Abstract

Mobile Ad Hoc Networks (MANET) have received significant interest of researchers and industries, and become very popular in last few decades. Most of the research in this area has been initially focused on routing issues due to the frequent route breaks caused by arbitrary change in the network topology. Many routing protocols have been developed and some of them have been considered by the IETF. Despite the progress made in developing the routing protocols, battery-powered devices continue to be the challenge since limited energy results in partitioning of the network. Even advances made in battery technology are not sufficient to ensure the longevity of network life. Hence it is important to use the energy optimally. Therefore, research into energy efficient design of protocols has attracted the attention of researchers in last few years. However, the key challenge of energy efficient design approach is to increase energy efficiency without trading-off other performance characteristics, such as network throughput and end-to-end delay.

A number of power saving schemes and energy efficient protocols have been proposed in the literature by researchers to deal with the problems of energy consumptions in mobile ad hoc networks. Energy efficiency issue in the network spans over each layer of the protocol stack. Therefore, energy efficiency can be achieved by collective collaboration of the physical layer, medium access control layer, network layer, and upper layers. In other words, a cross-layer design is needed to achieve the optimal energy efficiency in an ad hoc network.

Present work focuses on modifying the existing protocols and designing new protocols to reduce the energy consumption over end-to-end paths. In addition to conserve energy, the proposed schemes also satisfy the main objective of any network design i.e. maximizing the network throughput. In this work, firstly, we made the study with experiments to explore the relation between the transmit power levels and interference. This study is extended to show the fundamental impact of the carrier sensing range on the energy efficiency and throughput of the ad hoc networks. From the experimental results, it is
found that there exits an optimum carrier sensing range that reduces the interference effect of the ongoing transmission and increases the network capacity. Therefore, the network can achieve reduction in energy consumption and an improvement in network throughput.

The most popular power control schemes BASIC, PCM and COMPOW have been investigated in this work. Further, we proposed COMPOW based PCM protocols referred to as PCM/COMPOW and IPCM/COMPOW protocols for multi-hop wireless ad hoc networks. IPCM is an improved version of the PCM protocol in which a source node transmits packets with an optimum power level. The power level of the data packets is periodically increased to a suitable level just for enough time rather than to a maximum level as in PCM. Also a modified version of the IPCM protocol (MIPCM) has been proposed in this work. The MIPCM protocol is similar to the IPCM protocol except that the power level of the data packets is periodically increased to a suitable level sufficient to avoid collisions and make spatial reuse. This level is determined with the help of the measured SINR at both the receiver and the transmitter.

We have implemented and simulated the proposed protocols in Glomosim. PCM/COMPOW and IPCM/COMPOW protocols have been simulated for a network with single flow chain topology and single flow random multi-hop topology. But the MIPCM power control protocol is simulated for a network with single flow chain topology and single-hop random topology. Simulation results show that the proposed protocols have performed better than existing standard IEEE 802.11, BASIC and PCM protocols. We have also conducted experiment for our three proposed protocols under similar simulation environment to evaluate their comparative performance. The experimental results show that MIPCM protocol has performed better than other protocols under study.

Finally, we proposed an energy efficient MAC protocol for the Distributed Coordination Function IEEE 802.11b based ad hoc networks. This protocol also maximizes the overall network throughput in addition to efficient consumption of energy. We call this protocol Traffic Sensing adaptive Rate Power (TSRP) control MAC protocol. The basic idea of TSRP protocol is that in this a sender node selects the most energy efficient rate-power
combination to transmit the data packets by sensing the outgoing traffic rather than matching the channel conditions. The design of this protocol has its basis on the remarks obtained from the outcome of theoretical analysis for single-hop model.

We have implemented IEEE 802.11b with the proposed TSRP control protocol using MATLAB based on discrete event modeling approach. The evaluation of the proposed protocol is also conducted using Glomosim. We investigated its performance for different scenarios, various communication distances, different traffic loads and packet size. All the simulation results show that the proposed TSRP protocol can conserve more energy and achieve the same throughput that is obtained by adaptive rate protocol.