3. PROBABILISTIC SCHEME BASED AODV ROUTING WITH TCP VARIANTS FOR ROUTING OVERHEAD REDUCTION AND PACKET DELIVERY IMPROVEMENT

3.1 INTRODUCTION

In this chapter, a new Probabilistic Scheme Based AODV (PSAODV) Routing is introduced with an objective of control-overhead (routing-overhead) reduction and selection of a suitable TCP variant for an efficient end to end delivery. It is important to utilize the limited bandwidth, by minimizing the control packets during the route establishment. In this chapter, an enhanced reactive routing technique is suggested to modify the AODV routing protocol to establish routing paths with minimum control packets.

The proposed method is significantly important to control the broadcast storm problem through limiting the broadcasting nodes. Broadcasting in MANET poses more challenges than in wired networks due to node mobility and scarce system resources. Broadcasting a packet to the entire network is a basic operation and has extensive applications in MANETs. A Comparison of the TCP variants performance is made over different Routing Protocols on Mobile Ad Hoc Networks. A variant of TCP (Tahoe, Vegas) is the most widely used transport protocol in both wired and wireless networks.

The selection of suitable TCP variant for a better end to end delivery is made by testing and comparing the performance of the AODV and the modified routing protocols in different versions of transport protocols such as TCP Vegas, TCP Tahoe, and TCP SACK. The methodology of PSAODV routing, analysis of the existing and proposed routing with TCP variants, results and analysis are presented in this chapter.

QoS routing is an essential component of QoS architecture. AODV routing protocol extends the route table that improves request reply packet and employs selected flooding and local recovery mechanism to effectively reduce the control overload and route searching time. Specifically, users have a lot of interest in end to end QoS. Also when several different networks make one network, the users want to get high-quality services regardless of the type of network.

To retransmit a lost segment, TCP employs a retransmission timer that handles the Retransmission Time-Out (RTO) for an acknowledgement of a segment. When TCP sends a segment, it creates a retransmission timer for a particular segment. Then, the timer works based on the arrival of acknowledgement in any one of the following two situations may occur:

- If an acknowledgement is received for this particular segment before the timer goes off, the timer is destroyed.
- If the timer goes off before the acknowledgement arrives, the segment is retransmitted and the timer is reset.

3.2 METHODOLOGY OF PSAODV ROUTING AND ANALYSIS OF THE TCP VARIANTS

The objective of this proposed routing algorithm is to introduce a modified AODV routing protocol that uses a Probabilistic Scheme based routing for control overhead reduction and suggests a suitable selection of TCP variant for data traffic. The network nodes in the neighbourhood of every node are divided into five different regions namely sparse, medium-sparse, medium, medium-dense and dense. These are assigned with probability values from high to low respectively based on the number of neighbours around each node. The suggested strategy sets the probability based on the number of neighbours around every node and rebroadcasts the route request packets into the regions with fewer numbers of nodes which reduce the control packets considerably and minimize the routing overhead. The PSAODV routing protocol and AODV protocol are experimented with different TCP variants namely TCP Vegas, TCP Tahoe and TCP SACK in a simulation environment on varying node density. The performance of the protocols is compared in terms of routing overhead and packet delivery ratio for accurate data delivery from source to destination.

3.2.1 Methodology for Route Discovery

The algorithmic steps of PSAODV are as follows:

Step 1: Set the parameter values for transmission range, bandwidth, simulation time, packet size, packet generation rate, topology size, number of nodes, traffic type, MAC protocol, routing protocol, source type and mobility model for the experimentation of PSAODV routing in MANET.

Step 2: Calculate the average number of neighbours (N_{avg}) for every neighbour node 'n' using the Equation (3.1).

$$N_{avg} = \sum_{i=1}^{n} \frac{N_i}{n} \qquad (3.1)$$

Where,

N_{avg} is average number of neighbours for every sender's neighbour node

N_i is the number of neighbours around each node

n is the total number of nodes

Step 3: Calculate the minimum and maximum number of neighbours namely N_{min} and N_{max} values for every neighbour node using the Equations (3.2) and (3.3) respectively.

$$N_{min} = N_{avg} / 2 \qquad (3.2)$$

$$N_{max} = N_{avg} * 2 \qquad (3.3)$$

Step 4: Categorize the sender's neighbour nodes into anyone of five groups namely sparse, medium-sparse, medium, medium-dense, dense and assign the probability of broadcasting the RREQ packets in the high order to lower order respectively.

