CHAPTER 6

RESULTS AND DISCUSSION

6.1 INTRODUCTION

The experiments are carried out in Network simulator (NS-2). NS-2 simulator is an open source simulation tool that supports many routing and queuing algorithms written in C++ with Object Tool Command Language interpreter as the frontend. The MANETs are considered with dimensional area 1000X1000 m². A total of 100 nodes are initialized for the evaluation purpose. The experimental setup is given in Table 5.1. The evaluation of the proposed Threshold based EAODV is compared with that of DSR, AODV and Trust based SDSR for determining the efficiency.

To evaluate the performance of the proposed approaches, several parameters are used as such as Energy Consumption, Throughput, End-to-end delay, Packet Delivery Ratio, Network Lifetime, Packet Drop Ratio and Normalized Routing Load.

6.2 PERFORMANCE EVALUATION

This work considered the following important performance metrics for the evaluation by simulation. Figure 6.1 compares the end-to-end delay between proposed GSO-AFSA with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. If the size is increased, the GSO-AFSA uses an active energy consumption mechanism to detect the attacks between the source and destination nodes and quickly apply an alternative path finding mechanism for message transfer.
End-to-end delay

Moreover, when the no. of nodes is increased, the proposed method established a reduction in delay compare than existing methods. From the graph results, it is observed that, the proposed GSO-AFSA approach, the End-to-end delay attained for 40 numbers of nodes is 0.23%, which is 0.04%, 0.20%, 0.29% and 0.41% lesser than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. This is because of the proposed black hole attack detection based on GSO-AFSA helps to provide higher security. Hence while the packets transferred among the nodes the delay between the end to end gets reduced when compared to the other approaches.

Figure 6.1 End to End delay vs No. of Nodes
Packet Delivery Ratio

The delivery ratio is described in the Figure 6.2, it is simply the ratio of the number of delivered and transmitted message to the destination node. It is usually portrays the state of message sent to the destination node. It can be said that the proposed GSO-AFSA approach have a higher ration of transmitting the packets when compared with the other proposed Trust based SDSR, Threshold based EAODV approaches the existing DSR and AODV approaches. It is observed that, the proposed GSO-AFSA approach, the Packet Delivery Ratio attained for 40 numbers of nodes is 1.01%, which is 0.76%, 0.49%, 0.22%, and 0.11% higher than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. This is because of the proposed GSO-AFSA algorithm is used in the network for reducing the communication overhead. The performance of delivery ratio by nodes is observed to be still higher for further increasing nodes too.
Energy Consumption

Figure 6.3 illustrates the relationship between the Energy consumption on communications and the number of nodes. It can be said that the proposed GSO-AFSA approach consumes less energy when compared with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. Nonetheless, when consider the (energy) consumption incurred by both computation and communication; GSO-AFSA is still relatively efficient when number of nodes is large. It is observed that, the proposed GSO-AFSA approach, the energy consumption attained for 40 numbers of nodes is 0.54J, which is 0.05%, 0.11%, 0.35% and 0.46% lesser than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. This is due to the hybrid optimization algorithm which detects the black hole attacks more effectively. Based on the distance between the nodes, mobility of the nodes, residual energy and transmission range of the neighborhood nodes the weight of the each node will be calculated.
in efficient manner. The other algorithms are lack in calculating the residual energy between the nodes while transmitting the packets. The performance of Energy consumption by nodes is observed to be still lesser for further increasing nodes too.

**Throughput**

![Figure 6.4 Throughput vs No of Nodes](image)

Figure 6.4 shows the comparison result of throughput from the proposed GSO-AFSA with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. It is noted that the proposed GSO-AFSA attains higher throughput when compared with all the other proposed and existing approaches. From the graph results, it is observed that, the proposed GSO-AFSA approach, the throughput attained for 40 numbers of nodes is 0.98%, which is 0.08%, 0.21%, 0.27% and 0.35% higher than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. The performance of throughput by nodes is observed to be still higher for further increasing nodes too.
Figure 6.5 Normalized routing load vs. No. of Nodes

Figure 6.5 compares the normalized routing load between proposed GSO-AFSA with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. When the size of the network is 80 nodes, the normalized routing load of proposed approach is considerably lesser than that of existing approaches. When the size of the network is increased to 40 nodes, the normalized routing load of proposed GSO-AFSA is lesser than proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. It is observed that, the proposed GSO-AFSA approach, the normalized routing load attained for 40 numbers of nodes is 0.17%, which is 0.06%, 0.12%, 0.18% and 0.23% lesser than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. The total number of routing packets transmitted during simulation is called as normalized routing load. Normalized routing load is important as it measures the scalability of a protocol, the degree to which it will function in congested or low bandwidth environments. The performance of
normalized routing load by nodes is observed to be still lesser for further increasing nodes too.

**Packet drop rate**

![Figure 6.6 Packet drop rate vs. No of Nodes](image)

Figure 6.6 compares the packet drop rate between proposed GSO-AFSA with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. Packet drop takes place while one or more packets of data travelling across a network fail to reach their destination. It is measured as a percentage of packets lost with respect to packets sent. It shows that the proposed GSO-AFSA approach have a lower ratio of transmitting the packets lost when compared with the other proposed Trust based SDSR, Threshold based EAODV approaches the existing DSR and AODV approaches. It is observed that, the proposed GSO-AFSA approach, the Packet Drop Ratio attained for 40 numbers of nodes is 0.18%, which is 0.06%, 0.34%, 0.61%, and 0.83% lower than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. This is because of the
proposed GSO-AFSA algorithm is used in the network for reducing the communication overhead. The performance of drop ratio by nodes is observed to be still lower for further increasing nodes too.

**Network lifetime**

![Network lifetime vs. No. of Nodes](image)

**Figure 6.7 Network lifetime vs. No. of Nodes**

Figure 6.7 compares the network lifetime between proposed GSO-AFSA with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. Network Lifetime is the time a network operates until the first node or the group of nodes in the network runs out of energy. It is described as the overall network lifetime that is discovered through the remaining energy in the network. It is observed that, the proposed GSO-AFSA approach, the network lifetime attained for 100 numbers of nodes is 4.54%, which is 0.52%, 1.8%, 2.14%, and 2.5% higher than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. The performance of network lifetime by nodes is observed to be still higher for
further increasing nodes too. It proves that the proposed GSO-AFSA provides superior network performance rather than existing approaches.

**Reliability**

![Reliability vs. No. of Nodes](image)

**Figure 6.8 Reliability vs. No. of Nodes**

Figure 6.8 compares the reliability between proposed GSO-AFSA with the other proposed Trust based SDSR, Threshold based EAODV and the existing DSR and AODV protocols. Proposed GSO-AFSA algorithm has a high reliable path between a random source and destination pair considerably than Threshold based EAODV, trust based SDSR, AODV and DSR approaches. It is observed that, the proposed GSO-AFSA approach, the reliability attained for 100 numbers of nodes is 68.2%, which is 10.2%, 21.2%, 28.2%, and 33.2% higher than Threshold based EAODV, Trust based SDSR, AODV and DSR approaches respectively. The performance of reliability by nodes is observed to be still higher for further increasing nodes too. It proves that the proposed GSO-AFSA provides superior reliability rather than existing approaches.