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Cluster based Multicast Adhoc on Demand Routing Protocol for Increasing Link Stability in Manets

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Keywords: link stability, node stability; multicast routing; mobile adhoc network.

I. Introduction

Mobile Adhoc networks (MANET) are collections of wireless mobile devices, which can communicate with each other without any infrastructure support. It is denoted as self-configured and self-maintained network. Every node in MANET acts as both the host and a router and it communicate with each other without the support of any fixed centralized control. In MANET, the mobile nodes are interconnected by multi-hop wireless links in a dispersed manner [1]. The design of MANET routing protocol vary from wired network routing protocol; since a MANET is categorized by node mobility, node link unreliability, limited energy, limited bandwidth, high error rates, and security risk. The essential characteristics needed to design a routing protocol are dynamic topology, limited bandwidth, battery, CPU resources and multi-hop communication. There are many routing protocols projected for MANET. Based on the principles of routing, the protocols can be classified either proactive or reactive. Proactive routing protocols use to communicate regularly and update routes for every pair of nodes at every time of period. Every mobile node will operate as a sender, receiver or an intermediate node of the data in the system. Thus system will create the awareness towards the findings to deliver an outstanding merits and flexibility related to bandwidth spatial reuse, intrinsic fault tolerance and low-cost fast distribution [2]. In the network, the each node receives the information from the packet and updates their interpretation by applying a shortest-path algorithm to find the next hop node to reach the endpoint.

The main principle of a MANET routing protocol develop a competent route between the communicating nodes to reach the end point. Thus, the message will deliver on time with less number of packets drops providing stable connectivity with less routing overheads. MANET routing protocol is generally classified into two types. They are table-driven and source-initiated [3]. Table-driven routing protocol sustain with one or more tables at each node to save routing information. This protocol is used when there is a change in network topology in order to propagate the updates throughout the network to maintain a reliable network. Existing table-driven routing protocols include the following routing methods such as DSDV (Destination Sequenced Distance Vector) [4], CGSR (Cluster head Gateway Switch Routing) [5], and WRP (Wireless Routing Protocol) [6]. Source-initiated routing protocols are used when a source node requests for a route. This protocol process is inspected with only the possible routes. For example, source-initiated protocols contain AODV (Ad Hoc on Demand Distance Vector) [7], DSR (Dynamic Source Routing) [8], TORA (Temporally Ordered Routing Algorithm) [9], ABR (Associativity Based Routing) and SSR (Signal Stability Routing) [10], etc.

Link stability rely on wireless link features such as link failures, packet loss rate, channel sensing rate, channel fading rate, bit error rate, band width fluctuations and environmental effects. The wireless channel variation due to the packet loss resulting in link failures and reduces link reliability. Thus, the failure in channel sensing and channel fading increase the errors that

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trigger large dissimilarity in the existing bandwidth. The existing communication systems use checksum and sequence numbering for controlling the errors and some of them use positive recovery of packet retransmission. If checksum technique is not performed in the system then it affects the system performance. Similarly, Route stability relies on the performance of source, destination and intermediate nodes and the wireless channel connecting end-to-end route. When the lifespan of a route decreases, then the probability of end-to-end delivery can be improved with alternate routes between source and destination. Finally, to develop the route stability, there is a necessity to improve the constructed mesh based and multipath routing techniques.

The stability based routing protocols are intended to choose the stable route for passing through the stable links. These link stability and route stability protocols increases the lifetime of routing and the packet delivery. These protocols are compared with the shortest path routing protocols. Since mobile networks are very unstable links and the stability of routes becomes a main objective in the development of a mobile routing protocol. Communication links in Adhoc network are fundamentally unreliable because of their medium characteristics and varying internode distances due to node mobility. This leads to disconnection and result in reconfiguration of communication links. Each reconfiguration needs initiation of route discovery process and is expensive. Reconfiguration also expose to resource-constrained network as mobile devices that constitute MANET have limited resources in terms of computing power, memory, transmission power, and battery life.

A major challenge of MANET is to implement QoS to prevention of attacks, reduction in energy consumption, incorporating fault-tolerance and delay of nodes [12]. The primary objective of this paper is to improve QoS by improving the Priority based Adhoc on Demand Routing Protocol (PAODV) and thus increase the route stability through proper selection of links that are likely to be more stable. Some of the applications of MANET are rescue operations in military battlefield, disaster relief efforts, and audio and video conferencing. This applications needs support of survivable, reliable and efficient communication. Hence, this paper focus on developing a clustering based Priority Adhoc on demand routing protocol for increasing link stability and node stability in MANET.

