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RELATIVE CONNECTIVITY AND LINK STABILITY BASED ROUTING PROTOCOL FOR MOBILE AD-HOC NETWORKS

P. Gnanasekaran[1] and T. R. Rangaswamy[2]
[1]Department of IT, B. S. AbdurRahman University, Chennai, India
[2]Department of EIE B. S. AbdurRahman University, Chennai, India
E-Mail: gnanamp@yahoo.com

ABSTRACT

In Mobile ad hoc network stability of the path while discovering the route is an important factor to be considered for the data transmission from source to destination. The present requirement is to maintain the QoS and stable route. The main drawback of MANET is instability due to random mobility of nodes. In order to address this problem a route discovery protocol is proposed considering both relative connectivity and link stability. During the route discovery process, the node which has got maximum number inter connectivity among other nodes is selected. Along with relative connectivity, the stability of the route is achieved based on the signal strength of each node. The proposed system is simulated and compared with AODV and PLSRP (the previous work of authors). The results reveal that the proposed protocol improves the performance when compared to existing systems.

Keywords: link stability, relative connectivity, signal strength, routing overhead.

1. INTRODUCTION

The mobile ad hoc network is an infrastructure-less network. This is forming networks with frequently changing topologies. They do not have any centralized server, access points, and fixed base stations. All the mobile nodes in mobile ad hoc networks involve in routing process. All mobile nodes act as routers and cooperative in the discovery and maintenance of routes in the network. However, several mobile nodes are required in such networks for the transmission of data from one node to another, because of the limited wireless transmission range connected with the action of the each mobile node.

Due to the frequently changing topologies, the routes that were once considered to be the best routes may no longer remain the same at a later time instant. This, therefore, requires a continuous re-computation of routes, and there is no permanent convergence to a fixed set of routes in such networks. So, any routing protocol that needs to operate in MANET environments should take these issues into consideration.

In this paper, Relative connectivity and Link Stability based Routing Protocol (RLSRP) for Mobile Ad-hoc Networks along with signal strength selection method is proposed to improve the stability of route in mobile ad hoc network. Since the relative connectivity node plays an important role in delivering broadcast packets to its next relative connectivity nodes as well as to its neighbor nodes. The relative connectivity nodes can work as a hub in the broadcast packet delivery. In the proposed relative connectivity nodes selection method, a node chooses its additional 1-hop relative connectivity nodes so that they can cover the next 2-hop relative connectivity nodes n-times. Thus the protocol well balances the overhead and stability. Further RLSRP not only reduces flooding in ad hoc networks but automatically tries to keep the stability path in order to improve network performance. Simulation results showed that the proposed protocol has a higher packet delivery rate and lower control packets when compared to other routing protocols.

This paper is organized as follow. In Section II, review related works. Section IIIdescribes the proposed RLSRP selection method. Section IV gives the simulation and performance evaluations metrics. Finally, section V concludes.

2. LITERATURE REVIEW

In this section, several methods addressed by researchers for estimating the stability of route in MANETs are presented. To compute the stability, signal strength, nodes movement information and distance between pair of nodes were considered. The stability is a main issue for MANETs to support multimedia applications.

Floriano De Rango*et al* [1] proposed a novel routing protocol able to account for a joint metric of link stability and minimum energy drain rate in mobile ad hoc network (MANET). This protocol was enhanced by the integration of a multi-objective integer linear programming optimization model, whose solution was calculated through the LINGO tool. The main objective was to optimize the routing model within a MANET. The model attempts to minimize simultaneously the energy consumption of the mobile nodes and maximize the link stability of the transmissions, when choosing paths for individual transmissions. AnastasiosGiovanidis*et al* [2] considered two families of success probability functions. The first one is the one-minus-outage probability for the transmission over the channel and the second is the family of functions that take the SINR ratio as argument. A mechanism proposed by Xin Ming Zhang et al [3], was to evaluate the node lifetime and the link lifetime utilizing the dynamic nature, such as the energy drain rate and the relative mobility estimation rate of nodes. Integrating these two performance metrics by using the route lifetime-prediction algorithm, the least dynamic route with the longest lifetime was achieved. The Route Stability in MANETs under the Random Direction Mobility Model by Giovanna Carofiglio al [4] focus on the stability of a

