Chapter 2
Fuzzy-Clustering-Based Intelligent and Secured Energy-Aware Routing

Selvakumar Kamalanathan
Anna University, India

Sai Ramesh Lakshmanan
Anna University, India

Kannan Arputharaj
Anna University, India

ABSTRACT

In many applications such as disaster management, temperature control, weather forecasting, industrial control system and forest fire detection, it is very difficult for a human to monitor and control each and every event in real time. Even with advancement in technology, this issue has remained a challenging task. The existing Wireless Network may not be suitable for data communication with human network. Hence, to monitor and control the physical parameters of the environment, a special device with needed functionalities is required. The network which is formed with these devices is known as sensor network. This is used to monitor, control and send the collected information to the end user. These networks are formed with a large number of sensor nodes with limitation such as self-energized, low computation power, infra-structure less, multi-hop communication and without central administrator control. Due to the ad hoc nature, the nodes are deployed unevenly over a geographical region, it is necessary to provide some mechanism to manage and control the topology of the sensor nodes to prolong their life time. Clustering algorithms are useful for data mining, compression, probability density estimation and many other important tasks like IDS. Clustering algorithm utilize a distance metric in order to partition network traffic patterns so that patterns within a single group have same network characteristics than in a different group. The proposed system builds a Fuzzy logic clustering model that can perform three different types of clusters in order to achieve the secure and energy aware routing of packets.

DOI: 10.4018/978-1-5225-1008-6.ch002

INTRODUCTION

The heavy control overhead of high-density WSNs requires a cluster structure for achieving better performance since cluster structure reduces the routing overhead. Clustering helps to form small groups of nodes by dividing a large network into sub groups based on certain rules (Hsi-Lu Chao & Chen-Lung Chang 2008). Any node in each cluster is dynamically elected to the role of cluster head based on some criterion (e.g., Energy, Distance from the Base Station, lowest ID). Nodes within minimum hop within the transmission range of a cluster head will become the cluster member. A Gateway is a non-cluster head node with inter-cluster links, so it can access neighbouring clusters and forward information between clusters. Various distributed computation techniques can be applied to create clusters dynamically in WSNs.

A cluster topology provides a way to effectively manage the resources to improve the computation power, reduce overhead during data transmission, minimize end to end delay and maximize throughput. Hence, a new and efficient secure routing protocol called "Fuzzy Clustering based Intelligent and Secured Energy Aware Routing (FCISEAR) Protocol" has been proposed in this paper for providing effective and energy aware routing. The main usage of this newly developed protocol is that this protocol is secure as well as energy efficient and is independent of the application areas. Since it use fuzzy logic clustering is proposed for routing decisions, it is more efficient than the existing protocols.

In this work, the clustering process is conducted in three phases namely, Cluster Head Election, Cluster formation, Cluster based Routing and Maintenance. The cluster head election phase will be conducted under different conditions as initial condition, cluster head failure and critical energy level. The cluster heads are elected based on the cost metric computed using the node's remaining energy and the distance from the base station. It is assumed that the node will know its position using some localization technique. In addition to this, it is assumed that the consumption of energy is only due to transmission of the data. One among the nodes will be elected as a cluster head based on the metrics.

After the election, the CH will use the Modified-K Hop Clustering algorithm to form the cluster. Then, all the nodes within the K-hop distance will become the member of the cluster head and participate in the routing process. Traditionally, in the sensor network every node will send the information using multi-hop communication and flooding to reach the destination. Though, the multi-hop communication reduces the transmission energy but the flooding causes more energy loss due to duplication of the same information in all the directions through every node in the network. This degrades the performance and drastically reduces the network lifetime. In order to address these issues, in this research work a self-optimization technique using a modified Minimum Spanning Tree algorithm has been proposed and implemented. In this algorithm, nodes in the cluster can be grouped and operated in any one of the following three cluster groups such as Low packet transmission node group, Medium packet transmission cluster group and High packet transmission cluster group. Due to this, the participation of the number nodes can be reduced at a time of routing. So, the overall network energy consumption is minimized and performance can be improved. In addition to this, the routing concepts can be incorporated along with optimization to improve the routing process by avoiding floods and routing loops in the networks.

BACKGROUND

The main goal of developing secured routing protocols is to ensure that transmission of messages that takes place between the nodes of the wireless networks and thereby the forwarding of data through the