II. Literature Survey

Currently, there are several new multicast routing protocols are estimate to achieve efficient multicasting in MANET. Some of the routing protocols are Multicast Adhoc On-Demand Vector (MAODV), Adhoc Multicast Routing protocol Utilizing Increasing ID Numbers (AMRIS), Core Assisted Mesh Protocol (CAMP), Location Guided Tree (LGT), Lightweight Adaptive Multicast (LAM), and Differential Destination Multicast (DDM). The above protocols are mainly based on the features of distance vector routing or link-state routing with some benefits to help the routing process in definite ways [13]. Many multicast routing protocols reviewed in [2] which were scheduled to enhance QoS broadly and their behavior were assessed in terms of latency, packet loss ratio, jitter etc. Similarly, the performance in Ad-hoc networks was reviewed in [14]. Collision is a major problem since it results in packet drops, extensive delay of data and queuing of packets. So, the performance of Ad-hoc networks also reduces adversely. Hence, this paper proposed the model framework with the Enhanced Cluster head Gateway Switch Routing Protocol (ECGSR) with the origin of Ad-hoc On-demand Distance Vector Routing (AODV) based technique collision evading. A new AODV routing protocol was presented in [15], to enhance the stable link. In this paper the parameters are used for the establishment of Quality of Service (QoS) by node stability, load stability and least residual distance in order to select the link to the endpoint. The result showed that the proposed protocol enhanced the performance. Thus, the proposed work did not measure the power of the received signal at the endpoint though moving over the route.

Similarly, [16] examined an innovative Enhanced Adhoc On-demand Distance Vector (E-AODV) protocol which is related to AODV. AODV can be modified with reduced end to end delay with enriched packet distribution ratio. The ad hoc networks mainly select AODV protocols as it can deliver low routing overhead with high performance. His study proved that QoS in the MANET has no universally predefined parameters. But it was commonly a well-defined group of service quality which has the necessity to be achieved by the network while transferring a packet stream from a transmitter to its receiver end. The researchers also described that QoS is associated with certain parameters such as throughput, delay, and drop of packets. This would be established and approved by the mark of end user. QoS model also described an architecture that delivered the possible best facility.

Cluster Based Routing Protocol is intended to use in mobile ad hoc network (MANET). In this study, the mobile nodes of the Adhoc network is separated into a number of overlying or disjoints 2-hop distance clusters by the protocol in a dispersed manner [17]. Among the clusters, a cluster head is selected to maintain the information of all the cluster members. By this cluster participation, the information from Inter-cluster routes are projected dynamically and kept at each cluster head. Thus, by using this clustering technique, the flooding traffic between the data communication and the route discovery is competently minimized by the protocol and speeds up this process as well. The MANET network has two main protocols that are Tree-based protocols and mesh based protocols. MAODV and ODMRP (On-Demand Multicast Routing Protocol) are two popular

multicast routing protocols for tree-based and mesh based protocols, respectively.

The performance comparison and study of multicast protocols was reported by [18] which affords a vision into the functionality and presentation. Similarly, [3] justified MAODV as an on-demand routing protocol that determined the route only when a node has something to send. It is a hard state usage of protocol. This study revealed that if a member node of a multicast group needs to terminate its group membership, it must give a request for termination but, when a mobile node wants to join a multicast group or send a message but not having a route to the group, a Route Request (RREQ) was originated. All the nodes that are members of a multicast group and the non-member nodes that are not members of the group but their position are very critical for forwarding the multicast information that compose the tree structure. Every multicast group is recognized by a unique address and group sequence numbers for tracing the newness of the group situation.

In other study [19] examined an ant metaphor in dynamic routing for MANET, where ants spread the gathered data to nearest sources. Thus the dispersed routing system for motor vehicles that direct them through the city using the shortest way in time and the account of load is described. Similarly, a routing protocol based on swarm intelligence by using ants was reported by [20] where ants use heuristics to find the routes in multi-hop ad hoc networks. The other efficient hybrid multicast routing protocol suitable for high mobility applications was presented by [21] that addresses the scalability issue of ODMRP protocol. The data forwarding path and join query forwarding path were separate in this protocol. A routing protocol for MANET named as terminates routing, which has the purpose for keeping the assistance of scalability by considering the location-based routing, irregular topology and node mobility. A Mobility Prediction Aided Dynamic Multicast Routing (MPADMR) algorithm was proposed by [22]. Hence, this algorithm contains two steps, the construction of link lifetime constrained minimum hop count multicast tree and the dynamic multicast tree maintenance procedure.

The other study proved by [23] described multicast protocols performance characterization over a wide range of MANET situations. The performance of mesh and tree-based multicast routing schemes which related to flooding are evaluated and recommend by the protocols which is suitable for specific MANET situations. New algorithm for online multicast routing in ad hoc networks was proposed in [24]. A two level management approach for efficient constructing and maintaining a QoS routing path in ad hoc wireless networks was proposed in [25]. This scheme considerably reduced the quantity of control packets. So, for implementing real-time multicast services, degree constrained QoS aware routing algorithm was given by [26]. This scheme increased the overall performance of application-layer multicast services. Hence, this study proposed the new algorithm to find the clustering based Priority Adhoc on demand routing protocol for increasing link stability and node stability in MANET.

Similarly, the researches [29] established a Quality of Service (QoS) involved multi-cast routing protocol to select reliable neighbor nodes, which is named as QMRPRNS. Compared to other protocols this protocol have better reliability pair factor, hence it is preferable for reliable data transmission. QMRPRNS protocols select the route to transfer the data with more stability, reduced transmission delay. Further, it requires less time to data transmission, and the node failure probability is less due to QMRPRNS reliability pair factoring scheme. Moreover, these nodes have high reliability pair factor and associated with threshold reliability pair factor were designated for data transmission.