routing path, which is subject to link failures caused by node mobility. The path duration was defined as the time interval from when the route is established until one of the links along the route becomes unavailable. The algorithm by SudipMisra*et al* [5], aimed at the stability of the nodes. Stable nodes, were preferred, for sending acknowledgment. Hence the network traffic reduced, due to less number of transmitted acknowledgments. Shengming Jiang *et al* [6], Discussed critical issues for routing in MANETs to select reliable paths that can last long.The research introduces a prediction-based link availability estimation to quantify the link reliability. This quantity makes use of some instantly available information and also considers the dynamic nature of link status in order to properly reflect the link reliability. Then, this quantity has been further used to develop routing metrics for path selection in terms of path reliability to improve routing performances. In this paper by Yi Xu*et al* [7], three metrics were defined for quantifying network stability in a hierarchical architecture: 1) the cluster lifetime; 2) the intercluster link lifetime; and 3) the end-to-end path lifetime. These three correlated metrics measure different stability aspects of the hierarchical structure. The cluster lifetime indicates how often nodes change their cluster memberships, the inter cluster link lifetime assesses how long neighbor clusters remain connected, and the path lifetime evaluates how stable an end-to-end communication path can be. Study was made to the impact of random node mobility on the architectural stability of hierarchical networks on the cluster lifetime, the intercluster link lifetime, and the path lifetime in a given mobilityenvironment through both analysis and simulations.In this novel path stability computation model by Hui Zhang *et al* [8], the correlation factor is introduced to describe the dependency degree between arbitrary adjacent links. Furthermore, and constructed the dependency structure between adjacent links, and compute the joint stability of adjacent links. Then, the path stability was captured. The approach AbedalmotalebZadin*et al* [9], Discussed with position-based MANETs where, as part of the MANET protocols to maintain nodes' lists of current neighbors, at regular intervals all nodes send HELLO beacon messages containing their ID and current position information to their neighbors. Since the choice of the duration of the HELLO message interval cannot be arbitrary, the interval size is one of the significant issues that needs be investigated further to make communication reliable in MANETs. Studied the effect of varying the length of the time interval on two contrasting types of greedy-based stable routing protocols for MANETs, one using backup paths and the other using a conservative neighborhood range, in terms of the number of control messages exchanged and throughput for the protocols. The Link-Stability and Energy aware Routing protocol proposed by (LAER)Floriano De Rango*et al* [10] was to make a correct balance between link stability and energy efficient.

Even though several methodology adopted by researchers, an efficient and easily implementable protocol is proposed by considering relative connectivity and signal strength of nodes at the time of path discovery process.

3. MATERIALS AND METHODS

The main idea of relative connectivity is to reduce the more number of unwanted re-transmission while broadcasting the message in the network. This method selects less number of mobile node which is used to retransmit a message. Only these nodes forward a broadcast message during the route request process. Thus minimizing the flooding traffic and also reducing the message overhead as compared with AODV and PLSRP.

In this method, each mobile node selects its relative connectivity node among its one hop neighbors. The relative connectivity node covers all one hop and two hop nodes, which satisfies the following condition. (i). Every two hop neighbor node of the mobile node should have a link to the relative connectivity node. Each mobile node maintains the information about the set of neighbor nodes that are selected as its relative connectivity node. All mobile nodes obtain the information from the neighbors by periodic hello messages.

As shown in Figure-1, mobile node that transmits information through hello message and also receive neighbor node list. The source node S is the exchange of hello messages, then would find in mobile nodes 1, 2, 3 and 4 are in the one hop region nodes, and also the mobile nodes 5, 6, 7 and 8 are the two hop region nodes. Since nodes 2 and 3 have more connectivity than nodes 1 and 4. So the source node S selects the nodes 2 and 3 as a relative connectivity node based on Table-1.

