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Congestion Control Mechanism using Link Failure Detection in MANET

Abstract

A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using centralized access points, infrastructure, or centralized administration.In these network link failure is the major issue due to the nodes mobility which is one of the reasons behind congestion.The amount of time require to establish the new route have adverse effect on congestion control mechanism,which may be caused by movement of nodes. In addition when mobility speed is high, link failures occur more causing delivery ratio to decrease. So the problem of packet losses and delays can be solved to a certain extent by detecting the link failures. Using this mechanism we can resolves the link failure problem by searching the alternate from nearer to the faulty node by applying ACO. Using this method,the network performance in terms of parameters like end to end delay,packet delivery ratio and normalized routing overhead parameters can be improved.It is evident from the results that this protocol improves the congestion control mechanism in MANET with respect to increase in node density and node mobility.

Keywords: *MANET, Routing, Congestion , Pheromone*

1. INTRODUCTION

A mobile adhoc network is an autonomous system of mobile hosts connected by wireless links. The users wanting to communicate with each other form a temporary network, without any form of centralized administration. The biggest challenge in MANETs is to find a path between communicating nodes, that is, the MANET routing problem. The considerations of the MANET environment and the nature of the mobile nodes create further complications which results in the need to develop special routing algorithms to meet these challenges.

Congestion leads to packet losses and bandwidth degradation, and wastes time and energy on congestion recovery. Congestion control methods can be deployed on routers or node. In existing methodologies, the source is told about the congestion so that, either it may pacify the packet transmission rate or find an alternative path to reach the destination.

2. ANT COLONY OPTIMIZATION(ACO)

Ant Colony Algorithm has been used in Mobile Network since long because of isomorphism between them. ACO (Ant colony optimization) is used in the process of route discovery and load balancing only, but it will be used in case of link failure. Routing table at each will collect additional information of the next to next node. In case of link failure an alternate route for next to next node can be searched by applying ACO. Probably overhead parameter will also improve as control packets used in this case are only forward ants and backward ants. On the other hand control packets transmitted in pure AODV are RERR and R-RREQ (RREQ in case of route failure) will reduce.

Algorithm is based on two types of ant like structure, forward ant and backward ant .The working process of these ants is shown in fig.1 and fig.2.

