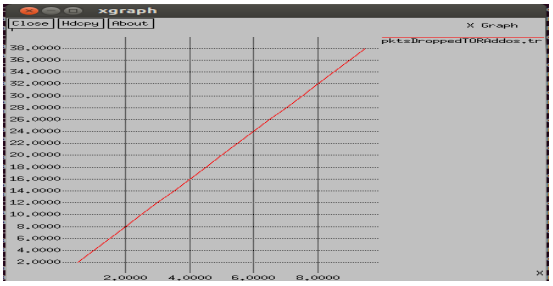

Figure 30: The graph of Packets Dropped

All of the results displayed in this simulation scenario have been recorded on the node 5 from first path. Data drop rate (Figure 25) has shown poor performance of the TORA protocol under attack situations in the MANETs. A higher data drop rate has been recorded in this simulation where TORA is under DDoS attack. Also, the results have shown that a higher delay of almost 70 milliseconds (Figure 5.2) has been recorded from the TORA MANET simulation under DDoS attack. The maximum delay observed in the simulation touches maximum 70 milliseconds and ranges between 3 to 70 milliseconds. In the figure 27 and 28, the jitter and network load has been recorded. A higher jitter and higher network load has been recorded in the TORA simulation under DDoS attack. Also the recorded network load and jitter shown a significant decrease in the performance of MANET with TORA. TORA performance on the basis of these four performance properties shows the poor performance in comparison with AODV under attack in MANETs.

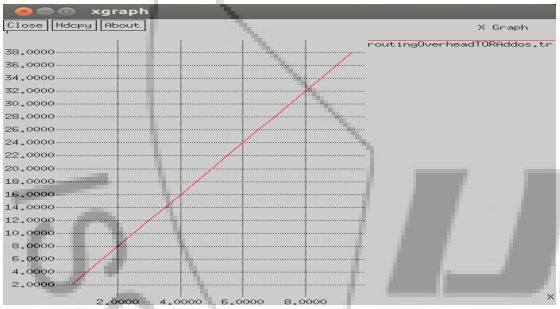

Figure 31: The graph of Routing Overhead

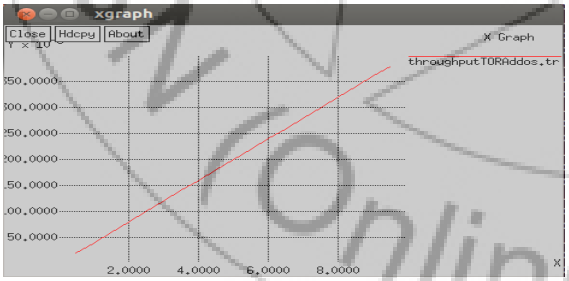

Figure 32: The graph of Throughput

The figure 29 and 30 shows the total number of packets dropped and number of packets sent per second respectively. The total number of packets dropped in the simulation with DDoS attack configured with TORA has been observed very high whereas, Packets sent at the rate of almost 21 packets per second which is very slow and reason behind it is the packet flooding done by the DDoS attacker in the MANET cluster in this simulation. The latter two properties have shown the effectiveness of the TORA protocol to handle the network under the DDoS attack in MANETs. Routing overhead and throughput has been shown under the DDoS attack MANET over TORA protocol shown in the figure 31 and 32 respectively. The Routing overhead is recorded at very higher rate and also, the throughput is pretty higher than the AODV under attack and TORA and AODV under normal situations results.

8. Conclusion

In this research, the performance evaluation survey has been performed on AODV and TORA protocols. Both of the protocols have been tested under the normal and attack situations in MANET environments using Network Simulator -2 (NS-2). The protocol performance has been evaluated on the basis of various parameters such as, delay, network load, packet drop rate, total no. of packets sent, throughput, etc.

Total 11 numbers of nodes has been simulated in the simulation. Each node functions according to following four categories: sender nodes, receiver nodes, end routing nodes, traversing nodes. There are total two paths between the sender nodes and receiver nodes. First Path consisted of the end nodes 7 and 8, followed by end routing node 0, which is connected to other end node 5 via nodes 1 and 2 to reach node 6. Whereas, the second path consisted of everything similar expect the two nodes 1 and 2. Instead of nodes 1 and 2 there are nodes 3 and 4 traversing nodes have been used to connect end nodes 0 and 5. The nodes 7 and 8 are launching the distributed denial of service attack on the node 1. This is pretty sure that DDoS attack has a definite tendency towards a decrease in the performance of TORA. But in this simulation, we had to test the results of TORA under normal conditions and under DDoS attack with each other and with AODV under DDoS attack. All of the simulations have been simulated with total 11 nodes. The nodes have been divided into four major parts: sender nodes, receiver nodes, end routing nodes, traversing nodes. There are total two paths between the sender nodes and receiver nodes. First Path consisted of the end nodes 7 and 8, followed by end routing node 0, which is connected to other end node 5 via nodes 1 and 2 to reach node 6. Whereas, the second path consisted of everything similar expect the two nodes 1 and 2. Instead of nodes 1 and 2 there are nodes 3 and 4 traversing nodes have been used to connect end nodes 0 and 5. The observed results of both of the TORA simulation have shown that TORA under normal conditions has worked far better than TORA under DDoS attack. Similarly, AODV under normal conditions has performed way better than AODV under DDoS attack. When the results of AODV and TORA, both under normal situations have been compared, the AODV has been observed as the better candidate in comparison with TORA under the normal simulation. It means the AODV protocol is recommended for the MANETs, where the probability of attack is lesser or no attack. The AODV and TORA under DDoS attack results have shown that TORA is the poor performer than the AODV. The AODV is observed effective to handle the MANETs under situation of DDoS attack. In both scenarios, the AODV has been observed as the perfect candidate out of the two compared.

9. Future Work

In future, the new security mechanisms against DDoS, balckhole or other variant of DDoS (like selective jamming attack, packet dropping attack, etc.) AODV or TORA can proposed. Also, the best considered AODV protocol can be compared with the other candidate protocols used for MANET simulations. AODV or TORA, or both of them can be compared with more protocols or with each other under different conditions in MANETs or other environments.

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