Priority based AODV Routing under Weight based Clustered MANET

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Abstract— Designing a routing protocol for MANET is challenging due to the infrastructure less and dynamic changing topology. The lack of centralized coordinator and limited resources in MANET degrade the Quality of Service provisioning and there for routing, process. AODV routing does not provide any local route repairing mechanism and QoS support. In this paper, AODV routing are modified with a weight based clustering technique, where a weight value is used for defining roles of nodes in network. Routing process is improving with priority where it is calculated based on available bandwidth. In the proposed method a local route repairing method is incorporated which reduces the routing overhead and increase the network performance. A route node is selecting based on the available bandwidth that included in the modified RREQ packet of AODV and if a node is failed, next highest priority node will select as the route node. The focus of proposed method is to reduce the routing overhead, improve the network performance and provide QoS for applications.

Key words: MANET, AODV, Priority, Clustering, QoS

I. Introduction

Routing protocols are used to establish a secure path between sender and receiver. Designing a secure routing protocol for ad-hoc network is a challenging task. MANET has several characteristics that adversely affect the performance of a routing protocol. The characteristics are dynamically changing topology, mobility of nodes, open and decentralized network, limited resources, and lack of centralized coordinator.

Routing protocols are divided into three categories called proactive, reactive and hybrid. This paper is focusing on reactive routing where route nodes are selected on demand and nodes does not need to maintain the topological information's of network. Ad-hoc On Demand Distance vector routing (AODV) is a reactive routing protocol that establish a route path only when there is a transmission required by the source node. AODV uses two control packets; RREQ and RREP. Each RREQ enters previous node address and Broad cast ID. A timer used to delete this entry in case of route reply is not received before the timer expires.

Due to the mobility of nodes, established routing path can get break easily and source node needs to send the control packets again for establishing a new path in AODV. It will increase the routing overhead and reduce the network performance. There is no local route repairing mechanism is existing in AODV.

If a route node is failed in AODV, the nearby nodes of failed node transmits RRER (Route Error) packet to other routes in that path. Source node reinitiates the route establishment by transmitting the RREQ packet again. The number control packets using in AODV are large for identifying the route nodes when any link break occurs. Therefore, the congestion in active route will increased and calculation of expiry time of route node is difficult. AODV is good in case of small networks because as the network size get increased the performance metrics get degraded. The routing information can be misused for attacks including node isolation, resource consumption and route invasion. AODV will discover a route when the flow is initiated. The route discovery latency is high for large-scale mesh networks. Routing information is not reused in AODV because the information is obtained on demand. Routing algorithm expects that the nodes in the broadcast medium can detect each other's broadcasts. AODV does not have any efficient route maintenance techniques and not considering the QoS levels that a user needs.

An efficient routing process should provide good QoS provisioning. The major challenges for providing QoS are lack of central coordinator, dynamically varying topology and limited resources like battery power and bandwidth. QoS can be provided using layer wise solution and approaches used. This paper is focusing on the layer wise solution. According to the application, the selected QoS parameters varied. Bandwidth and delay are considering for multimedia application whereas security and reliability is considering for emergency search and rescue.

In this paper priority based AODV routing under cluster based MANET is proposed. A clustering technique that select a cluster head based on weight value where weight is calculated on the basis of degree difference, summation of distance, mobility and energy value. Clustering technique can resist the dynamicity in topology and a node chooses as a header node, which manage the resource allocation and the load in network. Proposed clustering scheme can provide an efficient routing by in cooperating QoS provisioning.

AODV will work under this cluster and inefficiency in route maintenance is eliminated by including local route repair mechanism. Each node has a priority value based on the weight that calculated for cluster head election. If a route node is failed, the predecessor node will select alternative route based on the priority value that was recalculated. The routing overhead is reduce by above mechanism. For making the modified AODV in support of QoS, minimum bandwidth available field is added into the RREQ packet. The nodes that has high priority and required bandwidth considered for routing process. Therefore, the final system can improve overall network performance in terms of routing overhead and QoS metrics.

