSI protocol stack being a constant factor for all types of wire line or wireless networks, the MAC layer is the single most important layer which should be considered for evaluating performance of Wi-Fi networks. The MAC layer also being a common denominator between all IEEE 802.11 protocol families makes it even more relevant for performance issues.

The Universal Access Method (UAM) is a recommended methodology proposed by Wireless Internet Service Provide roaming (WISPr) - A Wi-Fi alliance committee for providing secure web-based service presentment, authentication, authorization and accounting for roaming users in Wi-Fi networks. In order to facilitate with the widest range of legacy Wi-Fi products, the committee recommended that WISPs or hotspot operators adopt a browser-based Universal

Access Method (UAM) for public access networks. The methodology enables any WiFi enabled TCP/IP device with a browser to gain access to the WISP network. However, the model does not presently support guaranteed end-to-end Quality of Service (QoS). This will result in user paying at a flat rate irrespective of the network performance in the hotspot. It is desirable that the service charges be correlated with the quality of service delivered to the user.

The objective set at the outset of the work described in this thesis is to develop an analytical framework supporting the idealized performance for wireless MAC protocols and demonstrate the effectiveness of such an approach in the UAM setup for hotspots

Therefore, in order to address these problems of WLANs under heavy traffic load, this thesis proposes a new MAC performance metric named '*A Unified Metric for Hotspot Performance Measurement*' (UMHP) which can ensure QoS in UAM setups.

We analyze the performance of MAC by using a number of experiments based on Network Sniffer Analyzer. Result shows that the proposed UMHP with MAC protocol performance parameters not only improves bandwidth utilization of WLANs but also improves average packet delay, throughput and response time performance under heavy traffic load conditions for achieving QoS in UAM setup.

In this thesis, we also argue that the substantial throughput and performance benefits of wireless 802.11 LANs make them ideally suited as a platform for networking in public places like hotspots.

This thesis also contains an exhaustive analysis and study of the proposed MAC protocol performance metric UMHP and its implementation in Universal Access Method (UAM) setups to improve the performance in the hotspots.

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