Chapter 6

Conclusion and Future Work

6.1 Conclusion

This dissertation has primarily focused on detection of packet dropping attack (PDA) in MANETs and many aspects concerning PDA in MANETs has been investigated. Consequently, the thesis makes three contributions for detection of packet dropping attack (PDA) in MANETs namely, centralized packet dropping attack detection methodology, distributed packet dropping attack detection methodology and game theoretic approach to distributed packet dropping attack detection. In this chapter, we summarize the main contribution made in this dissertation and provide direction for future works.

6.1.1 Centralized PDA Detection

As security is a vital part in the MANET and is often very cumbersome. In Chapter 3 we have proposed a centralized packet dropping attack detection methodology in order to detect the PDA centrally. In this methodology, each node in the network provides its gathered information to a central entity in the network. The central entity analyzes the information received from the nodes individually in order to detect the PDA at a particular node. From the extensive simulation results that are illustrated in Chapter 3, it has been observed that, the performance significantly degrades when the node mobility in a network is quite high. The system gets initialized for every change in the network topology. Thus the proposed methodology is incapable of detecting
PDA in highly dynamic networks like MANET. Failure of the central entity will lead to the failure of the whole network as well.

### 6.1.2 Distributed PDA Detection

Centralized packet dropping attack detection methodology is incapable of detecting PDA in highly dynamic networks. In Chapter 4, we have proposed a distributed PDA detection methodology based on cooperative participation of nodes in MANETs. In distributed PDA detection methodology, PDA at a node is detected and confirmed by not only using the node’s information but also from the information received from its neighbors. It is assumed that intelligent agents are supposed to adapt decision making by cooperation with other nodes in the network. Here, TRUST and CONFIDENCE level of nodes are utilized along with an efficient decision tree algorithm namely; ID5R to handle the dynamic network information to detect PDA in MANETs. From the simulation results, it has been observed that the proposed distributed methodology outperforms the centralized PDA detection methodology in terms of accuracy in detecting and segregating the malicious nodes in MANETs.

### 6.1.3 Game Theoretic Approach

To eliminate the arbitrariness in distributed PDA detection methodology, game theoretic based distributed PDA detection methodology has been proposed in Chapter 5. In MANETs, node cooperation is the most desirable property to communicate amongst them. As the non cooperative nodes create anomalies to the network, hence, MANETs has been formulated as cooperative game to increase the utility of the network by restricting the non cooperative malicious nodes. Coalition is formed by all the genuine nodes. Thereby, each player in the coalition tries to strengthen their position by cooperative participation in the game to increase the overall utility of the network. Value of a coalition and payoff received by a player, the main parameters of coalition game theory, are shown very distinctly in the proposed methodology. Here, payoff received by independent players are represented by trust value assigned to the players depending on their cooperation.
This approach in proposed methodology is a kind of non-transferable utility game as the payoff i.e. trust obtained by each player under coalition is not distributed to other nodes in the coalition. Thereby, it encourages the nodes to show their cooperation for their existence in the coalition. Otherwise, if their trust value falls below threshold trust, then these will split out from coalition.

6.2 Future Research Direction

In this section, we outlined some of the possible avenues for future research works in this field of research. Few of the research directions are listed below:

- The performance of the proposed distributed PDA detection methodology under various networking environments are evaluated using Network Simulator 2 (NS-2). Performance evolution of the proposed methodology in a real time network setup is left as a part of future works.

- The Utility characteristic function of the game theoretic approach based distributed PDA detection methodology has been investigated in a simplified way. Incorporation of other parameters like residual energy of a node, computational overhead and different mobility models needs further investigation, which is left as a part of future works.

- The proposed methodologies are mainly concerned in dealing with malicious nodes in the MANET only. Further enhancing methodologies in order to efficiently detect the selfish nodes in the MANET is also left as a part of the future works.

- In our work, it presumed that the malicious nodes introduce the attack individually. Hence, schemes to deal with cooperative malicious coalition packet dropping attack is yet to be investigated and left as a part of future works.