III. Existing Protocols

To increase the performance of the MANET, many researchers mainly suggest their view on the route discovery. In MANET the AODV routing protocol is mostly used for path discovery. The AODV routing protocol which creates less reactive routing protocol is used to determine the route after accepting the route request (RREQ) and the communication from the sender node. In this protocol, the route failure in the network was projected by sending the Route Error (RERR) indication message to the source node and it is achieved by the AODV protocol. Then the AODV resends the information's to the receiving node. In MANET system, MAODV is used to multicast the data packets. This multicast protocol creates the multicast group by developing the multicast tree. MAODV is the most effective protocol used for multicasting to provide service quality. The main drawbacks of MAODV and the chief principle of the group is it continuously send the multiple messages even if there is no transmitter, because of which the next sender will get delay and the controversy will be large in MAODV [27]. Metric based enhancement to AODV protocol [12] suggested reducing the link failure by picking the best link. Hence, this protocol accepts the route constancy to reach the endpoints. In order to avoid the overload of the messages due to traffic, the EM-AODV routing protocol supported various links as well as path to the endpoint. When compared with the AODV this protocol provides enhanced performance [28]. The major drawback of reactive routing protocol is the respective route detection methods were not considered with loss of route reply message during data communication which indicates the drop of network efficiency. Hence, [29] QMRPRNS: QoS based multicast routing protocol scheme only used to select reliable neighboring nodes for data transmission.

IV. Proposed Methodology

In this section, Link Stability Based Priority Multicast Adhoc on Demand Routing Protocol (LS PMAODV) using reliable neighboring nodes selection scheme has been proposed.

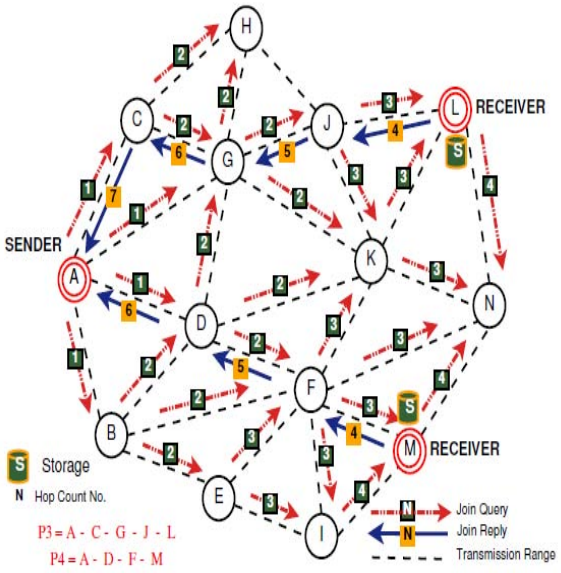

Figure 1: Flow diagram of LS PMAODV

The study deployed few mobile nodes randomly in a specific region which are associated with some initial energy. Here a reliability pair factor (F th RP) = 2.8 is taken as a threshold value. However, in general the value of (F th RP) is application dependent and fixed by the system administrator. Since multicast routing in MANET for a group communication is needed to establish a reliable communication links among the neighbouring nodes.

So in order to overcome the limitations of the MAODV multicast routing protocol, this paper presents a Link Stability based Priority Multicast Adhoc on demand routing protocol. The proposed protocol is processed in several phases such as basic idea formulation, route discovery mechanism, route reply process and route maintenance process.

a) *Proposed Link Stability Based Priority Multicast Adhoc On Demand Routing Protocol*

The flow of LS PMAODV protocol is illustrated in Figure 1. In this topology there is one sender, two receivers M and L (denoted by double ring). In LS PMAODV, forwarding nodes use the shortest path between multicast group members. Red arrow indicates 'JOIN Query' and blue arrow indicates 'JOIN Reply'. Weight on an arrow indicates hop count value for respective link. A link marked with both red and blue arrow is part of a path which returns back to source. Information about other possible paths is not discarded and is used to establish links in event of disconnections induced by mobility. For example, in Figure 1, route (P3) A → C → G → J→ L is established as soon as (P4) A → D → F → M is disrupted because of movement of J. As a result, this mesh structure is more resilient to tree-like topology as there is no requirement to reconfigure the entire route in change of node position.

According to LS PMAODV protocol, minimum hop count is utilized to determine the paths between source and destination nodes. Figure 1 shows paths between source A and destinations L and M is P3 and P4 that obtained from LS PMAODV protocol using minimum hop count while P3 and P4 are shown in Figure 1 using signal strength of nodes. Path P3 has changed from path P4 due to less signal strength of node A as compare to C. But in Path P4 doesn't change to P3 because it's already getting best signal strength.

b) *Link Stability*

Fluctuating link stability induced by mobility and/or medium characteristics in wireless network impacts network performance. Efficiency of a dynamic routing protocol can be characterized by its ability to deal with link unreliability and routing overhead in terms of computation and reconfiguration/ rerouting (Torkestani, 2011).