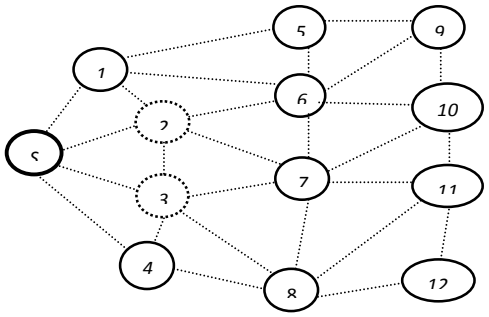

Figure-1. Connectivity of nodes.

Table-1. One hop and two hop list of nodes.

Node	One hop list	Two hop list
1	S,2,5,6,	3,4,7,9,10

Node	One hop list	Two hop list
2	S,1,3,6,7	4,5,8,9,10,11

Node	One hop list	Two hop list
3	S,2,4,7,8	1,6,10,11,12

In this method, each node exchange hello message to their neighbor nodes and receives the

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neighbornode list. In such a way that the one hop neighbor node gets the two hop neighbor node list by exchanging the hello packets. So in this method, each node maintains the two hop list. Hence, it reduces the flooding traffic in the network.

Step 1: (Node S ⟶ RREQ)

Thenodes 1,2,3,4 are the neighboring nodes of node S and the node 5,6,7,8 be the corresponding neighbor node of 1,2,3,4. The source node S starts route request by broadcasting RREQ and receive from each one hop neighbors 1, 2, 3 and 4. After receiving RREQ, each one-hop neighbor node checks whether it is the destination node or not. If it is not a destination, then update the current information of each node. (RREQ – RREP shown in Figure 2 and 3).

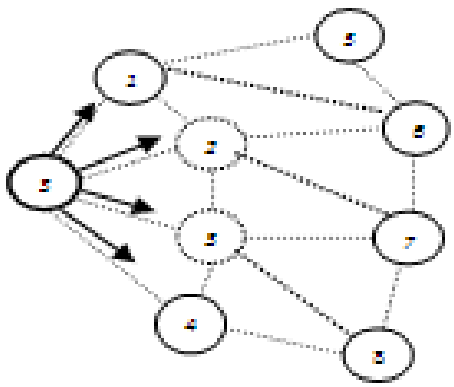

Figure-2. Route request process.

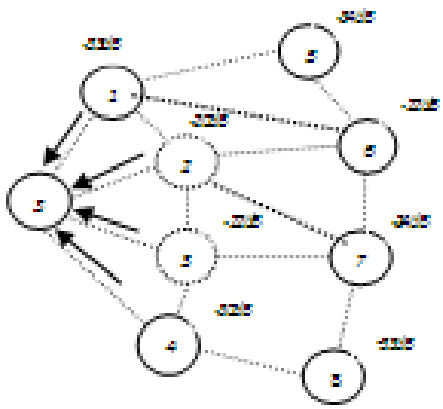

Figure-3. Route reply process.

Step 2: (Node S ⟶ Get signal strength information)

After updating current information about one hop, two hop neighborlist and signal strength in nodes 1,2,3,4 they send a route reply to source node with signal strength and one hop two hop neighbor list as shown in Figure-4 and Table-2.

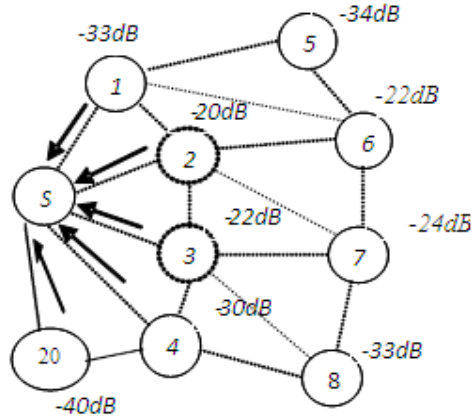

Figure-4. Route reply process

Table-2. Signal strength of nodes 1-20.

