CHAPTER 10

CONCLUSION AND FUTURE SCOPE

10.1 CONCLUSION

Clustering can provide large scale MANETs with a hierarchical network structure that is of significant importance for routing operations, network stability and management, mobility management, quality of service support. In this thesis, the recently proposed clustering algorithms have been analyzed and are classified into different categories based on its distinguished features. The mechanisms and descriptions of each clustering protocol are presented and their performances are rated against the very significant metrics viz. Cluster size, Cluster head change, Cluster count, Dominant set updates, Re-affiliation count, Membership lifetime, Cluster head lifetime, Cluster stability, Time complexity, Message complexity, Total overhead.

The extensive literature survey of clustering protocols enabled to define the problems clearly that exists in the field of clustering. To improve the stability of the network, a novel AHPC protocol has been proposed that utilizes AHP methodology to compute relative weights for all the nodes in the network. The AHPC protocol has been simulated in NS2 and adequate experiments were conducted to evaluate the performance of AHPC protocol. The experiments were conducted to find out the variation of average number of clusters, re-affiliation count and dominant set updates by varying transmission ranges for 500, 1000 and 1500 nodes moving at the Max-speed of 20m/s. It has been observed that for small transmission ranges (50-100m), the number of clusters formed was relatively high and it decreases as the transmission range increases.
range increases. It has been found that re-affiliation count increases as the transmission range increases and reaches a maximum between 200-400m of transmission ranges and it decreases with further increase of transmission ranges of mobile nodes. It has been observed that dominant set updates is very high for small transmission ranges and it decreases for further increase of transmission ranges of the mobile nodes in the network.

Experiments were conducted to compare the average number of clusters of AHPC protocol with other three protocols viz. ECS, RCC and HCCM by varying the Max-speed of the mobile nodes with the transmission range of 250m and also by varying the number of nodes at Max-speed of 10m/s. It has been observed that AHPC protocol outperforms other three protocols by forming less number of clusters.

Sufficient experiments were conducted to find out the variation of re-affiliation count, dominant set updates and average cluster size by varying the Max-speed from 20m/s to 100m/s for 500, 1000 and 1500 nodes by fixing the transmission range of the mobile nodes. It has been observed that re-affiliation count and dominant set updates increases as mobility of the node increases. It has been found that for AHPC protocol, the mobility of the nodes does not affect the cluster size of the network and remains almost constant with increase in mobility of the nodes. Experiments were also conducted to find out the average cluster size by varying transmission ranges from 200 to 800m of the mobile nodes. It has been observed that cluster size increases as transmission range of the mobile node increases.

Experiments were conducted to compare the average cluster size of AHPC protocol with other three protocols viz. ECS, RCC and HCCM by varying the Max-speed of the mobile nodes with the transmission range of 250m and also by varying
number of nodes at Max-speed. It has been observed that AHPC protocol outperforms the other three protocols by forming clusters with less size.

Experiments were conducted to find the cluster head changes by varying transmission range of the mobile nodes and fixing up the Max-speed of the mobile nodes in the network. It has been observed that cluster head changes are high for smaller transmission ranges and decreases as the transmission range increases. It was found that AHPC outperforms MobDHop algorithm with very less cluster head changes. Experiments were conducted to find the packet delivery ratio with the suitable underlying routing protocol. It has been observed that packet delivery ratio of AHPC protocol is relatively higher than other protocols.

The experiments were performed to find the cluster head lifetime by varying the mobility of the nodes for a particular transmission range. The experimental results of AHPC protocol has been compared with other three protocols viz. HCCM, RCC and ECS. It was observed that AHPC outperforms ECS, RCC and HCCM protocols. The experiments were also performed to find the cluster head lifetime by varying the number of nodes moving at the particular speed in the network. It has been observed that, as more number of nodes are added to the network, more clusters are formed leading to the more number of neighborhood cluster heads resulting in high merging of cluster heads and shorter lifetime. The AHPC outperforms ECS, RCC and HCCM protocols with less cluster head change by the usage of CCI timer during the during the merging of cluster heads in the network. Extensive mathematical analysis has been carried out to analyze the stability, control overhead, time complexity and message complexity of AHPC protocol.
The AHPC protocol has been further enhanced with the utilization of Beta distribution into the cluster head selection process of AHPC protocol to reduce the number of clusters in the network. The step-wise procedure has been designed and a new protocol named Beta-AHPC protocol has been proposed. The Beta-AHPC protocol was implemented in NS2 and suitable experiments have been performed to obtain the necessary results. It is found that Beta-AHPC protocol reduces the number of clusters and further enhances the stability of AHPC protocol. It has been observed that Beta-AHPC shows better performance than the AHPC protocol. The sufficient lemmas have been proved that AHPC protocol supports Beta probability distribution.

The new protocol named Analytical Hierarchy Process Clustering Mobile Agent protocol (AHPCM) has been framed that utilizes mobile agent concepts to improve the bandwidth utilization and to reduce the control overheads incurred and to avoid the token lost in AHPC protocol. It has been found that mobile agents enhance the performance of the network by reducing network traffic, communication overhead and delay caused during the transmission of packets among the mobile nodes in the network. The adequate experiments have been conducted for AHPCM protocol and compared with AHPC protocol. It has been observed that AHPCM protocol shows better performance than the AHPC protocol. The control overheads have been analyzed mathematically for the cluster formation phase and cluster maintenance phase of AHPCM protocol. It has been observed that control overheads incurred in AHPCM protocol reduces drastically compared to AHPC protocol.

The cluster head selection process of AHPC protocol has been optimized by adopting an evolutionary technique, Genetic Algorithm to optimize the number of clusters in the network. The LibGA genetic algorithmic tool has been used to optimize
the cluster head selection process and the optimum number of clusters is obtained. The optimized AHPC protocol (OAHPC) has been simulated in NS2 simulator with the obtained optimal number of cluster heads. The performance metrics viz. Cluster count, Cluster size, Cluster head changes and Cluster head lifetime have been evaluated and compared with AHPC protocol. The optimization of clusters has resulted in decrease of cluster head changes decreases and increase of cluster head lifetime compared to AHPC protocol. It has been observed that optimized AHPC protocol (OAHPC) shows better performance than the AHPC protocol.

10.2 Future Scope

The following research directions can be focused in future to further enhance the system performance to a great extent.

1. Feasibility of adopting Fuzzy logic in AHP methodology can be studied and analyzed for reduction of computation cost incurred during the computation of relative weights for the mobile nodes in the network.

2. Analysis of other efficient optimization technique viz. Particle Swarm Optimization (PSO), hybrid PSO and Ant Colony Optimization can be studied and evaluated to optimize the cluster head selection process of AHPC protocol and to obtain optimized results.

3. Analysis on the load sharing among the cluster heads of AHPC protocol can be studied and evaluated by adopting new techniques to enhance the efficient resource utilization in mobile ad hoc networks.