II. Related Work

There are several routing protocols existing that provide network solutions for QoS provisioning and improved route maintenance schemes for AODV routing protocols.

In Ticket Based QoS Routing, source node issues certain number of tickets and sends these tickets for finding a QoS feasible path [1]. The number of ticket packet is generated based upon the state information stored at source node. Based upon ticket based routing two algorithms are proposed, Delay constrained and Bandwidth constrained. The protocol has control overhead due to maintaining of global state information at each node. In delay, constrained routing the queuing delay and processing delay at intermediate nodes are not considered. If the topology change occur rapidly finding of feasible path is difficult.

AODV routing protocols in cooperated QoS surviving methods for increasing the performance level with consideration of user requirements. Ad hoc QoS on-demand routing (AQOR) [2], considering bandwidth and end-to-end delay as QoS parameters. The neighbourhood information is maintained by sending HELLO packets periodically. Every node will maintain a neighbour list based upon the HELLO packet received. In route discovery process, on demand transmission of RREQ and RREP packet is occurred. Two steps are there: Route exploration and Route registration. Source node sends a RREQ packet, which includes the minimum bandwidth and maximum end-to-end delay. If the RREQ packet is accepted then node will add an entry in its routing table with status explored and rebroadcast the packet. A RREP send back to source along reverse path, if QoS parameters are accepted the route status will change to Registered. If a late route update packet came with a valid route sequence and signals violation of QoS, source decided to continue transmission with the absence of QoS guarantee.

EN-AODV is an energy based route calculation in AODV where the energy is calculated based on the sending and receiving rate of transmission [3]. If the node has energy level greater than a predefined threshold value then the node is considering for routing. If EN-AODV found any path with low energy level, it will choose an alternative path for routing. In MANET, energy may drain easily because of mobility of nodes. The frequent alternative route calculation can be increase the network overhead. Bidirectional Route Repair Method [BRRM], proposed for accelerate the route repair procedure in AODV routing [4]. When an old route disconnects, both the source and destination start the route discovery simultaneously to shorten the disconnection duration. In addition, a density-based method was proposed for minimizing the hop count in the repaired route and improving the successful probability of repairing the route. This method is applied when two ends of a route are already known.

In stable weight-based on-demand routing protocol [SWORP], every node has a weight in terms of hop count, error count and expiring time [5]. The path with largest weight is considered for routing. If such path is not source node, reinitiate the route discovery process, which increase the routing overhead. Dynamic Route Optimization Mechanism for AODV is known as a shrinking mechanism, which eliminates unwanted routes and shorten the path [6]. Shrink mechanism is initiated periodically by the source node of each connection, as long as the connection is active and has data being sent on it.

QoS of Manet through Trust Based AODV Routing Protocol by Exclusion of Black Hole Attack [7], most trusted path would select between sender node and destination node instead of shortest path. In addition, a node can be excluded which is not trusted from the route. The trust value of a node is calculated depending upon the packet forwarding ability and a weight factor.

Local Recovery Based Route Maintenance (AODV-LR) for AODV Routing Protocol [8], improves the route recovery process in AODV, because the recovery process is initiated by the detecting node. The RERR packet is send by neighbour node and check for a backup path and if a path is available it will choose as a routing path. Backup path does not store all the possible paths. It only stores the best and efficient path that is based on hop count and the signal strength.

Reliability Based Variant of AODV [9], is based on conferring stability to routes. The chosen routes are constrained with End-to-End Delay and Bandwidth parameters to provide quality services. The reliability is defined in terms of speed of intermediate nodes. If node moves with slow speed stability of route is large but if not, high-speed node has to adjust some of its neighbouring node, which can act on its behalf as a part of ongoing route part. In MANET every node are highly mobile and the factor stability will affected by mobility.

The existing systems are improved the QoS using energy, bandwidth and end-to-end delay. But the primary facts like dynamically changing topology and lack of centralized coordinator that adversely affect the QoS provisioning are not considered for increasing the performance level.