Using link stability as a basis for routing decision can lead to protocol being,

- *Energy Efficient:* low communication and computation overhead as less number of link breaks reduces number of re-routings.
- *Resilient to Mobility:* links are selected to resist connectivity breaks for longer periods in events of node movements
- *Stable:* same path is sustained for longer duration reducing overhead on routing tables. Link stability can be estimated using parameters such as (1) Signal to interference plus noise ratio, (2) Energy, (3) Link Delay and (4) Bit Error Rate. If node has more energy, it is likely to remain alive for a longer duration and its transmission range is higher.

Less the link delay, smaller is the distance and hence more probability of link remaining intact. Smaller BER means higher bandwidth and better quality of link.

c) *Mathematical modeling of the proposed system*

Link Stability is given by,

$$LS_{i,j} = \frac{v_2 - DSS_{i,j}}{v_2 - v_1} \quad (1)$$

Where, DSS is the differential signal strength. It is computed as follows.

$$DSS_{i,j} = SScur_{i,j} - SSnew_{i,j} \quad (2)$$

Where, SS represents Signal Strength at nodes in the interval i and j.

A path between source and destination is given as

$$P(s,d) = (s, e(s,x), x, e(x,y), y, ..., e(z,d), d) \quad (3)$$

The feasible path is represented by,

$$P(s,d) = P0, P1, ...Pn \quad (4)$$

Here, P is define as the path stability, by the product of link stability of its edges as follows,

$$Stability(P) = \prod_{e \in P} LS(e) \quad (5)$$

Where, LS is the Link Stability.

d) Algorithm of proposed protocol

In this section the algorithms for link stability discovery process and Link stability maintained process are provided.

i. *Algorithm 1 (Link stability discovery process)*

Link stability is estimated for every link routing from source to destination. For the selection of the next hop in establishing a route, link stability is estimated by computing Proposed Link Stability based Priority Multicast Adhoc on demand routing protocol in shortest path process.

1. Begin
2. Initialize $F^{th}_{RP} = 2.8,\ RQ = \{S_{addr}, MC_{addr}, ...\}$ and other fields of the request packet at S.
3. S broadcast the (RQ) packet to its adjacent nodes those are coming in its transmission range.
4. For every packet request (RQ) packet attained at its neighboring node do
5. If there is no neighbor of a particular node which broadcast the packet
6. Go to step 17.
7. Else
8. If F_{RP} (Rec node) $< F^{th}_{RP}$ value then
9. Discard the packet
10. Else
11. Store the request (RQ) packet at received node header and broadcast further across the network.
12. Repeat step 3-13 until destination nodes received the request (RQ) packets.
13. End if
14. End for
15. End

ii. *Algorithm 2 (Link stability maintained process)*

1. Begin
2. If a node N_i send a request (RQ) packet to the node N_j however, the node N_j go out from the transmission range of the node N_i (i.e.) there is no channel exist between the these two nodes then
3. At this stage the node N_i saves the current data packet in its multicast routing information table (MRIT)
4. After channel break down node N_i-1 to repair the path.
5. If the node N_i received the route repair reply (RR_REP) packet return from node N_i-1 within a fixed timeout ($T_{timeout}$). Then
6. The node N_i is ready to send a request packet (RQ) to node N_j.
7. Else
8. The node N_i send a route error (RE) packet to source node S to restart the routing discovery process
9. End if
10. End if
11. End

V. Results and Discussion

The parameters used in stimulation, are shown in Table I.

Table 1: Simulation Senario

Parameters	Values
No of nodes	60
Number of clusters	3
Network size	1000 × 1000 m^2
Node placement	Random
Node mobility	Mobility
MAC layer protocol	IEEE 802.11
Simulation time	100sec
Initial energy	100j

The proposed LS PMAODV protocol and the technique is implemented using Network Simulator 2 (NS-2) software. Generally, NS-2 is the most standard nonspecific network simulator which supports a wide range of protocols in all layers. It uses OTcl as configuration and script interface. NS-2 is the paradigm of reusability. The network size of the proposed simulation model in terrain area is 100 m x 100 m using Adhoc On-Demand Distance Vector (AODV) routing protocol for monitoring the important parameters like Packet Delivery Ratio (PDR), end-to-end Delay, energy consumption, network life time, computation overhead, connectivity, link stability and throughput. The parameters used in stimulation, which are shown in Table 1.

a) Packet delivery ratio

Packet Delivery Ratio is defined as the ratio of aggregate number of data packet that is successfully delivered to the aggregate number of data packet sent. Fig.2 shows the packet delivery ratio for different number of nodes. It is clearly evident the proposed approach achieves high packet delivery ratio than other protocols. Fig.3 shows the packet delivery ratio for varied speed. The proposed protocol LS PMAODV has high packet delivery ratio when compared to other protocols.