Node	Signal strength
1	-33dB
2	-20dB
3	-22dB
4	-30dB
5	-34dB
6	-22dB
7	-24dB
8	-33dB
20	-40dB

Table-3. One hop and two hop neighbor of node 1, 2, 3, 4 and 20.

Node	One hop list	Two hop list
S	1,2,3,4,20	5,6,7,8

Node	One hop list	Two hop list
1	S,2,5,6,	3,4,7,9,10,20

Node	One hop list	Two hop list
2	1,3,6,7	4,5,8,9,10,11,20

Node	One hop list	Two hop list
3	2,4,7,8	1,6,10,11,12,20

Node	One hop list	Two hop list
4	S,3,8,20	1,2,7,11,12

Step 3: (Node S⟶selection of node based on signal strength)

After receiving information from neighbors, the source node compute best fit node according to signal

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strength. The signal strength of each node is tabulated in Table-2. 0 to -35 dB is considered as best signal strength for the proposed method. The source node compare all the signal strength and ignore node 20 because of low signal strength and find out the node 2 and 3 is best fit nodes because the signal strength is -20db and -22dB comparatively -33dB, -30dB and -40 dB of node 1,4 and 20 as shown in Figure-5.

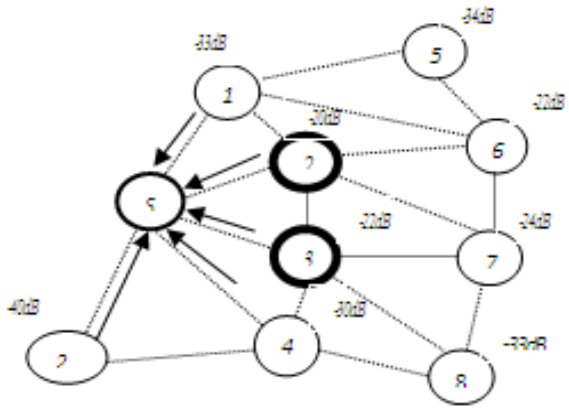

Figure-5. Best fit node selection based on signal strength.

Step 4: (Node S ⟶ selects node based on relative connectivity information)

The relative connectivity of node 2 and 3 is tabulated in Table-4. The source node already selected the nodes 2 and 3 based on signal strength. The source node further compares node 2and 3 based on relative connectivity information of each node. The node 2 consist of the first hop is 1,3,6,7 and second hop is 4, 5, 8, 9,10,11,20. The node 3 consist of the first hop is 2,4,7,8 and second hop is 1, 6, 10,11,12,20.The source nodefind out node 2 as best fit based on relative connectivity information as shown in Figure-6 and Table-4.

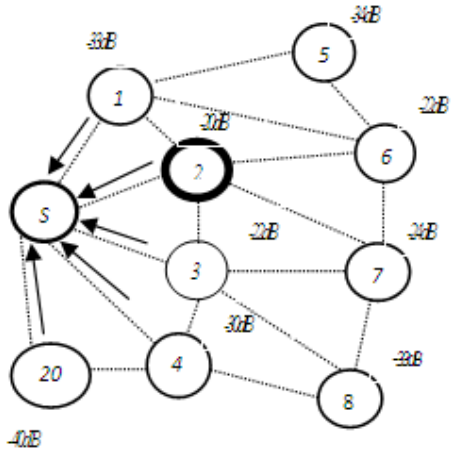

Figure-6. Best fit node selection based on relative connectivity information (Node S ⟶ Node 2).

Table-4. One hop and two hop neighbor of node 2 and 3 and signal strength.

Node	One hop list	Two hop list
2	1,3,6,7	4,5,8,9,10,11,20

Node	One hop list	Two hop list
3	2,4,7,8	1,6,10,11,12,20

Step 5: (Node 2 ⟶ RREQ process)

The node 2 rebroadcast route request packet to its neighbor node such as node 1, 3, 6 and 7. The node 3 and 1 are not considered because already rejected by relative connectivity and signal strength. The node 6 and 7 receive one hop and two hop information by sending hello packet to neighbor.