The major contribution of proposed system are:

– Weight based Clustering method on MANET

Define the roles of network nodes by calculating a weight based on the degree differences, mobility, energy value and summation of distances.

– Priority valuation

According to the weight value, priority will set for every node. Priority and weight are inversely proportional to each other.

– Local Route Repairing

If a route node gets failed, alternative node with highest priority is selecting for routing purpose locally for reducing the routing overhead.

– QoS enabled routing

The RREQ packet of AODV is added an additional field for indicating the bandwidth available. If a node with highest priority value has the bandwidth requirements of a user, then only the node will choose for the routing process.

III. PROPOSED SYSTEM

The proposed work has modules like Cluster formation, Weight based Cluster head election, Priority assignment, QoS enabled routing, Route repairing.

A. Cluster Formation

Every node calculates the neighbour nodes using Euclidean distance formula. A transmission range (200m) is predefined and nodes under this range will come undera cluster. Number of neighbour node is known as Degree. A node can be a member of only one cluster accroding to the distance.

B. Weight based Cluster Head Election

Every cluster has to select a single node as Cluster Head (CH). CH has the responsibility to allocate the resources to member nodes and load balancing for improving the network performance. The presence of centralized coordinator helps in provisioning of QoS by utilizing the resources in efficient manner. CH is electing based on the Weight factor, which is calculated, based on Degree differences, Mobility, Energy and summation of distances and Link Expiry Time prediction.

– Degree differences

Every node has neighbour nodes and number of neighbour is known as Degree. There is a threshold value for cluster head according to the number of nodes that can handle.

$$D_V = |d_v - M| \quad (1.1)$$

Where D_V is the degree difference, d_v is the number of neighbour nodes and M is the threshold value.

– Mobility

The average speed of running nodes and denoted as $M_{V.}$

– Energy

The battery power of nodes are identified and denoted as $E_{V.}$

– Summation of distances

For every node V the distance between nodes and neighbour are summed and denoted as $P_{V.}$

– Node Expiry Time prediction

The link expiry time is predicted based on current position, mobility and direction of movements of nodes [13]. The prediction method is a linear method, which focus on the physical topology of network.

$$D_t = \frac{-(ab+cd)\pm\sqrt{(a^2+c^2)r^2-(ad-bc)^2}}{a^2+c^2} \quad (1.2)$$

Where D_t is the Link Expiry Time that predicted at time t based on a, b, c, d. Parameter a is calculating based on the current mobility of node and direction of nodes. The nodes have a coordinate (x_i, y_i) and m_i is the current mobility of node. If link is between node i and j then value of :

$$a = m_i \cos \emptyset_i - m_i \cos \emptyset_j \quad (1.3)$$

$$b = x_i - y_i \quad (1.4)$$

$$c = m_i \sin \emptyset_i - m_i \sin \emptyset_i \quad (1.5)$$

$$d = x_j - y_j \quad (1.6)$$

r = Transmission range

The Link Expiry time is predicted for every links from every node in a cluster and summation of expiry time is calculated (D_V) for every single node in the cluster. If the value is small the links that related with nodes are weak and node's mobility with respect to its neighbour nodes are high. The elected CH should have maximum efficient links associated which increase the stability of each cluster.

According to above parameters a weight value is calculated for every node and define the roles of nodes.

$$W_V = C_1{*}D_V+C_2{*}M_V+C_3{*}E_V+C_4{*}P_V+ C_5{*}\, D_V \quad (1.7)$$

Where C_1, C_2, C_3, C_4 and C_5 are the fixed factors that are predefined.

$$C_1+C_2+C_3+C_4+C_5= 1 \quad (1.8)$$

C_1, C_2, C_3, C_4 and C_5 are choose based on importance of parameters. If energy value is important then corresponding factor, (C_3) will fix as 0.4. The factors C_2 and C5 are set as 0.2 and remaining factors are adjusted for equating the sum to one by assigning 0.1. The node with least weight value elected as CH. CH should maintain information about cluster members and their priority too. If a node join or leave from cluster, then member list should updated and re-elect a CH.