Step 4 a: If $N_i <= N_{min}$

The sender's neighbour node is situated in a sparse region (i.e. Group 1)

Set rebroadcast probability as very-high

p=p1=0.7

Step 4 b: If $N_{min} < N_i <= N_{avg}$

The sender's neighbour node is situated in a medium sparse region (i.e. Group 2)

Set rebroadcast probability as high

p=p2=0.6

Step 4 c: If $N_i = N_{avg}$

The sender's neighbour node is situated in a medium region (i.e. Group 3)

Set rebroadcast probability as medium

p=p3=0.5

Step 4 d: If $N_{avg} < N_i <= N_{max}$

The sender's neighbour node is situated in a medium dense region (i.e. Group 4)

Set rebroadcast probability as low

p=p4=0.4

Step 4 e: If $N_i > N_{max}$

The sender's neighbour node is situated in a dense region (i.e. Group 5)

Set rebroadcast probability as very-low

p=p5=0.3

Step 5: Select the neighbour node of the sender for rebroadcasting the RREQ packets by choosing that node in a lower group (having a fewer number of nodes) with the higher probability.

Step 6: The PSAODV routing protocol and AODV protocol are experimented with different TCP variants namely TCP Vegas, TCP Tahoe and TCP SACK varying the number of nodes. The performance of the protocols is compared in terms of routing overhead and packet delivery ratio for accurate data delivery from source to destination.

Step 7: The suitable TCP variant for accurate delivery of data is identified based on the highest packet delivery ratio.

The probability values are set based on the density of the neighbour nodes. If the sender's neighbour node is situated in a dense region then the rebroadcast probability is set as very-low. The need of the probability value is for rebroadcasting the RREQ packets. In the proposed method the probability values are statically assigned between 0.3 and 0.7.

In this approach the number of nodes does not remain the same always. It increases or decreases based on the nodes that join the network or leave from the network. Based on the number of neighbours available at the specific time, the rebroadcasting probability will also change. The actual value of the probability for low is 0.4 and the high is 0.6. The routing overhead is the primary performance metric considered for the PSAODV algorithm.

3.2.2 PSAODV Routing with TCP Vegas, TCP Tahoe and TCP SACK

The performance of the PSAODV routing protocol is compared with the existing AODV routing protocol in TCP Vegas, TCP Tahoe and TCP SACK. The performance of existing and proposed routing protocols is measured in terms of packet delivery ratio and routing overhead varying the number of nodes.

3.3 SIMULATION ENVIRONMENT

The simulations are performed using Network Simulator 2.34 (NS 2.34). The nodes are distributed randomly over the two-dimensional grid of the terrain size 1000m × 1000m. Table 3.1 shows the Simulation Parameters for PSAODV routing.

Table 3.1: PSAODV - Simulation Parameters

PARAMETERS	SETTINGS
Transmission Range	250 m (Meter)
Bandwidth / Channel Capacity	2 Mbps (Megabits per second)
Simulation Time	300 s (Seconds)
Packet Size	512 Bytes
Packet Rate	5 Packet / Sec.
Topology size	1000 m X 1000 m
Number of nodes	200 Nodes
Node's Speed	8 m/s(Meter per second)
Traffic Type	Constant Bit Rate(CBR)
MAC Protocol	IEEE 802.11
Routing Protocols	AODV,PSAODV
Transport Protocols	TCP Vegas, TCP Tahoe, TCP SACK
Mobility Model	Random Waypoint

The source-destination pairs are randomly chosen from the set of available nodes in the network. A sample set of nodes run in this simulated environment based on the different number of nodes. In this research work, the values for the parameters such as transmission range, bandwidth, simulation time, packet size, packet generation rate, number of nodes, traffic type, etc. have been set with the assumption for a simple multimedia application, such as video conferencing chat for the Farmers' Awareness Application. This chat application will be helpful to the farmers' to acquire the awareness about the suitable time for cultivation of paddy, seed production and seed technology for a group of 50 to 500 farmers. With the assumption of this application the values to the parameters have been set.

3.4 RESULTS AND ANALYSIS

The performance of existing and proposed (PSAODV) routing protocols is implemented and the performance metrics evaluated are the packet delivery ratio and routing overhead.

3.4.1 Varying Number of Nodes

The performance of the PSAODV routing protocol is compared with the existing AODV routing protocol in TCP Vegas, TCP Tahoe and TCP SACK is measured varying in number of nodes.