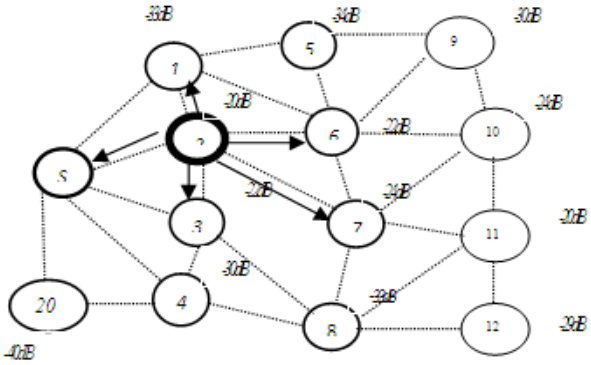

Figure-7. Route request process of node 2.

Step 6: (Node 2 ⟶ selects next neighbor based on signal strength)

The node 6 and 7 after receiving route request packet from node 2 and send a route reply to node 2. The node 2 find out best fit node among 6 and 7 based on good signal strength. The node 6 and 7 having the signal strength -22dB and -24dB.Hence, the node 2 select node 6 and 7 as best fit node. (Figure-8, Table-5)

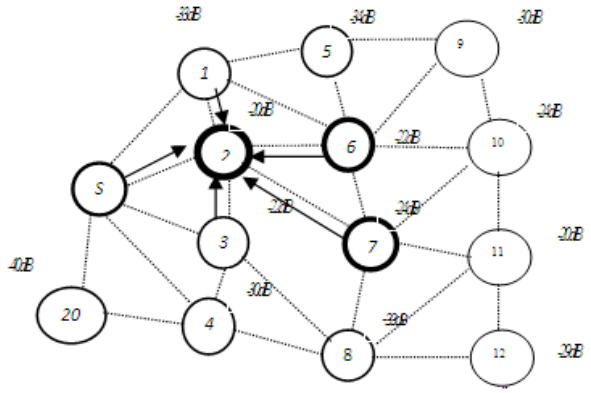

Figure-8. Best fit node selection based on signal strength information (node ⟶ 6, 7).

Table-5. One hop and two hop neighbor of node 6 and 7.

Node	One hop list	Two hop list

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6	1,2,5,7,9,10	S,3,8,11,13,14

Node	One hop list	Two hop list
7	2,3,6,8,10,11	S,1,4,5,9,12,14,15

Node	Signal strength
5	-34dB
6	-22dB
7	-24dB
8	-33dB
20	-40dB

Step 7: (Node2 ⟶ selects node based on relative connectivity information)

The node 2 select the node 7 as the best fit node based on relative connectivity information as shown in Table-5.

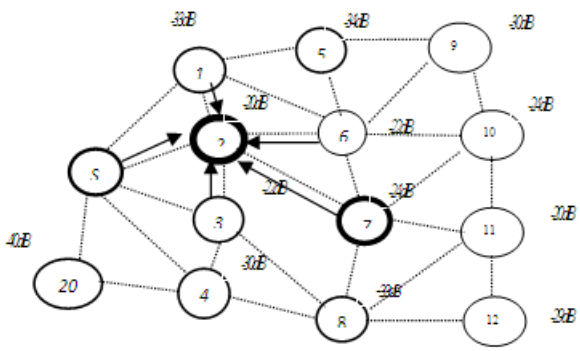

Figure-9. Best fit node selection based on relative connectivity information (node2⟶).

Table-6. One hop and two hop neighbor of node 10 and 11.

Node	One hop list	Two hop list
10	6,7,9,11,14	1,2,3,5,8,12,13,15,17,18

Node	One hop list	Two hop list
11	7,8,10,12,14,15	2,3,4,6,9,13,16,17,18

The sequence continued as node 7 selects node 11,node 11 selects node 14, node 14 selects node 18, node 18 selects destination node D, over all route map is shown Figure-10. The route discovery process is computed as

S ⟶ 2 ⟶ 7 ⟶ 11 ⟶ 14 ⟶ 18 ⟶ D.

