Chapter – 6

DISCUSSION OF RESULTS

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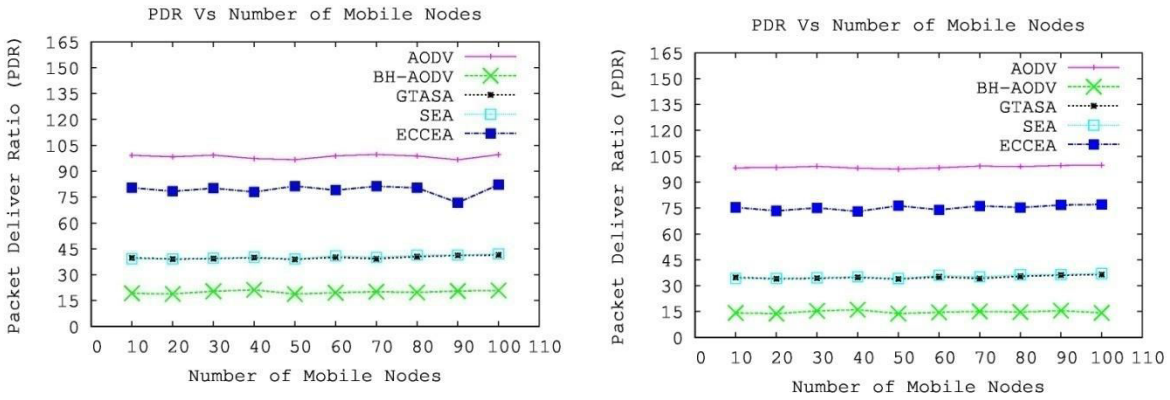
The performance of the traditional AODV and proposed GTASA, SEA, and ECCEA routing protocols is evaluated and compared based on the simulation results using different quality of service parameters such as Packet Delivery Ratio (PDR), Throughput, Normalized Routing Load (NRL), and Average End to End Delay (AEED). Initially using different seed values and random node movements, different traffic and connection pattern scenarios of MANET are generated with and without blackhole nodes. This is done to expose the routing protocols to different MANET environments so that their performances can be evaluated under different practical scenarios.

The scenarios are generated with number of mobile nodes as 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 and each scenario is repeated by considering with 0 and 3 blackhole nodes, the seed values as 0, 1, 2, 3, and 4 and random mobility of the nodes as 5 and 10 m/Sec respectively. Then the simulations are performed on these MANET scenarios for different routing protocols. Based on the simulation results the graphs are plotted as shown below. The Graphs are plotted using the Gnuplot tool by varying the number of MANET nodes along the x-axis and the respective quality of service parameter along the y-axis.

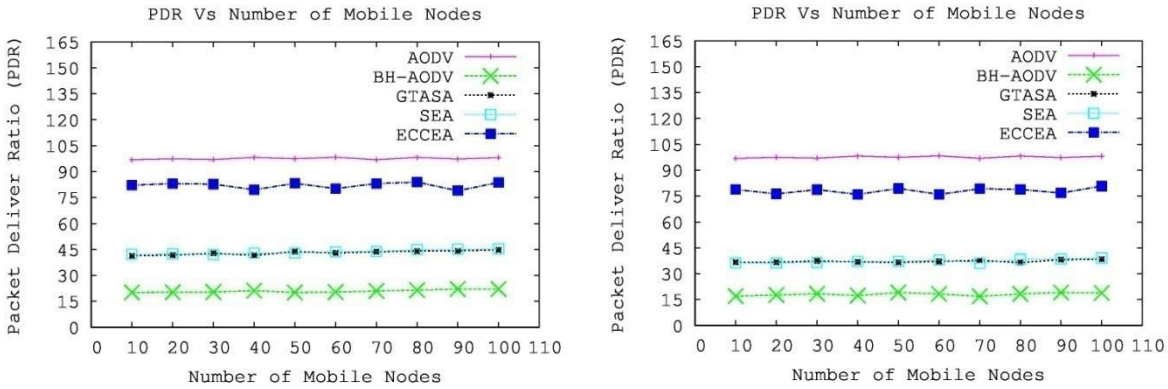
6.1. Packet delivery ratio (PDR):