3.4.1.1 Packet delivery ratio using TCP-Vegas

The evaluated performance of PSAODV is compared with AODV under different node densities using TCP-Vegas and is elucidated in Table 3.2. Simulation results confirm the direct proportionate relationship between node density and packet delivery ratio. The PDR is high for PSAODV compared to AODV and effect of packet delivery ratio on varying node density using TCP-Vegas is depicted in Figure 3.1.

Delivery of data packets from end to end depends with routing as well as the transport protocol. When the node increases proportionally more paths are available to forward packets to the neighbour nodes and provides better packet delivery ratio. The node density is higher and it leads to more connectivity and hence the PDR is increased. In particular, the PSAODV routing achieves 5% improvement in the packet delivery ratio than the AODV routing algorithm for the sample node density of 200 using TCP Vegas as the transport protocol.

Table 3.2: PSAODV - Effect of Packet Delivery Ratio on varying node density using TCP-Vegas

Number of Nodes	Packet Delivery Ratio (%)	
	AODV	PSAODV
25	70	82
50	74	84
100	81	87
150	83	88
200	85	90

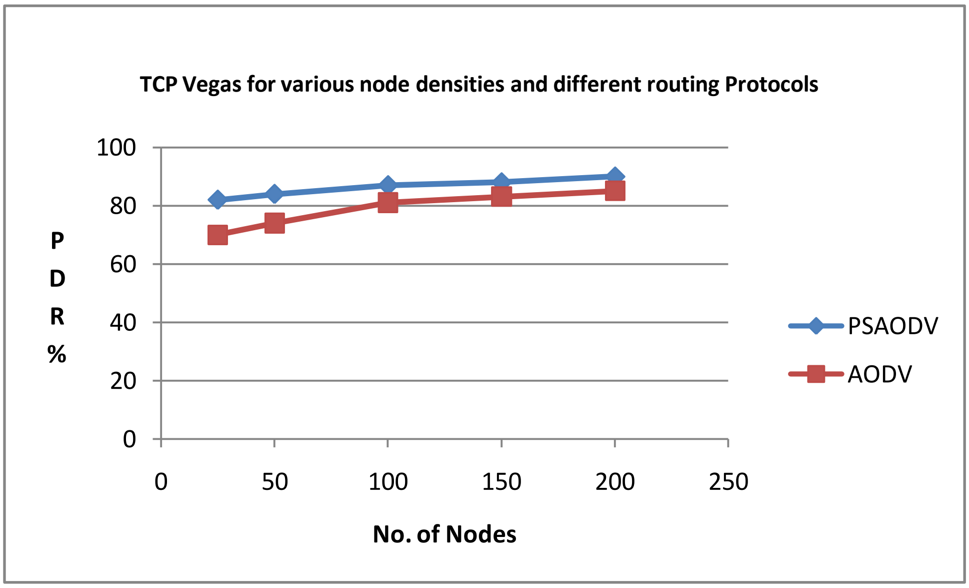

Figure 3.1: PSAODV - Effect of Packet Delivery Ratio on varying node density using TCP-Vegas

In the thesis both the graph and table are given for easy and quick understanding of experimental results.

3.4.1.2 Packet delivery ratio using TCP- Tahoe

Sensitivity analysis is carried out on the performance of PSAODV and AODV by varying the number of nodes. Table 3.3 shows the effect of Packet Delivery Ratio on varying node density using TCP-Tahoe. As the node density increases the PDR is also increases for the transport protocol TCP-Tahoe.

Table 3.3: PSAODV - Effect of Packet Delivery Ratio on varying node density using TCP-Tahoe

Number of Nodes	Packet Delivery Ratio (%)	
	AODV	PSAODV
25	72	84
50	75	85
100	81	88
150	83	89
200	85	92

