Abstract

Wireless ad hoc networks are self-configurable and dynamic networks where the network connectivity is on purely temporal basis. Since wireless nodes are battery operated, energy efficiency is recognized as a critical problem in ad hoc networks. Many routing protocols have been proposed in the literature - though the design of a routing protocol that is robust and efficient in terms of power consumption is still a challenging issue. A routing protocol achieves robustness by introducing fairness in energy consumption or balancing the traffic load among the nodes. This thesis proposes a family of efficient and robust routing protocols that minimize the energy consumption and, inter-alia, balance the energy dissipation among the energy constrained nodes for maximizing network lifetime without sacrificing scalability and QoS requirement. Extensive simulations have shown that the proposed algorithms outperform other existing routing algorithms in terms of energy efficiency as well as QoS performance (e.g., delay) in a network.

In a many to one traffic pattern, the imbalanced dissipation of energy among nodes may affect the lifetime of the nodes as well network. Additionally, this thesis proposes a dynamic energy efficient routing protocol for maximizing the lifetime of wireless ad hoc networks. The proposed algorithm is based on a load-balanced routing technique that balances the traffic among the nodes in terms of power consumption and thus ensures a longer network lifetime. The proposed method considers node cost metric for relaying the packets to the sink. This metric considers both the residual energy of nodes as well as energy efficiency to locate the next hop node. Moreover, Distinct Energy Efficient Routing Trees (DEERTs) are formed to improve the network lifetime. DEERT balances the load of nodes so that no node is overburdened. This DEERT generation is completely dynamic. At each round, DEERT is formed by exploiting the information locally available at nodes. Simulation results highlight that the proposed dynamic energy efficient routing improves the network lifetime and energy efficiency significantly than other well-known energy efficient routing algorithms.

Next, a Delay-Optimized Energy Efficient Routing Algorithm (DO-EERA) is investigated with two-fold objectives of minimizing: (i) the total energy consumption of the network and, (ii) the end to end network delay. The proposed DO-EERA, while selecting the next
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A hop node, makes a fine trade-off between the aforesaid parameters, i.e., the total energy consumption of the network and the end to end network delay. The proposed method considers both link energy consumption and link delay in the next hop selection process. A weight factor is introduced so that it can attain flexibility between them. This thesis shows that using the van Emde Boas tree data structure, the proposed DO-EERA can be solved in sub-logarithmic time. Performance evaluation demonstrates that DO-EERA outperforms other algorithms in terms of total energy consumption and end to end network delay.

Thereafter, two energy efficient routing algorithms, viz., Interference Aware Energy Efficient Routing (IAEER) and its enhanced version i.e. Interference Aware Energy Efficient Multipath Routing (IAEEMR) have been presented for wireless ad hoc networks. In IAEER, interference at a node is quantified using the SINR (Signal to Interference plus Noise Ratio) model with Fixed Power Method (FPM), while in IAEEMR, that is done using the SINR model with power allocation method. IAEEMR employs an iterative method for multipath route construction along with power allocation. Under this method, assignment of transmission power in routing paths is optimized inter-alia. Optimization of transmission power implies minimization of interfering nodes so that various transmissions can run simultaneously. Compared to the existing routing algorithms, the results show that both IAEER and IAEEMR improve the network performance in terms of total energy consumption and load balancing.

Last of all, the thesis proposes a distributed load balanced clustering algorithm, Weighted Energy Aware Hierarchical Clustering (WEAHC) for wireless ad hoc networks, especially in wireless sensor networks. WEAHC considers both the residual energy and topological information of 1-hop neighbor nodes in clustering process. Here, clustering is done using weight based clusterhead selection and then energy balanced cluster formation. Moreover, WEAHC rotates the role of clusterhead among the nodes according to the residual energy and energy consumption of nodes and thus achieves almost uniform energy dissipation of the whole network. The experimental results show that the proposed WEAHC outperforms other existing energy aware clustering algorithms in terms of network lifetime and energy balancing.