C. Priority Assignment

Priority is assigned on the basis weight value that calculated for Cluster Head election. Highest priority is indicated by 3 and remaining priorities are 2, 1 and zero. The least weighted node has highest priority value 3. The weight values of nodes in a cluster should arranged in ascending order. The least weight value will come on top of list with a priority 3 and next node has weight value greater than CH with a priority value 2. Priority value 1 is assigned for one more node from weight list. The remaining node has priority value zero. The node with least weight value has highest priority and elected as Cluster Head.

In routing process every nodes are communicating with destination node through CH. The QoS parameter like Bandwidth consumed a lot by CH because of the involvement in multiple communications and load of traffic at CH is large. If multiple communications are there instead of routing only through CH, the nodes with priority 2 and 1 can involve in routing process. This will improve Quality of Servicing extend. Proposed priority assignment will repair route nodes locally.

D. QoS Enabled Routing

Routing process is carried through elected CH and source node send information's to its CH, CH will communicate to Base Station (BS) and BS forward the data to destination's CH further to destination node. This routing reduces the number of intermediate router nodes and resist network from attackers. Inter cluster and intra cluster communication is possible. Improved AODV based routing is used in proposed system that aware about the QoS parameter too. In this system Bandwidth is consider as QoS parameter. User can define the required value of bandwidth and path that satisfying user requirement is chosen for routing purpose. Multiple priority nodes are already selected and any node can select for routing process.

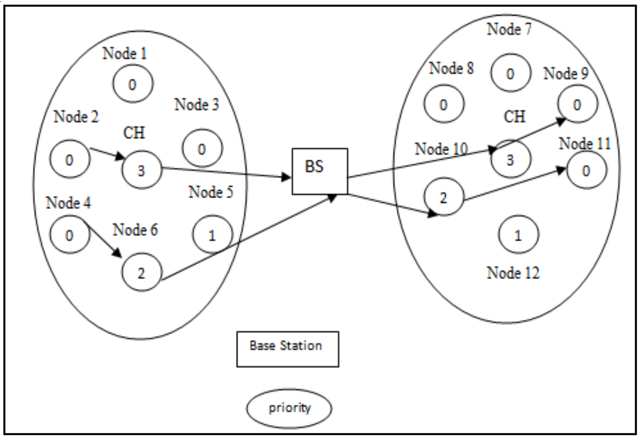

Fig. 1: Inter Cluster Communication

As shown in figure 1 inter cluster communication is take place with the help of cluster heads. In figure node 2 from cluster 1 want to communicate with node 9 in cluster 2. Node 2 communicates with its cluster head, which has priority value 3, and it forward to base station. Base station will communicate to destination node cluster head and it forwards the data to destination node 9. If multiple communications are there then bandwidth that utilized by cluster head will be large and QoS level produced for user will be less. For avoiding this next high priority node (priority is 2) can be select as s router node to communicate with base station. In basic AODV, routing protocol RREQ packet and RREP packet are used, where in proposed system the packets are modified with additional field of bandwidth. Minimum bandwidth that available for the link is inserted in bandwidth field. Before forwarding the RREQ, the intermediate node compares the available bandwidth with bandwidth field in RREQ. If the available bandwidth is larger the packet will forwarded by intermediate node (CH). If the value of bandwidth is less, then packet will forward to next high priority node. In RREP packet, the destination node set the bandwidth field as infinity and intermediate nodes compares its available capacity and bandwidth field in RREP and updates its RREP field with minimum of two. RREP packet reached at source node indicates the bandwidth that available for corresponding routing path.