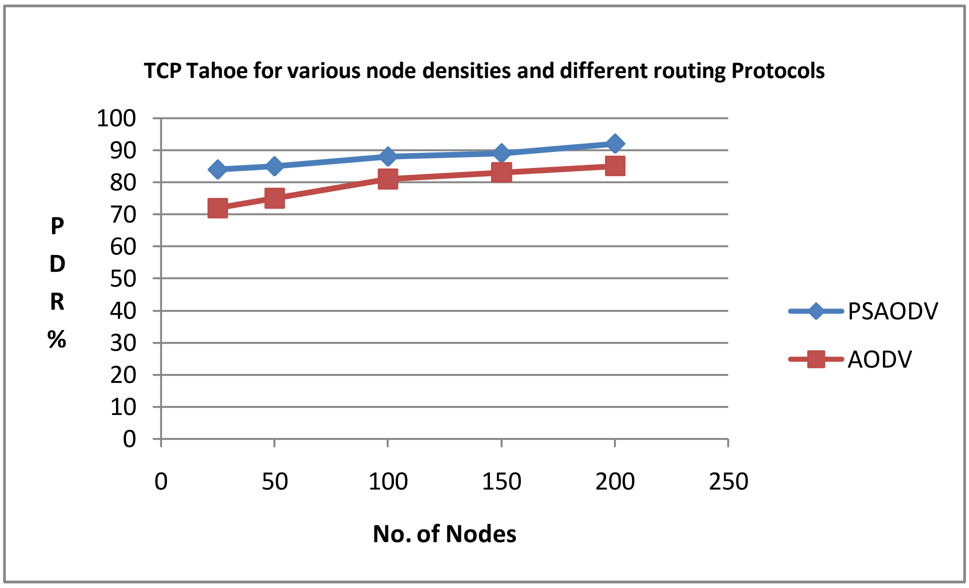

Figure 3.2: PSAODV - Effect of Packet Delivery Ratio on varying node density using TCP-Tahoe

In a sample scenario of the node density 200 using TCP Tahoe as the transport protocol, the PSAODV routing achieves 7% improvement in the packet delivery ratio than the AODV routing algorithm. Figure 3.2 illustrates the effect of Packet Delivery Ratio for routing protocols AODV and PSAODV on varying node density using TCP-Tahoe as the transport protocol.

3.4.1.3 Packet delivery ratio using TCP-SACK

The performance of PSAODV and the existing routing protocol AODV are evaluated in terms of packet delivery ratio by varying the node capacity is presented in Table 3.4.

Table 3.4: PSAODV - Effect of Packet Delivery Ratio on varying node density using TCP-SACK

Number of Nodes	Packet Delivery Ratio (%)	
	AODV	PSAODV
25	74	84
50	75	85
100	81	88
150	84	89
200	84	93

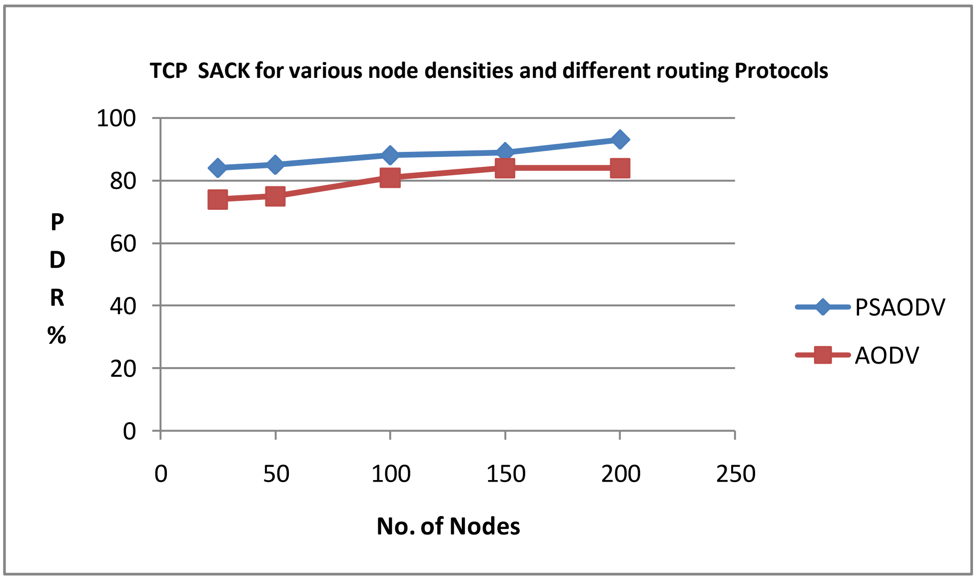

Figure 3.3: PSAODV - Effect of Packet Delivery Ratio on varying node density using TCP-SACK

Figure 3.3 illustrates the effect of Packet Delivery Ratio on varying node density from 25 nodes to 200 nodes for two routing protocols AODV and PSAODV using TCP-SACK as the transport protocol. In particular, with 200 nodes density, PSAODV exemplified 9% of the increase in packet delivery than AODV using TCP-SACK as the transport protocol.