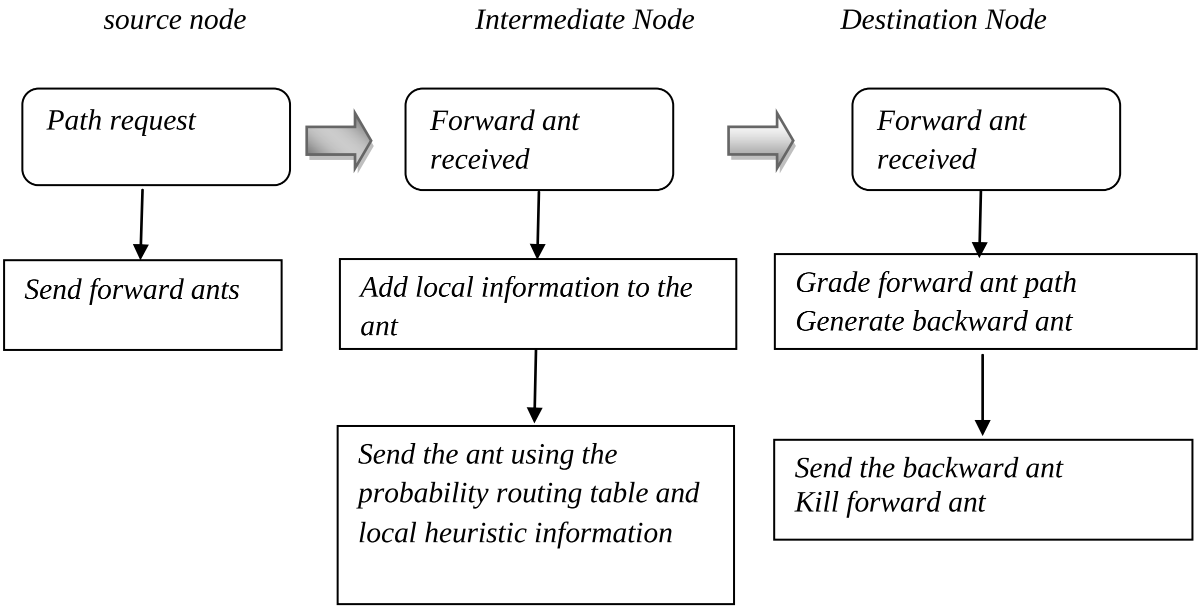


Fig 1: Working of Forward ant

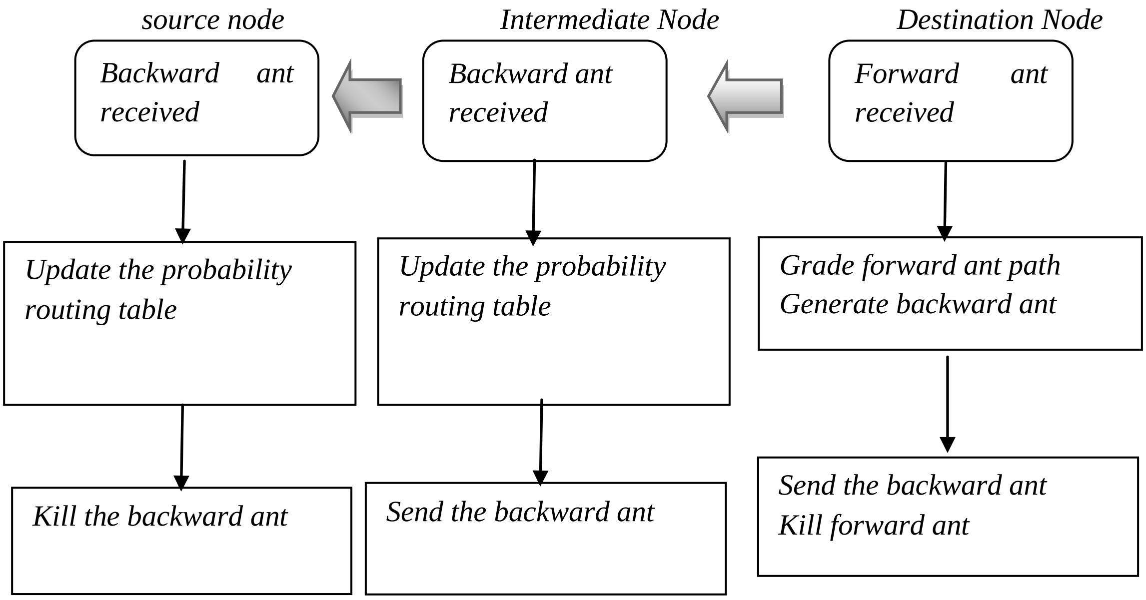


Fig 2: Working of Backward ant

Step 1: When a node enters in the network, it indicates its presence by the exchanging Hello message from other nodes in the network. Each active node periodically broadcasts a Hello message that all its neighbors received. If a node fails to receive several Hello messages from a neighbor, a link break is detected. Hello messages are used to detect and monitor links to neighbors.

Step 2: When data transmission is required from a source to a particular destination the source node broadcasts a Route Request (RREQ) for that destination. The following cases are possible, if the destination is previously unknown to the source or if the previously valid route to the destination expires or is marked as invalid.

An intermediate node creates a route to source, when a RREQ is received. If the receiving node has not received this RREQ before, is not the destination and does not have a current route to the destination, it rebroadcasts the RREQ.

Step 3: Route Reply (RREP) is generated if the receiving node is the destination node or has a current route to the destination node. RREP is unicast in a hop-by-hop fashion to the source node. As the RREP propagates, each intermediate node creates a route to the destination. When the source receives the RREP, it records the route to the destination.

Step 4: Source begin sending data through the available valid route. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. During the transmission route table at each node is maintained by updating the timer associated with the route from source to destination.

Step 6: Neighbor detection: All the neighbors of a particular node are exchanging hello message. Each node in the network is aware about its surrounding nodes.

Step 7: Routing table Management: In this algorithm routing table will have one additional column. This column will have IP address of next to next node in the active link, which is modified by RREP packet. RREP has information about all nodes present in the link i.e. generated by destination.

Step 8: Ant-agent generation: Two types of artificial ant are generated, forward ant (F-ANT) and backward ant (B-ANT), which is utilizes to accomplish the route maintenance. The node in a MANET that employs this algorithm broadcast forward ants toward the destination. As each forward ant moves toward the destination, it constructs a route from the visited node to the source node. A route is indicated by a positive pheromone value in the intermediate nodes' routing tables. When the forward ant reaches the destination, it creates the backward ant and sends it back to the source node in order to construct the correct forward route.