The different plots in Fig 6.1 a & b shows the values of packet delivery ratios as a comparison chart of different proposed secure routing protocols and traditional AODV protocol for different MANET scenarios with node mobility of 5 m/Sec under the influence of 1 and 3 blackhole nodes respectively. The graph 6.2 a & b also plots the same as in the previous graph, but with a node mobility of 10 m/Sec. The simulation results indicate that the PDR of routing protocols decreases with MANET scenarios where black hole nodes exist. The results also indicate that the PDR of routing protocols further decreases with the increase of blackhole nodes in MANETs. From the graphs it can be understood that new secure routing protocols are doing well in the presence of blackhole nodes and producing better PDR as compared to the normal AODV protocol. The ECC enabled ECCEA secure routing protocol is the best performer among the all. It is producing a PDR of around 80% and 75% as compared to 40 % and 35% of GTASA and SEA and 14% and 20% of normal AODV for different MANET scenarios in the presence of 1 and 3 black hole nodes for node mobility's of 5 m/Sec and 10 m/Sec respectively. However, a slight decrease in the success rate of blackhole nodes can be noticed from the graphs with the increase of node mobility but it is negligible. From the graphs it is also noticed that the new secure routing protocols adopt well with different node mobilities as they use the reactive routing approach for finding the routes between any pair of nodes.



(a) (b)

Fig 6.1a & b: PDR with 1 and 3 blackhole nodes respectively, with 5 m/Sec mobility



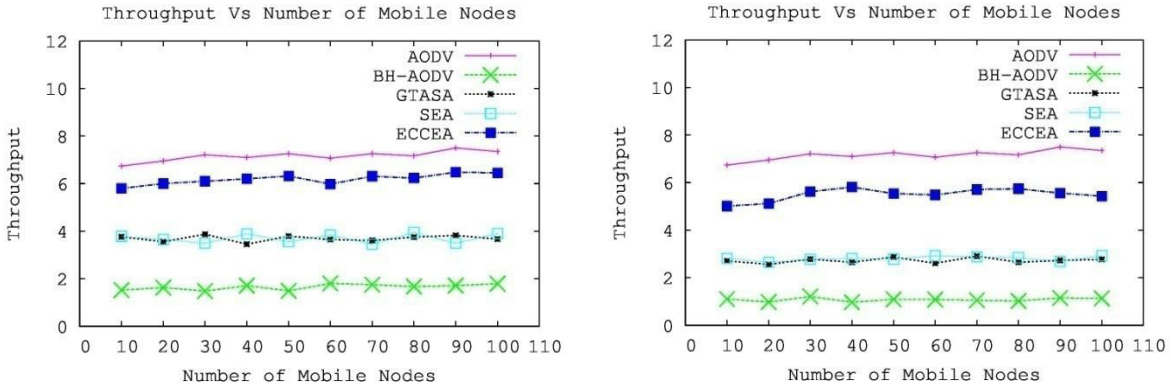
(a) (b)

Fig 6.2 a & b: PDR with 1 and 3 blackhole nodes respectively, with 10 m/Sec mobility

6.2. Throughput:

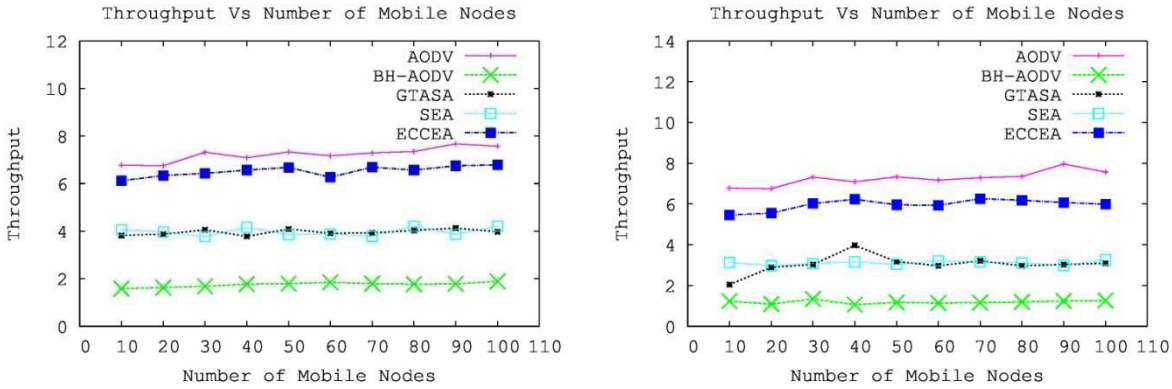
The different plots of Fig 6.3 a & b and 6.4 a & b illustrates the variation of throughput as a comparison chart for different proposed secure routing protocols and conventional AODV protocol. The plots are drawn by considering different MANET scenarios with node mobility's of 5 m/Sec and 10 m/Sec in the presence of 1 and 3 blackhole nodes respectively. The simulation results indicate that the throughput of routing protocols decreases with MANET scenarios where black hole nodes exist. The results also indicate that the

throughput of routing protocols further decreases with the increase of blackhole nodes in MANETs.