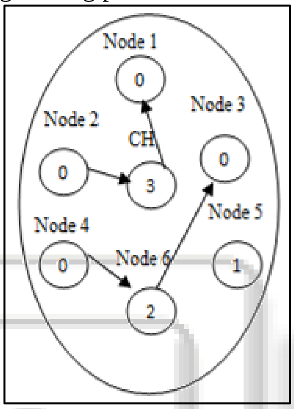

Fig. 2: Intra Cluster Communication

In intra cluster commination the source node and destination, nodes are come under same cluster. As shown in figure 2 node 2 want to communicate with node 1 and intermediate node is Cluster Head. Similarly, node 4 communicates with node 3through next high priority node 6. So the bandwidth is utilized in an efficient manner. Each cluster head and high priority nodes know about member nodes in cluster and their priority values. If both of high priority node get failed re-assignment of priority needs to take place. So the weight value should update.

E. Local Route Repairing

In basic AODV when an intermediate node gets failed, neighbour node sends a RERR message to its neighbours. Source node gain send RREQ packet for finding an alternative path, which increase the routing overhead, and bandwidth consumption. The proposed system is in cooperating a local route repairing method.

If cluster head get failed due to drainage of battery power, the routing path gets failed. Node with zero priority can communicate with high priority node. If both nodes with priority value 2 and 1 are busy in their communication, still node send packets to high priority node, which may work initially. As much the bandwidth get reduced the QoS level may compromised.

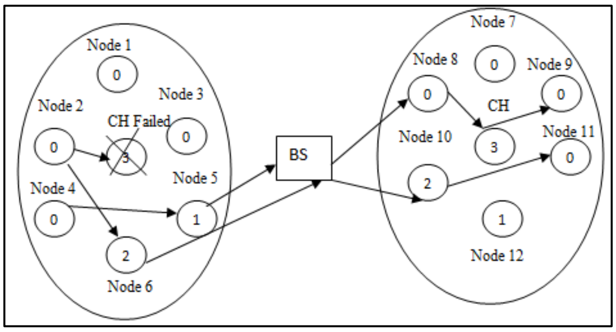

Fig. 3: Local Route Repairing

As shown in figure 3 cluster head of cluster 1 get failed and node 2 transfer the commination to node 6 which has priority 2. Instead of transmitting RERR message to neighbour nodes, Node 2 can directly transmit the message to next high priority node which reduces the routing overhead.

IV. Simulation & Results Analysis

The simulations are performed for comparing the proposed system with AODV [10] and P-AODV [11]. NS2.34 simulator is used for comparing the systems. Proposed system is implemented in AODV routing protocol code of NS2.34. Two-ray propogation model, IEEE standard 802.11 for MAC layer were used in simulation. Network size of 37 nodes those arranged in area of 1200*800.

A. Results Analysis

Different Trace files are generated according to different simulation times (45s-235s). From each Trace files Packet delivery ratio, Routing overhead, Packet drop, End- End delay, Throughput, Jitter were calculated.

1) Packet Delivery Ratio

Packet Delivery Ratio is large for proposed system comparing to existing AODV and P-AODV. In proposed system local route, repairing mechanism is used. Whenever a route node gets failed the alternative router (node with high priority) send the data packet to destination node. So the packet drop can be reduced. In AODV routing when a route node get failed, neighbouring node transmit RERR packet to other nodes in the rouing path. Then source node re-initiate the re-routing process. In P-AODV the routing is done based on the priority. If a node involved in any data transmission then the priority is high, otherwise set low priority for the node. Priority is calculated using overhearing mechanism, which consumes resource like bandwidth and degrades the performance level. This method avoids multiple transmissions on a single node by utilizing priority in routing.