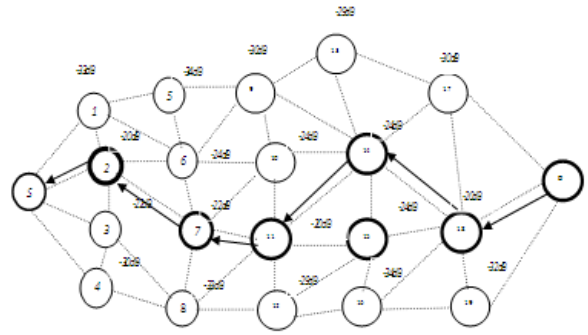

Figure-10. Stable route based on signal strength and relative connectivity.

The route is discovered based on signal strength and relative connectivity information. Hence it is considered as stable route.

4. RESULT AND DICUSSIONS

The performance of the proposed Relative connectivity and Link Stability based Routing protocol for a Mobile ad-hoc network (RLSRP) was compared with AODV and Relative Link and Path Stability based Routing Protocol for Mobile Ad-hoc Networks (RLPSR) by using ns-2 simulator. The simulation parameters presented in Table-9.

Table-7. Simulation parameters values.

Simulation parameter	Value
Simulator	NS-2
Transmission range	250 meters
Mobility model	Random way point
Propagation model	Two ray ground reflection model
MAC protocol	IEEE802.11
MAC queue size	50
Antenna model	Omni-Antenna
ss_threshold_low	-35 dBm
threshold_high	0 dBm
Pause time	0 sec
Bandwidth	2 Mbps
Interface queue length	50
Packet size	512 byte
Traffic type	CBR
Packet rate	4 packets/sec
Terrain range	500 x 500 m
Number of nodes	40 - 120
Simulation time	900 sec
Waiting time	Default*3

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To compute the link stability based on received signal strength parameter, a two ray ground reflection model used in ns2. This model provides the details of the received signal strength values. The good signal strength means, the received signal strength value closer to zero. The weak signal strength means, the received signal strength value closer to -35dBm considered for the proposed system.

The following performance measures are considered through simulation study.

Retransmission rate

The performance of the retransmission rate at various mobility speed in shown in Figure-11. It is observed that the proposed RLSRP protocol has a low retransmission rate than other scheme RLPSR and AODV. Because of consider both signal strength and relative connectivity information.

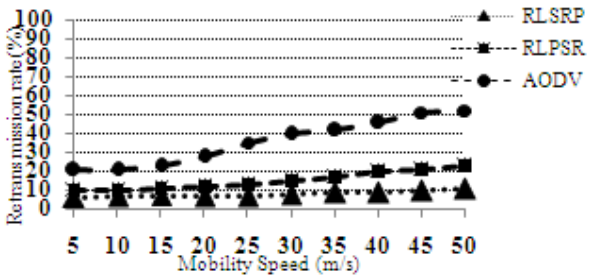

Figure-11. Retransmission rate vs. mobility speeds.

Figure-12 depicts the comparison of the retransmission rate with respect to number of nodes. RLSRP scheme has low retransmission rate. When the number of nodes is high, there is a greater chance of route break. In addition, the number of retransmission rate increases. RLSRP scheme has reduced transmission rate.

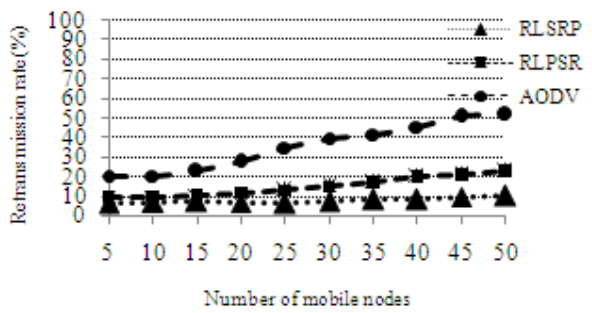

Figure-12. Retransmission rate vs. Number of mobile nodes.