Superiority and inferiority are determined by the pheromone values that are computed based on the number of hops of the route. F-ANT is in charge of establishing the pheromone routes from source node to its destination node. At the same time, the pheromone routes from a destination to source node are created by B-ANT.

The formats of them are as follows:

F-ANT<node address, Sequence, number (Sn), Destination address, route records (dynamically increasing list, including the intermediate nodes which F-ANT passed through and the corresponding arriving time), Hop count (Hc)>

B-ANT< node address, Destination address (the Source address of corresponding F-ANT), dynamical route records (its meaning same as in FANT), Sequence number (Sn)>

Step 9: Transition probability: The transition probability from node i to node j for the kth ant as

$$P_{ij}^{k}(t) = \frac{\tau_{i,j}^{\alpha} \ \eta_{i,j}^{\beta}}{\sum_{k \epsilon N\ (s^p)} \tau_{i,j}^{\alpha}\, \eta_{i,j}^{\beta}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where τ_{ij}^{α} and η_{ij}^{β} are respectively the pheromone value and the heuristic value associated with the component. While $k \in N(s^p)$ is the set of nodes which have yet not been visited by ant k .Furthermore, α and β are positive real parameters whose values determine the relative importance of pheromone versus heuristic information.

Step 10: Trail intensity: The trail intensity is updated according to the following formula

$$\tau_{ij}(t) = (1-\rho)\, \tau_{ij}(t) + \Delta\, \tau_{ij}(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$\Delta\tau_{i,j}\ (t) = \begin{cases} \frac{1}{L_k}, & where \quad L_k \quad is\ the\ number\ of\ nodes\ visited\ by\ the\ \text{kth ant} \\ 0, & otherwise \end{cases}$$

Where the amount of evaporation ρ is a value between 0 and 1. And the value of $\Delta\ \tau_{ij}(t)$ is between $1/\ L_k$ and 0, where L_k is the number of nodes visited by the k^{th} ant.

3. RESULTS AND DISCUSSIONS

The investigation has been carried out by mainly considering the following three different scenarios:

1. The packet delivery ratio: The ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination. (∑ Number of packet receive / ∑ Number of packet send)

2. The average end-to end delay : The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.(∑ (arrive time – send time) / ∑ Number of connections)

3. The normalized routing overhead : Routing overhead is calculated as sum of the route request, route reply and route error packets used for route discovery and maintenance.

The following table gives the details of the simulation environment and the input given to the system for different scenarios like static random and mobile random topologies.

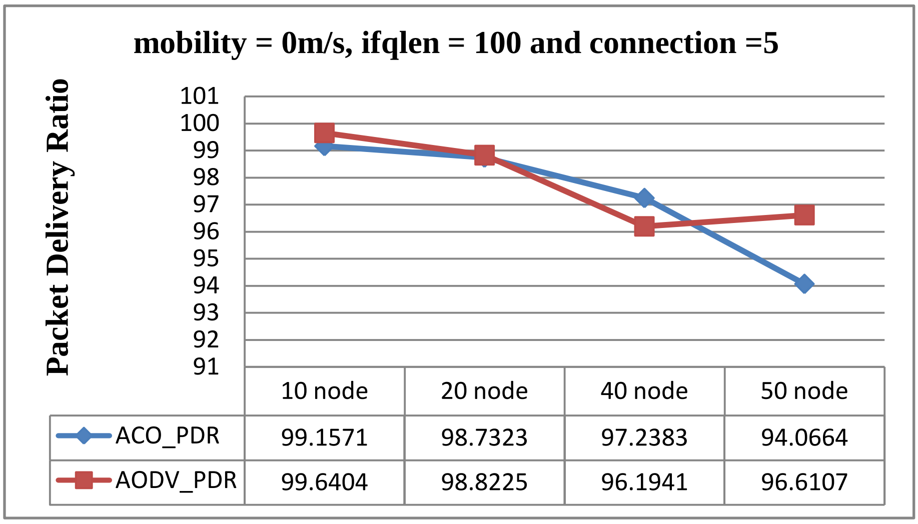
Table 1: Simulation Configuration

Sr.No	*Parameters*	*Value*
1	*Simulator*	*NS 2.34*
2	*MAC Type*	*802.11*
3	*Transmission Range of a node*	*250 m*
4	*Interferance Range of a node*	*500 m*
5	*Channel Type*	*Wireless Channel*
6	*Routing Protocol*	*AODV, ACO*
7	*Antenna Model*	*Omni*
8	*Simulation Area*	*1000 m X 1000 m*
9	*Traffic Type*	*CBR / TCP*
10	*Data Payload*	*512 Bytes/Packet*
11	*Network Loads*	*50,100 Packet/Sec*
12	*Simulation Time*	*100 Sec*