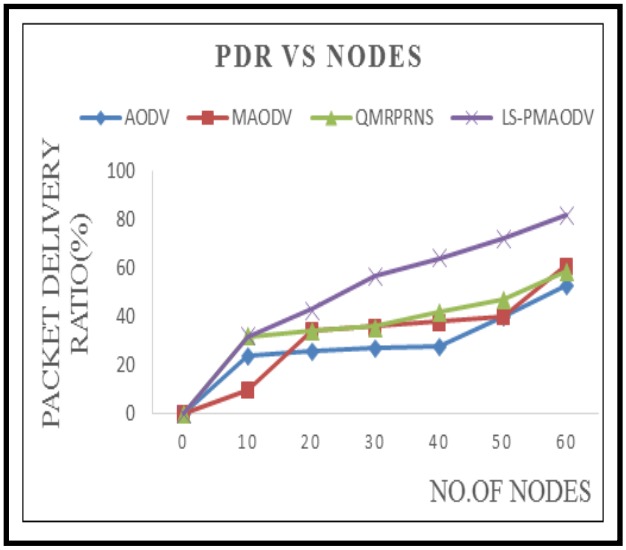

Figure 2: Packet Delivery Ratio Vs Node

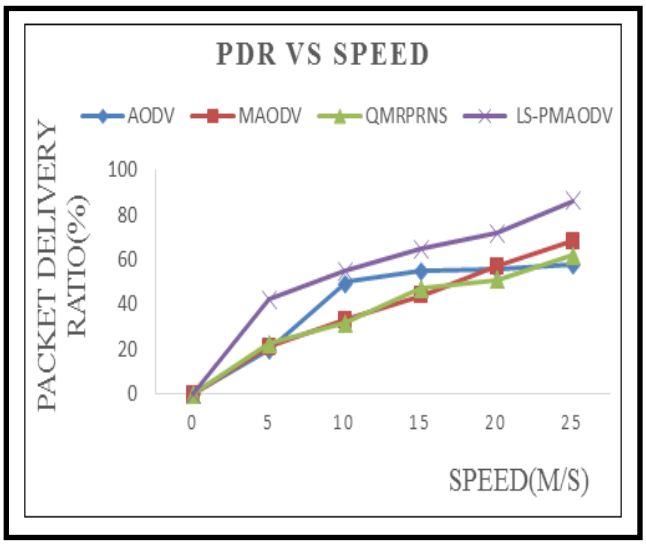

Figure 3: Packet Delivery Ratio Vs Speed

b) End-to-End Delay

End-to-End Delay of data packets is calculated as the time it takes to transmit data packets from the source to the destination. Low end-to-end delay is preferred for better application execution. Fig.4 shows the end-to-end delay for different number of nodes. It is clearly evident the proposed approach provides less end-to-end delay than other protocols. From Fig 5, it is obvious that the LS PMAODV has lower end-to-end delay for different node speed. Furthermore, LS PMAODV achieves lower end-to-end delay than AODV, MAODV and QMRPRNS.

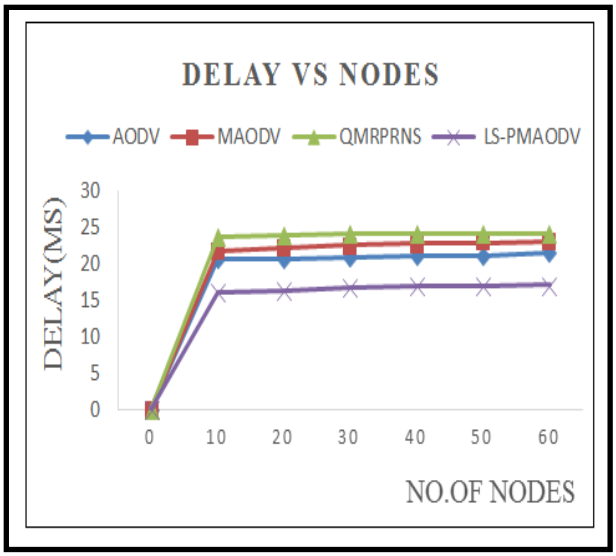

Figure 4: End-to-End Delay Vs Node

c) Energy Consumption

The energy consumption is the total of utilized energy of the considerable number of nodes in the system, where the energy is utilized due to transmitting (P_t), reception (P_r), and initialization (Pi). Accepting every transmission expends a vitality unit, the aggregate energy utilization is proportional to the aggregate number of parcels sent in the system.

Fig.6 shows the energy consumption for different number of nodes. It is clearly evident the proposed approach has less energy consumption than other protocols. From Fig 7, it is obvious that the LS PMAODV has less energy consumption for different speed when compared to other existing protocols.

