Abstract

During the last fifteen years, 802.11 Wireless Local Area Networks (WLANs) have emerged as one of the most accepted method of computer networking. Majority of current WLANs such as 802.11 b/g/n operate in 2.4 GHz unlicensed Industrial, scientific and Medical (ISM) frequency spectrum and share the available spectrum resource with large number of electronic appliances including bluetooth, cordless phones, microwave ovens and many others. This wide spread use of ISM band has resulted into its saturation and WLANs operating in this spectrum block are now facing a serious threat of spectrum scarcity. The situation becomes even worse due to inefficient frequency management protocols deployed in conventional WLANs. The primary source of this spectral inefficiency is rooted in static width channelization used in majority of WLANs. Modern wireless networks fine tune several communication parameters such as transmission rate, modulation and central frequency in response to ambient conditions like Signal to Interference and Noise Ratio (SINR), Bit Error Rate (BER) and Signal Strength (SS) values. However, the width of communication channel remains static throughout the course of transmission, disregarding any change in communication conditions. This static behavior may potentially cause under-utilization of spectrum resource and hence results in sub-optimal network performance. Moreover, spectrum sharing protocols in WLANs are context unaware and use standard operating procedures for communication without considering the perspective of communication.

This research work aims to present a detailed theoretical analysis and rigorous experimentation in order to investigate the use of adaptable width channelization in WLANs. The elementary concept of proposed mechanism is to assign spectrum resource to any transmitting node based on its current bandwidth requirements and ambient conditions such as SINR. The proposed mechanism assigns channels with high level of granularity and maximizes spectrum utilization by efficiently managing the width of communication channel. This high percentage of spectrum utilization in turns, substantially increases the overall network capacity. For accurate quantification of performance benefits achievable through adaptable width channelization, we have implemented the proposed mechanism on real testbed of configurable software defined radios. Using this testbed, the impact of adaptable width
channelization on exhaustive list of essential network performance measuring parameters has been evaluated. These parameters include spectrum utilization, throughput, interference, delay spread, Bit Error Rate (BER), transmission range, power consumption, transmission delay, mitigation of Medium Access Control (MAC) layer performance anomaly, channel access fairness and implementation of Quality of Service (QoS).

It is observed that, use of adaptable channelization technique can tackle many performance limiting factors in current WLANs. For instance, if required throughput is low, switching to a narrower channel width simultaneously increases range and decreases power consumption, while both of these are conflicting quantities in traditional WLANs. Similarly SS values at relatively longer distances improve significantly at narrower channel widths while simultaneously decreasing BER. The achieved results depict considerable increase in network wide throughput and decrease in interference among communicating nodes. Moreover, the use of adaptable channelization can also minimize the effect of MAC layer performance anomaly. This anomaly arises when two nodes with variable transmission rates have equal channel access probability. Additionally, using communication channels of adaptable width, we can also implement QoS in WLANs. This can be achieved by providing variable width channels to nodes based on their QoS class.