(a) (b)

Fig 6.3 a & b: Throughput with 1 and 3 blackhole nodes respectively, with 5 m/ Sec mobility



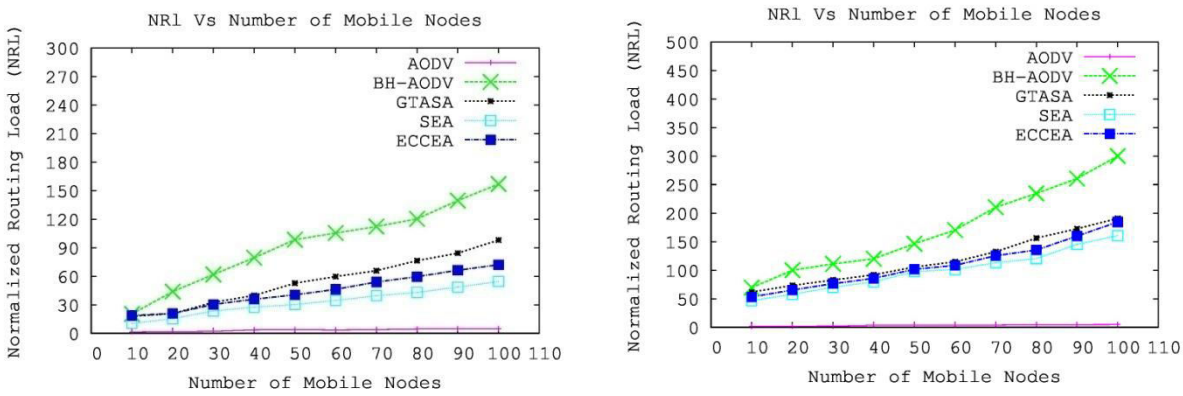
(a) (b)

Fig 6.4 a & b: Throughput with 1 and 3 blackhole nodes respectively, with 10 m/ Sec mobility

6.3. Normalized Routing Load (NRL):

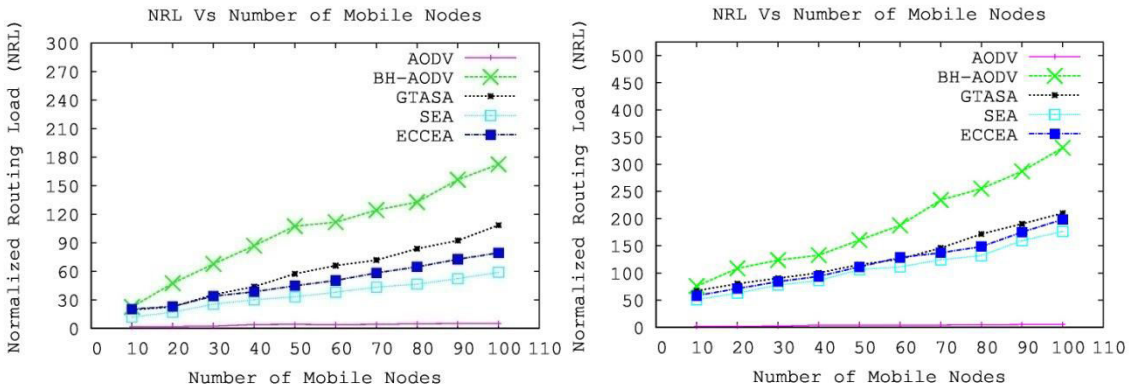
The Fig 6.5 a & b and 6.6 a & b illustrate the variation of normalized routing load for different proposed secure routing protocols and conventional AODV protocol as a comparison chart. The different plots are drawn by considering the same simulation setup as

discussed earlier, i.e. with node mobility's of 5 m/Sec and 10 m/Sec in the presence of 1 and 3 blackhole nodes respectively.