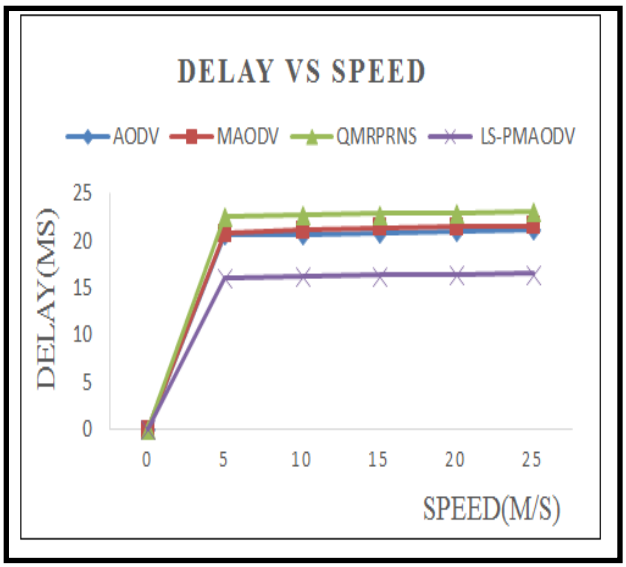

Figure 5: End-to-End Delay Vs Speed

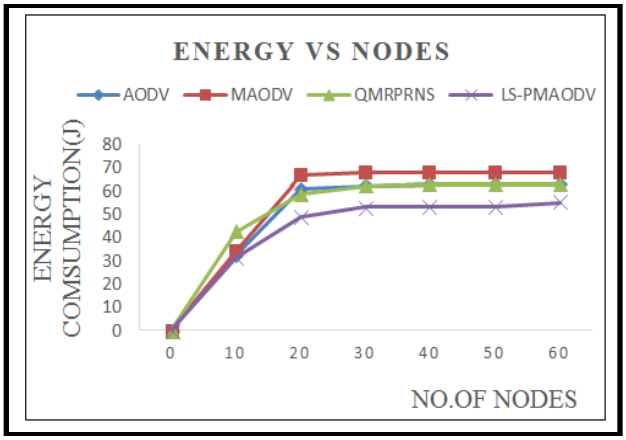

Figure 6: Energy Consumption Vs Node

d) Network lifetime

Network lifetimes determine the interval between the start of a packet transmission of the network till the first node fails due to battery depletion. Fig. 8 depicts the lifetime of nodes for different number of nodes It is obvious that the proposed method results in longer node life time when compare to other existing methods. Fig. 9 depicts lifetime of nodes for different speed. It reveals that LS PMAODV increases the node lifetime than other methods.

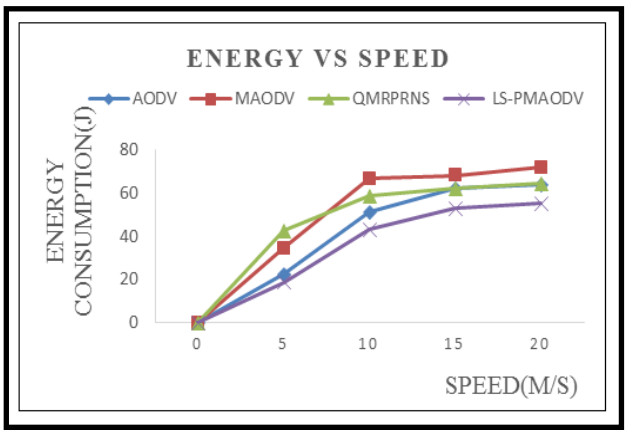

Figure 7: Energy Consumption Vs Speed

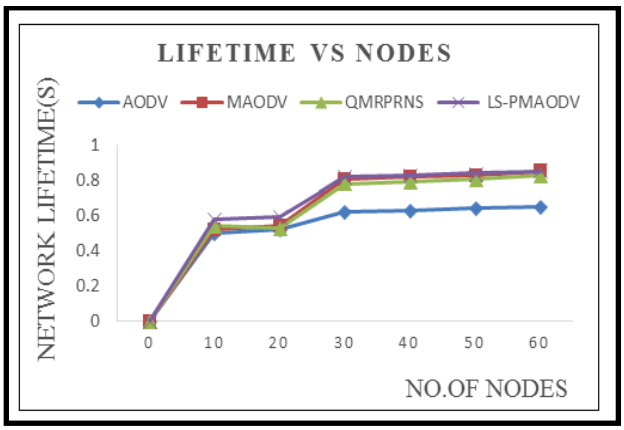

Figure 8: Network Lifetime Vs Node

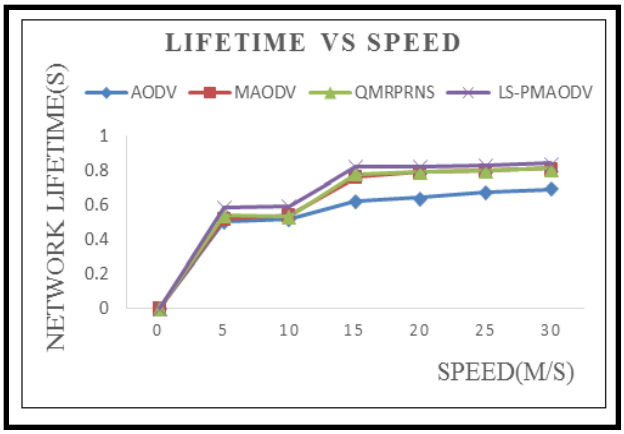

Figure 9: Network Lifetime Vs Speed

e) Computation overhead

Computation Overhead is the combination of excess or indirect computation time, memory and bandwidth. The main problem of wireless network is reliability and traffic overhead. Overhead is also the combination of excess or indirect computation time, memory, and bandwidth.

Fig. 10 shows the computation overhead for different number of nodes. It is clearly evident the proposed approach has less computation overhead than other protocols. From Fig 11, it is clear that the LS PMAODV has less computation overhead for different node speed when compared to other existing protocols.