Packet delivery ratio

Figure-13 illustrates the performance of the packet delivery ratio under various mobility speeds. RLSRP scheme has higher packet delivery ratios than the other schemes. When the mobility speed is high, there is probability of RLSRP scheme high packet delivery ratios in a high mobility environment because the stability considered through signal strength and relative connectivity information.

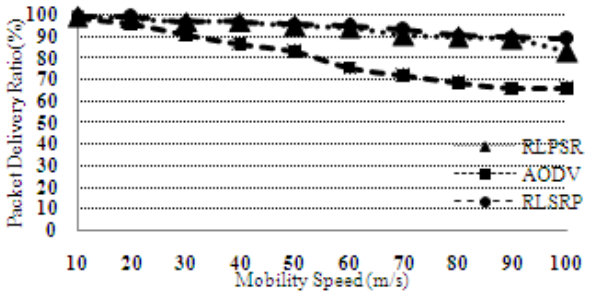

Figure-13. Packet delivery ratio vs. mobility speeds.

Figure-14 depicts the comparison of the packet delivery ratio and various number of node scenarios. RLSRP scheme has high packet delivery ratio when compared to other schemes due to discarding of nodes beyond -35 dB and selection of nodes based on relative connectivity information.

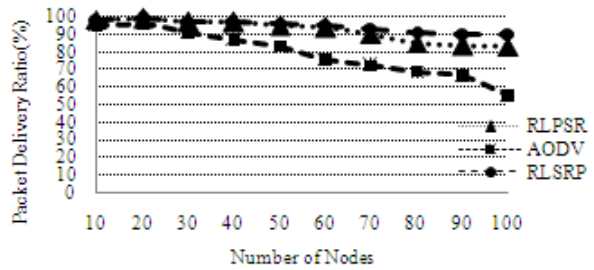

Figure-14. Packet delivery ratio vs. Number of mobile nodes.

Average end to end delay

In Figure-15, the performance of the average end-to-end delay is shown at various mobility speeds. RLSRP scheme has low end-to-end delay because it has a more stable routing path from the source node to the destination node, when compared to other schemes.

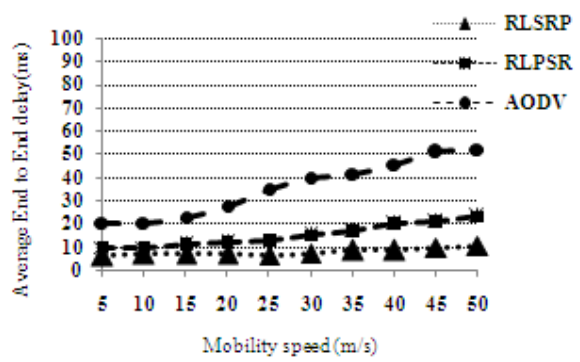

Figure-15. Average end to end delay vs. mobility speed (m/s).

Figure-16, presents the performance of the Average End to End delay at various number nodes consider. RLSRP scheme has a low End to End delay, because it uses the stable route.

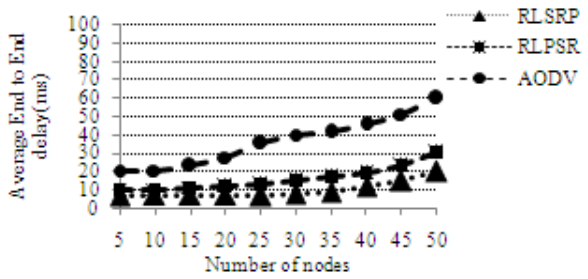

Figure-16. Average end to end delay vs. number ofnedes.

5. CONCLUSIONS

The link stability of the proposed protocol during route discovery process is achieved by selecting the nodes which has got efficient signal strength and more number of connectivity with neighbor node. Performance of the proposed Relative connectivity and Link Stability based Routing protocol for a Mobile ad-hoc network (RLSRP) was compared with existing protocols. From the simulation, it was observed that the retransmission rate is reduced to 10% when compare to AODV. The packet delivery ratio is reduced to 10%, when compared to AODV. Average end to end delay reduced to 10ms when compared with AODV. Performance result shows superiority of the proposed scheme when compared with existing system.

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