4. PERFORMANCE ANALYSIS

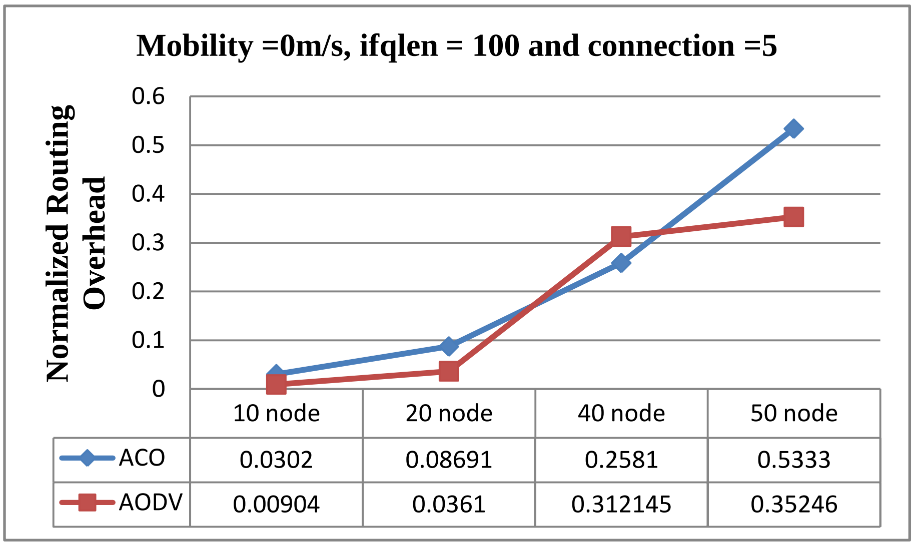
4.1.Performance comparison for Static Scenario

The performance of the system is analysed by increasing the node density from 10 to 50 nodes and increase in traffic load from one connection to 5 connections.And we consider the interface queue length from 10 to 100.



	10 node	20 node	40 node	50 node
ACO_PDR	99.1571	98.7323	97.2383	94.0664
AODV_PDR	99.6404	98.8225	96.1941	96.6107

Fig 1(a) : NO OF NODES Vs PDR for static scenario



	10 node	20 node	40 node	50 node
ACO	0.0302	0.08691	0.2581	0.5333
AODV	0.00904	0.0361	0.312145	0.35246

Fig 2(b) : NO OF NODES Vs NRO for static scenario

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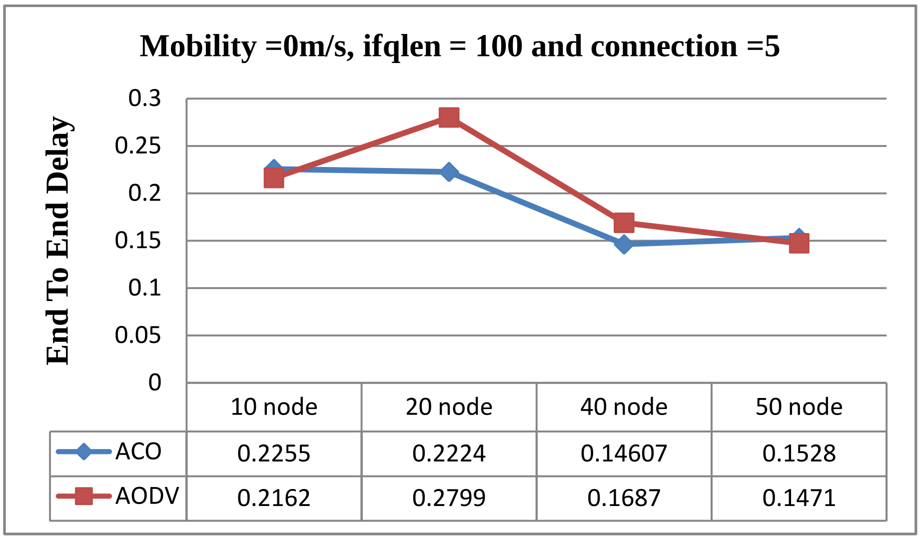