(a) (b)

Fig 6.5 a & b: NRL with 1 and 3 blackhole nodes respectively, with 5 m/ Sec mobility



(a) (b)

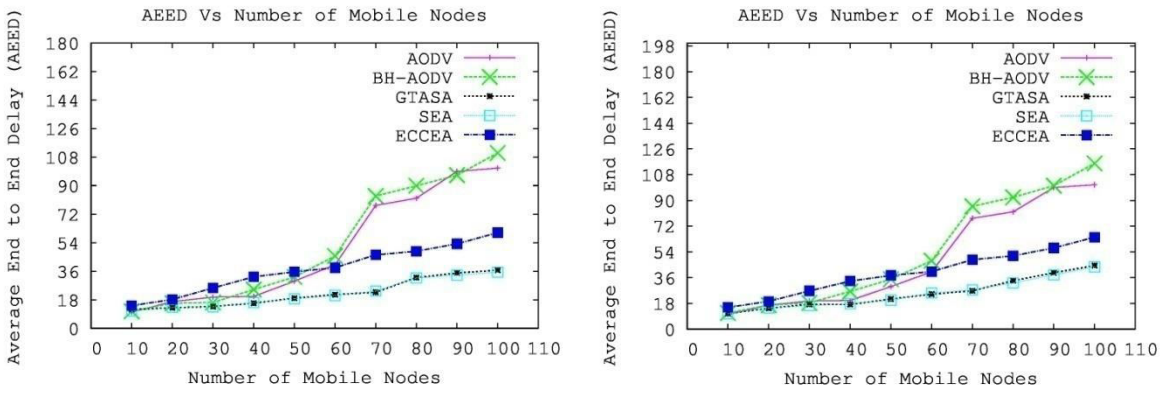
Fig 6.6 a & b: NRL with 1 and 3 blackhole nodes respectively, with 10 m/ Sec mobility

The simulation results indicate that the new secure routing protocols are producing lower normalized routing load as compared to the normal AODV routing protocol in the presence of blackhole nodes. From the graph, we can also notice that the ECC based ECCEA is producing more NRL as compared to the IDS based GTASA and SEA as it uses public key cryptography. The graphical analysis also

indicates that the NRL of different routing protocols increases with the increase of blackhole nodes and also with the increase of MANET size.

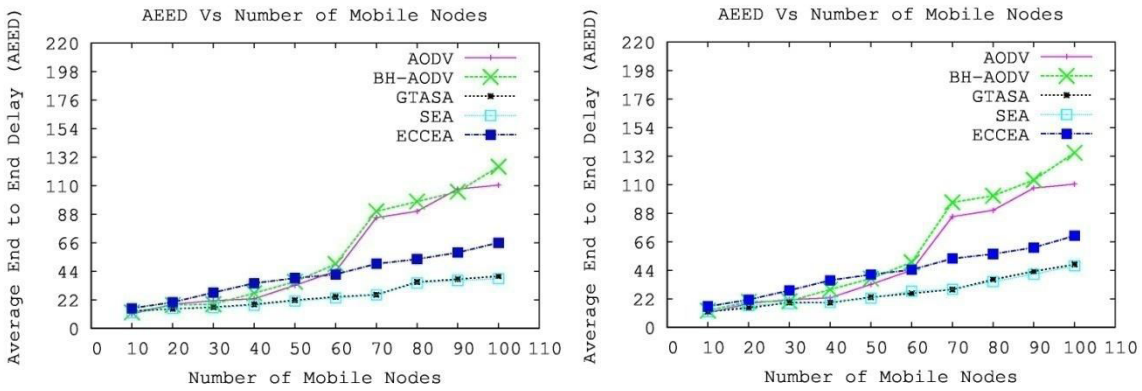
6.4. Average End to End Delay (AEED):

The different plots in Fig 6.7 a & b shows the variation of the average end to end delay as a comparison chart of different proposed secure routing protocols and traditional AODV protocol for different MANET scenarios with node mobility of 5 m/Sec under the influence of 1 and 3 blackhole nodes respectively.



(a) (b)

Fig 6.7 a & b: AEED with 1 and 3 blackhole nodes respectively, with 5 m/Sec mobility



(a) (b)

Fig 6.8 a & b: AEED with 1 and 3 blackhole nodes respectively, with 10 m/ Sec mobility

The graph 6.2 a & b also plots the same as in the previous graph, but with a node mobility of 10 m/Sec. The simulation results indicate that the AEED of routing protocols increases with MANET scenarios where black hole nodes exist. From the graphs it can be understood that new secure routing protocols are doing well in the presence of black nodes and producing less AEED as compared to the normal AODV protocol. From the graphical analysis, it can be observed that ECCEA is resulting more delay when compared with GTASA and SEA routing protocols as it involves the more complex operations of public key cryptography.