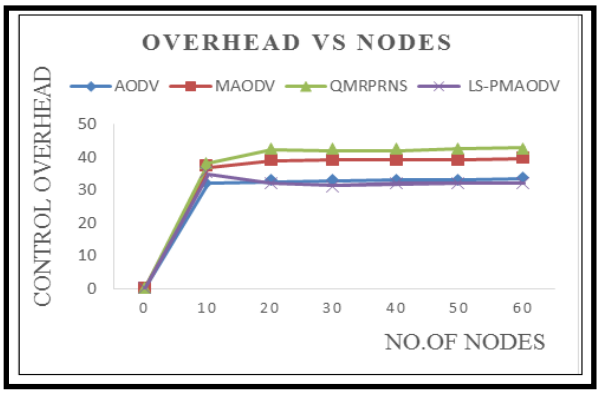

Figure 10: Computation Overhead Vs Node

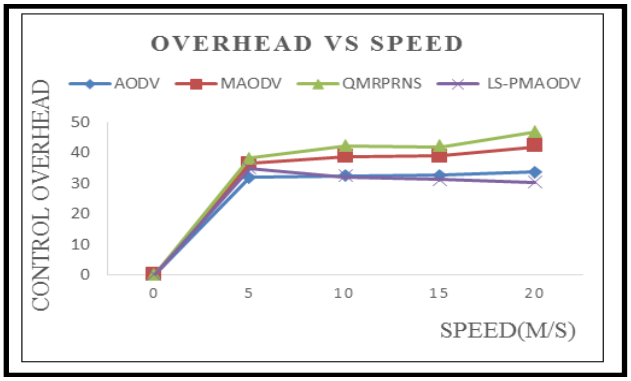

Figure 11: Computation Overhead Vs Speed

f) Connectivity

Connectivity plays the main role, which have the ability to report information to the fusion center, even though it has the critical for sensing the coverage. A wireless sensor network (WSN) is a network comprises of enough space for distributing the autonomous devices using sensors to screen the physical or environmental conditions. A WSN framework combines to form a portal that gives remote network which acts a backbone to the wired world and conveyed hubs.

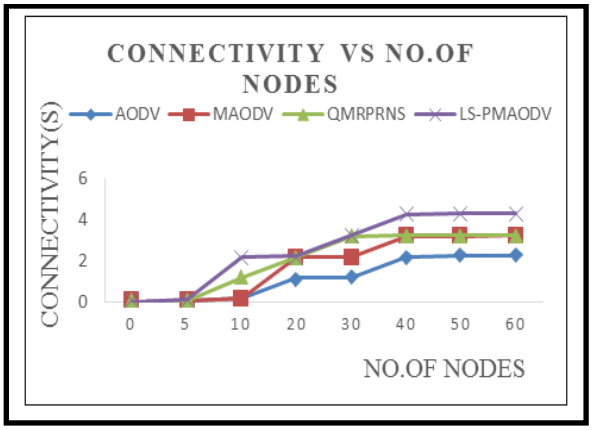

Figure 12: Connectivity Vs Node

Fig. 12 shows the connectivity for different number of nodes. It is evident the proposed approach provide high connectivity than other protocols. From Fig 13, it is clear that the LS PMAODV has high connectivity for different node speed when compared to other existing protocols.

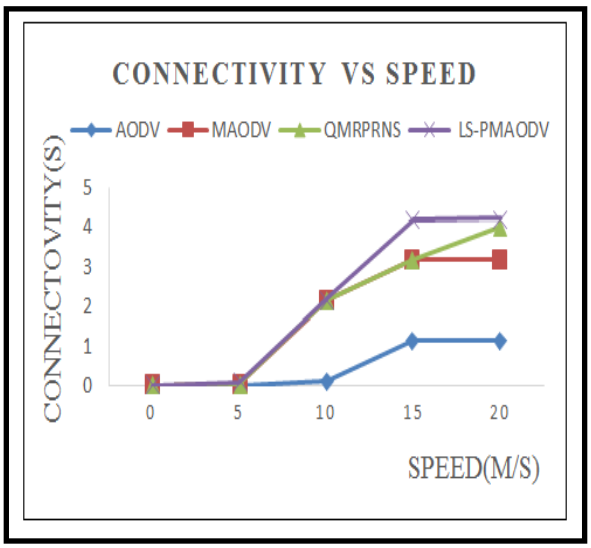

Figure 13: Connectivity Vs Speed

g) Link Stability

Link Stability is a statistical-based approach has been adopted in order to discriminate among several links which are more stable for some periods of time without exactly predicting the residual link lifetime of each link. Thus, to enable mobile devices to make smart decisions in connection to the stability, a practical method is used, based exclusively on observations related to the link, in previous time instants. As a result, this analysis produces an evaluation of the link residual lifetime of the link, since the stability of a link is given by its probability of persisting for a certain time span. Fig 14 and 15 shows the number of nodes vs. link stability and speed vs. link stability respectively.