Fig 3 (c) : NO OF NODES Vs E2E for static scenario

The Fig (a),(b) and (c) shows the comparison between the two protocols AODV and ACO by increasing the node density from 10 to 50 nodes.It shows that ,normalized routing overhead is high in AODV protocol , end to end delay is lower in ACO protocol and packet delivery ratio is slightly lower than AODV protocol.

4.2.Performance comparison for Random Topology

The following figures shows the various scenario of the protocol by considering the mobility as 10 and 25 m/sec.

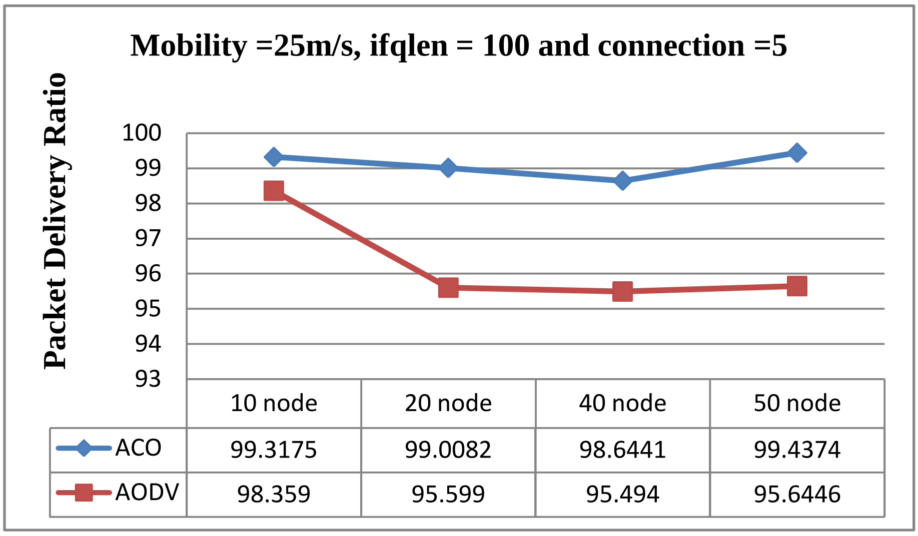
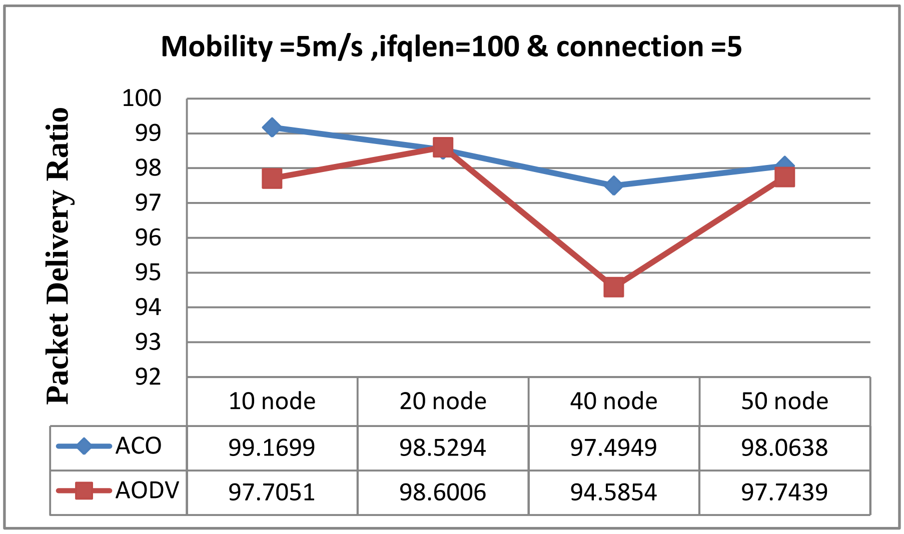
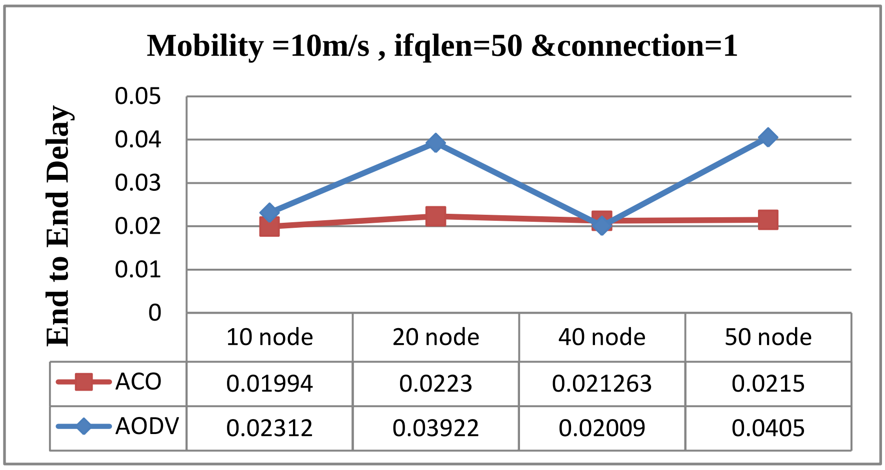