3.4.1.4 Routing overhead with the highest packet delivery-TCP variant (TCP-SACK)

The comparison of PSAODV and AODV routing protocol with respect to the performance metric namely routing overhead on varying number of nodes, are analyzed and shown in Table 3.5. As the number of nodes increases, the control packets also increase in PSAODV and AODV as shown in Figure 3.4. However, this increase is proportionately lower, in the case of PSAODV, because PSAODV sets the probability based on the number of neighbours around every node and rebroadcasts the route request packets into the regions with fewer numbers of nodes which reduces the control packets considerably and minimizes the routing overhead.

The PSAODV routing achieves 14% reduction in routing overhead than the AODV routing algorithm for the node density of 200 using TCP SACK as the transport protocol. The proposed routing strategy has enhanced the existing AODV routing protocol performance in terms of packet delivery ratio and routing overhead as a significant improvement on delivering the data packets in MANET environment.

Table 3.5: PSAODV - Effect of Routing-Overhead on varying node density using TCP-SACK

Number of Nodes	No. of Routing overhead Packets	
	AODV	PSAODV
50	14614	14112
100	34372	30283
200	56098	47980

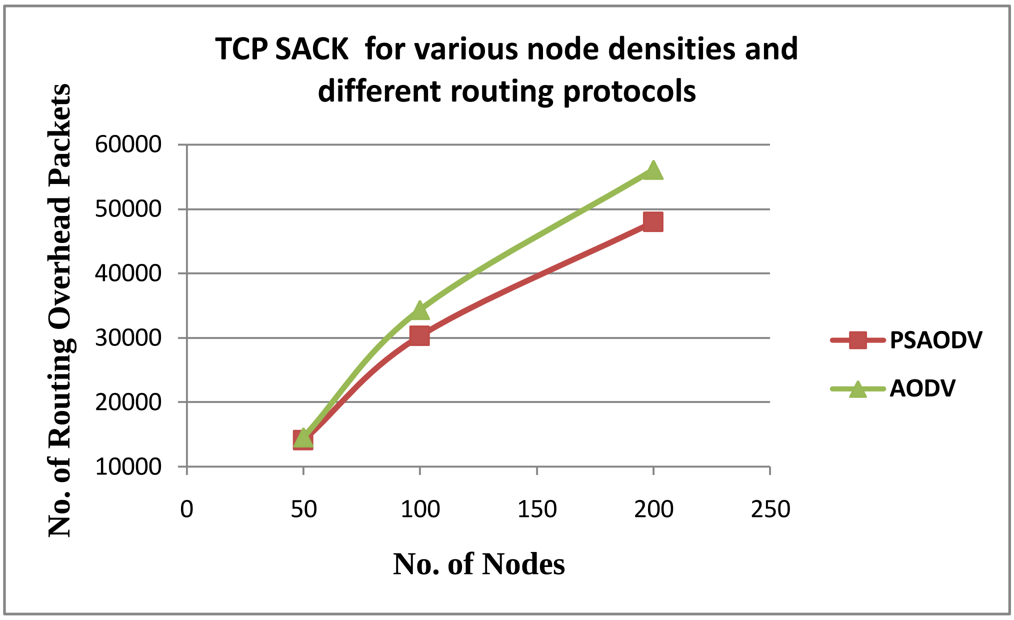

Figure 3.4: PSAODV - Effect of Routing overhead on varying node density using TCP-SACK

3.5 CONCLUSION

In this chapter, the PSAODV routing algorithm has been introduced and its performance has been compared with the existing AODV routing protocol and a suitable TCP variant is identified for a particular scenario in data traffic. The highlight of the PSAODV routing achieves 5%, 7% and 9% improvement in the packet delivery ratio than the AODV routing algorithm for the sample node density of 200 using TCP Vegas, TCP Tahoe and TCP SACK respectively as the transport protocol. Further, it attains 14% reduction in routing overhead than the AODV routing algorithm for the node density of 200 using TCP SACK as the transport protocol. The simulation results reveal that the proposed routing strategy has enhanced the existing AODV routing protocol performance in terms of packet delivery ratio and routing overhead as a significant improvement on delivering the data packets in MANET environment.

The performance of the PSAODV protocol is compared with the existing AODV routing protocol in TCP Vegas, TCP Tahoe and TCP SACK, it is concluded that the performance of PSAODV is found better than the AODV routing protocol in TCP-SACK in terms of packet delivery ratio. Simulation results confirm that the PSAODV performs better than AODV. However, there is a possibility of packet drops due to the occurrences of routing loops between same two nodes while selecting the next neighbour node for rebroadcasting. Hence, the Loop-Free Multipath Reactive Routing strategy is proposed as the second strategy in the following chapter to reduce the packet drops.