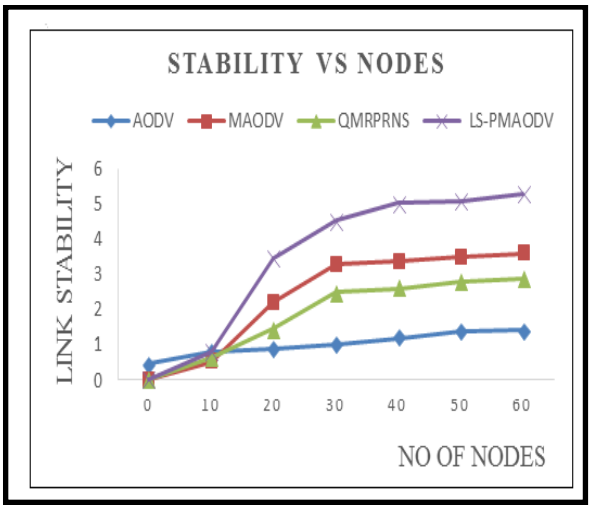

Figure 14: Link stability Vs Node

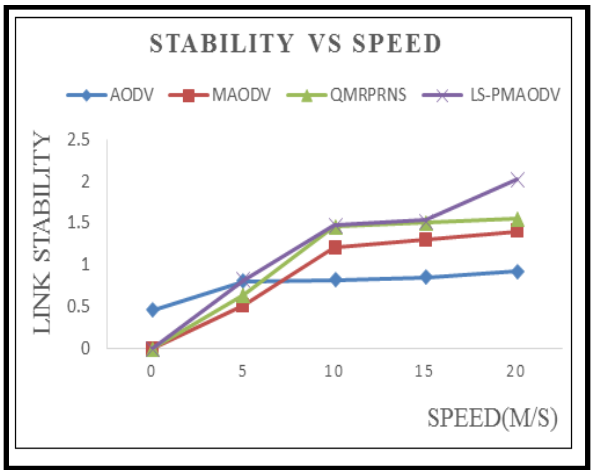

Figure 15: Link stability Vs.Speed

It is clearly evident that LS PMAODV provides high link stability than AODV, MAODV and QMRPRNS.

h) Throughput

In data transmission, network throughput is the amount of data transmitted successfully from sender node to receiver node in a given time period and typically measured in bits per second (bps), megabits per second (Mbps) or Gigabits per second (Gbps). Fig 16 and 17 shows the throughput achieved for different number of nodes and different speed respectively. From Fig 17 and 18, the throughput for LS PMAODV is greater than other protocols.

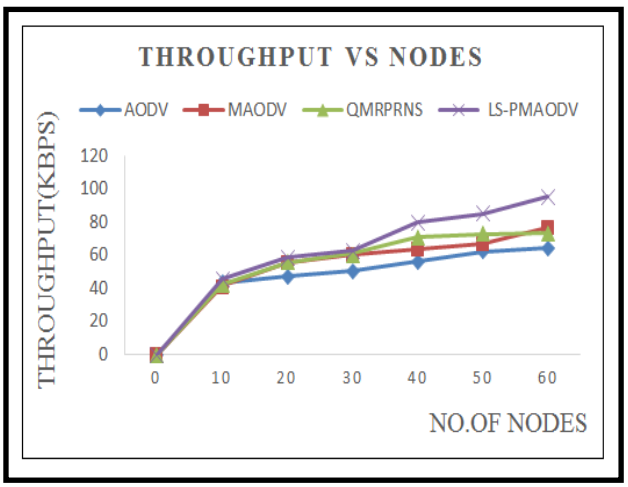

*Figure 16:*Throughput Vs Node

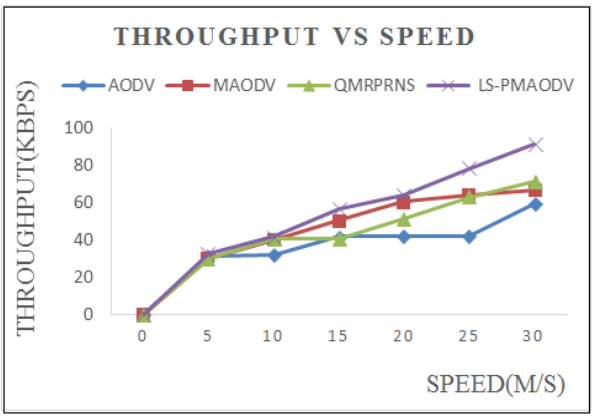

Figure 17: Throughput Vs Speed

VI. Conclusions

This research paper describes the link stability based priority multicast Adhoc and demand distance vector routing protocol to enhance the route discovery of nodes which is stable of MANET .The proposed LSMAODV protocol is implemented using Network Simulator 2 (NS-2). The support level of predictable performance for network system is decreased the delay and to enhance the efficiency. The QoS metrics such as delay, energy consumption, an end to end latency, loss, overhead are minimized and PDR, throughput are enhanced using the proposed protocol compared to the existing AODV and MAODV routing protocols. The clustering arrangement stores the energy of the cluster member nodes. Hence, the proposed method is enormously energy efficient which is linked to the AODV and MAODV algorithm in achieving high QoS in MANET.

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