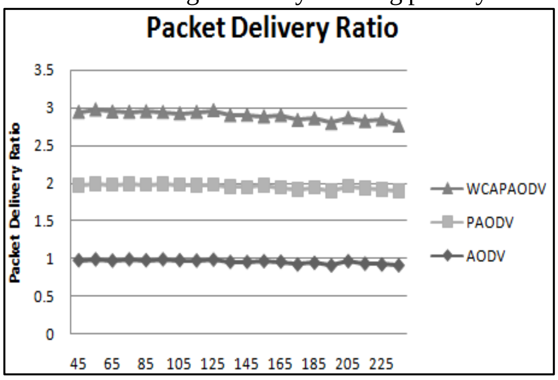

Fig. 4: Packet Delivery Ratio

As shown in figure 4 packet delivery ratio is large for proposed system than existing AODV and P-AODV. The network congestion is large for AODV due to route repairing. P-AODV uses overhearing method for setting priority which reduces the resources available and link get failed easily. So the packet drop can be increased and delivery ratio of packets reduced.

2) Packet Drop

The routing path length of proposed system is small due to clustering and routing take place through cluster heads. The load in network is balanced and resources available are used in efficient manner. So packet drop is reduced in proposed system as shown in figure 5.

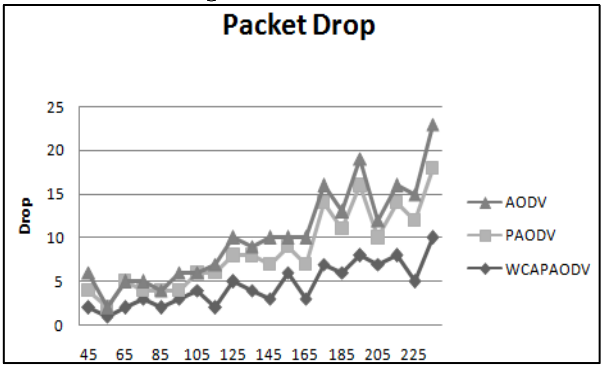

Fig. 5: Packet Drop

3) Packet Jitter

Packet jitter is also known delay variance. The time taken for a packet to reach from source to destination is known as delay. If delay is large, the routing path length is also large and chance of packet drop, link failure, route failure is increased.

In proposed system, a data packet is transmitted through cluster heads. The number of intermediate nodes are less and delay to transmit the packets are increased. I P-AODV routing is done based on the priority value and not considering the shortest distance to reach destination and this may increase the routing path length. The proposed system can provide good QoS level for user with minimum jitter value as shown in figure 6.

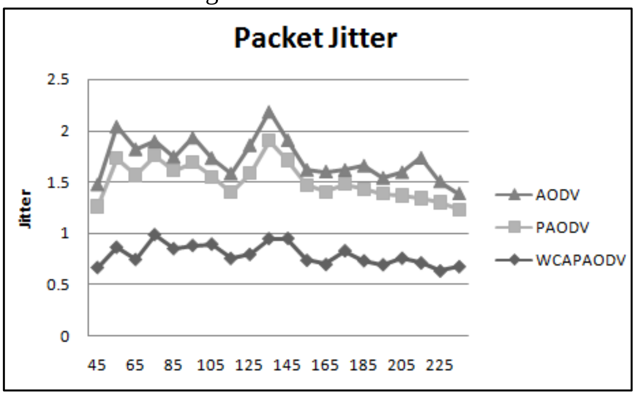

Fig. 6: Packet Jitter

4) End-to-End Delay

The delay taken by a data packet to reach destination node from source is known as end-to-end delay. The time taking process of reroute discoveries and long routes in AODV results high end-to-end delay. In P-AODV, route length is not reduced thereby the delay for transmission is increased.

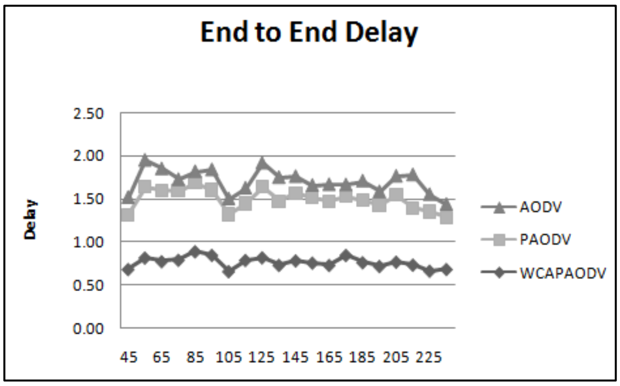

Fig. 7: End-To-End Delay

In proposed system, unnecessary route discoveries are avoided and thereby the delay gets reduced. The routing is occurred through cluster heads.