Fig.4(a) : NO OF NODES Vs PDR for Random scenario



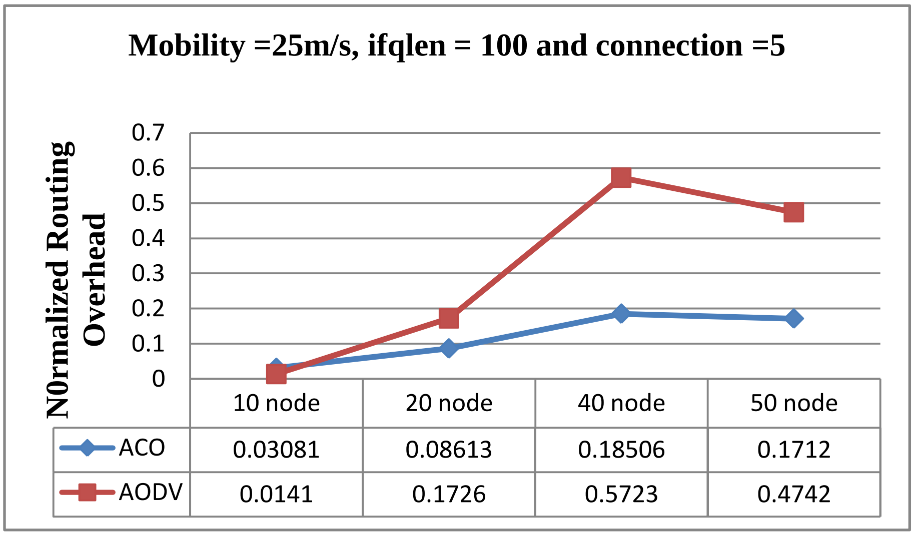
	10 node	20 node	40 node	50 node
ACO	99.1699	98.5294	97.4949	98.0638
AODV	97.7051	98.6006	94.5854	97.7439

Fig.4(b) : NO OF NODES Vs PDR for Random scenario



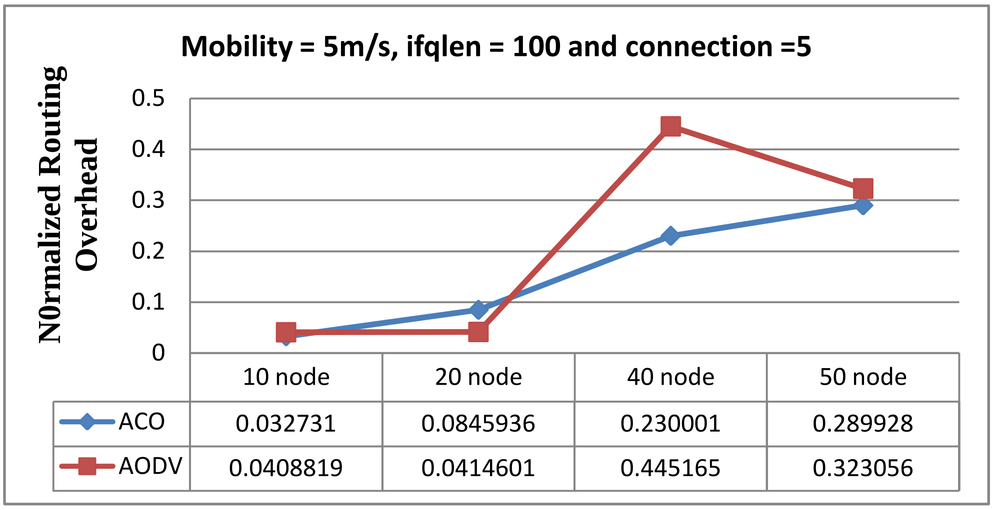
	10 node	20 node	40 node	50 node
ACO	0.01994	0.0223	0.021263	0.0215
AODV	0.02312	0.03922	0.02009	0.0405

Fig.5 : NO OF NODES Vs End_To_End Delay for Random scenario



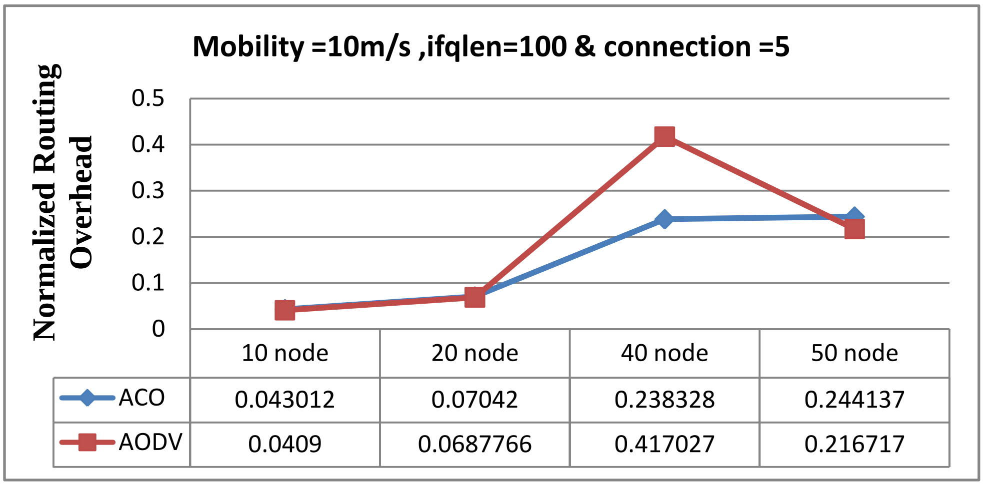
	10 node	20 node	40 node	50 node
ACO	0.03081	0.08613	0.18506	0.1712
AODV	0.0141	0.1726	0.5723	0.4742

Fig.6 (a): NO OF NODES Vs NRO for Random scenario



	10 node	20 node	40 node	50 node
ACO	0.032731	0.0845936	0.230001	0.289928
AODV	0.0408819	0.0414601	0.445165	0.323056

Fig.6 (b) : NO OF NODES Vs NRO for Random scenario



	10 node	20 node	40 node	50 node
ACO	0.043012	0.07042	0.238328	0.244137
AODV	0.0409	0.0687766	0.417027	0.216717

Fig.6 (c) : NO OF NODES Vs NRO for Random scenario

The Figure (a),(b) and (c) shows the scenario of the comparison between the two protocols AODV and ACO by increasing the node density from 10 node to 50 node.

It shows that normalized routing overhead is low in ACO ,end to end delay is higher in AODV protocol and ACO gives the highest packet delivery ratio as compared to AODV

5.CONCLUSIONS

Congestion control mechanisms discussed so far have their own pros and cons along with its complexities .In traditional mobile and wired-network routing algorithms, a change of path occurs in one of two cases: (i) a link along the path fails (ii) a shorter path is found. A link failure is costly since: (i) multiple retransmissions/timeouts are required to detect the failure.(ii) a new path has to be found and used (in on-demand routing).

In MANET, routes may fail due to failure of links that may be caused by movement of nodes. In addition when mobility speed is high, link failures occur more causing delivery ratio to decrease.

So the problem of packet losses and delays can be solved to a certain extent by detecting the link failures. Packet delivery failures due to wireless link collisions may incur unnecessary route reestablishments from the source node. Thus this type of route reestablishment can be prevented if there exists a mechanism different mechanisms for the link failure detection by using alternate route finding from the nearer of the faulty node resulting into improvement in throughput and end to end delay parameters.

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