5) Routing Overhead

The routing overhead is related with routing packets. In basic AODV two control packets are used- RREQ and RREP. If a route node failed in network source node, re-initiate routing process by sending control packets again. This increase the routing overhead. In P-AODV overhead is reduced by assigning priority to each node. For assigning priority, overhearing method is used and consumes resource like bandwidth and link lifetime is reduced. The QoS level acquired by P-AODV is less than proposed system.

In proposed system local route repairing method is used for avoiding unnecessary transmission of control packets. When a route node failed, alternative route node (node with priority 2 or 1) is selected for data transmission from the point of failure.

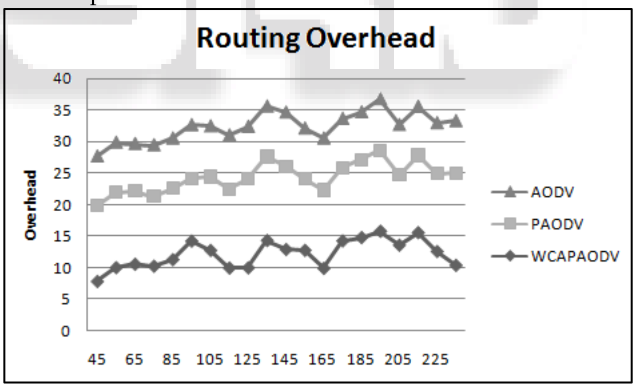

Fig. 8: Routing Overhead

As shown in figure 8 routing overhead is large for AODV and P-AODV compared to proposed system.

6) Throughput

As the congestion in network is increased throughput will decrease. The network congestion is large for AODV comparing to proposed system.

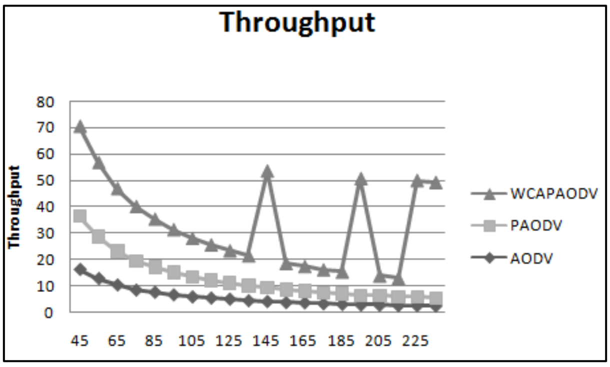

Fig. 9: Throughput

In P-AODV congestion is reduced compared to AODV. The large routing paths in P-AODV degrades the throughput. Proposed mechanism avoids unnecessary reroute discoveries and inherent delays and packets.

V. CONCLUSION

In proposed system AODV routing is improved by weight based clustering technique and priority based routing. A good QoS level is achieved in terms of delay and jitter for user. Major obstacle for acquiring good QoS level are dynamically changing topology of MANETs and lack of centralized coordinator. Those are resisted by utilizing weight based clustering. New route maintenance method is incorporated which use priority factor for finding a new route node locally. Resource like bandwidth is lessly available for MANET and in proposed system bandwidth is utilized in efficient manner by switching routing through high priority nodes instead of only through cluster heads. Link capacity is increased by balancing the load in network. Proposed system also avoids unnecessary packet transmissions by repairing route nodes locally. If a cluster head failed instead of selecting a new head node routing is transmitted to node with next high priority (priority like 2 or 1). According to simulation results proposed system,perform in a better way than existing AODV and P-AODV in terms of Packet Delivery Ratio, Packet Drop, Routing Overhead, Jitter, End-to-End delay and Throughput.

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