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Enhanced Multipath Optimized Link State Routing Protocol for MANETs

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Abstract: *Mobile Adhoc Networks (MANETs) are dynamic and self-organized temporary networks which include a set of mobile routers and hosts sharing same radio channel using wireless connections exchanging data without a centralized management. Due to limited transmission range of wireless Adhoc network nodes, multiple hops are usually needed for a node to exchange information with any other node in the network. Thus routing is a crucial issue to the design of a MANET. Optimized Link State Routing Protocol (OLSR) is a table driven proactive routing protocol, with topology information and routes. Its efficiency depends on multipoint relay selection. Various studies were undertaken to decrease control traffic overheads by modifying present OLSR routing protocol. A novel routing protocol for Adhoc networks named as SR-MPOLSR develops from OLSR, incorporating multi-path strategy and source routing controlling scheme. It raises the throughput and drops the average delay. The proposed multipath OLSR for MANETs is based on link quality. It is compared with OLSR and SR-MPOLSR. This new algorithm calculates link quality based multiple routes. Source data transmission is through multiple paths. The experiment includes 50 nodes distributed over a 3 square kilometre area.*
Keywords: *Mobile Adhoc networks (MANET), Optimized Link State Routing Protocol (OLSR), Quality of Service (QoS) in MANET.*

I. Introduction

MANETs simply are unplanned, self-organizing networks of mobile nodes using mesh networking principles for interconnectivity. MANETs have many advantages for a military force. MANET's ability to self-form and self-manage eliminates central network links management reducing support personnel and equipment in forward areas. By nature, MANETs allow mobile nodes to share data easily and get better situational awareness than a non-networked force. These benefits are not without disadvantages [1]. Some of MANET's main features are listed below [2]:

a) MANETs are formed without preexisting infrastructure.
b) It follows dynamic topology where nodes join/leave network any time and multi-hop routing keeps changing as nodes join/depart a network.
c) It has very limited physical security, and so increasing security is a prime concern.
d) Every MANET node assists packet routing in a network.
e) Limited Bandwidth and Power.

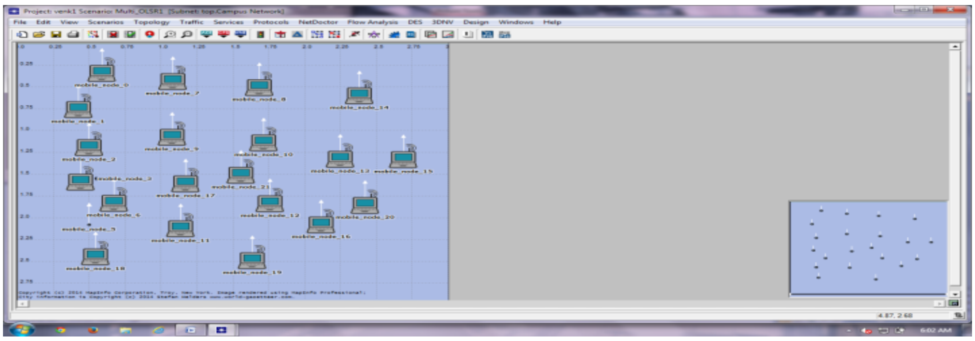

Fig. 1: MANET

Conventional wired network routing protocols are based on either link state or distance vector routing algorithms. Both require periodic routing advertisements to be broadcast by routers. In distance vector routing, a router broadcasts to all neighboring routers its view of distance to other nodes; neighboring routers compute shortest path to each node. In link-state routing, a router broadcasts to neighboring nodes its view of adjacent links status; neighboring routers compute shortest distance to every node based on complete network topology.

Conventional routing algorithms are not efficient for dynamic changes in Adhoc networks. Routers do not usually move around and rarely leave/join a network, in conventional networks. In a mobile node environment, changing topology trigger frequent route re-computation and overall convergence to stable routes may be infeasible due to high mobility. So, MANET routing must consider their important characteristics like node mobility [3].

OLSR is a proactive routing protocol and so routes are available when needed. OLSR is an optimization version of pure link state protocol. So topological changes flood topological information to all network hosts. To reduce network overhead, Multipoint Relays (MPR) are used. MPRs reduce broadcast flooding by reducing same broadcast in some network regions. It also has to ensure the shortest path. Reduction of time interval for control message transmission ensures more reactivity to topological changes.

OLSR uses Hello and Topology Control (TC) control messages. Hello messages locate information about link status and host's neighbours. With Hello message, MPR selector set describes which neighbour has chosen a host to act as MPR, then host calculates its MPRs set. Hello messages are sent only a hop away but TC messages are broadcasted throughout a network. TC messages broadcast information about self-advertised neighbours including the MPR selector list. TC messages are broadcast periodically and only MPR hosts forward TC messages [4].

The MPR selector is from HELLO packets forwarded between neighbour nodes, and routes are built before a source node sends a message to a destination. Each network node keeps a routing table and is the reason why OLSR routing overhead is minimum compared to other reactive routing protocols as it provides the shortest route to a network destination. There is no need for new routes, as existing routes do not increase routing overhead. It reduces route discovery delay and network nodes send HELLO messages to neighbours.

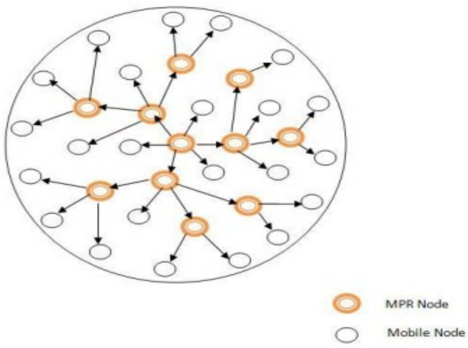

Fig.2: TC message sent from MPR node

Messages are sent at regular intervals in OLSR to determine link status as seen in Figure 3. When nodes A and B are neighbours, the former sends HELLO message to the latter. When B node receives the message, the link is asymmetric. If node B sends same HELLO message to node A it is called asymmetric link. When two way communications is possible it is called a symmetric link, as seen in Fig. 3. HELLO messages have neighbours information, helping mobile nodes have tables with information about multiple hop neighbours. A node chooses minimal MPR nodes during symmetric connections. It broadcasts TC messages with information on link status at TC intervals. TC messages calculate routing tables. MPR node information is also included [5] in TC messages.

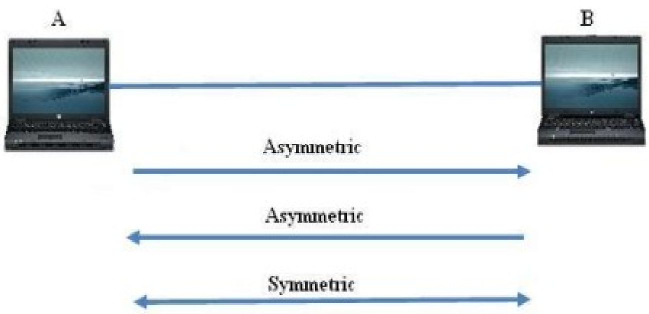

Fig 3: HELLO messages using OLSR in MANET

1.1. SR-MPOLSR

Traditional OLSR can search only one path to the destination while there are more paths, which is similar to most portable Adhoc routing protocol. Thus network resource is wasted. Multi-path routing refers to a routing strategy that finds more than one path to the destination according to certain constraints. These paths share one network load, aiming as routing efficiency.

SR- MPOLSR adds multi-path mechanism into traditional OLSR. It employs Dijkstra algorithm to seek more than one path to the destination when routing for business. A source routing scheme similar to DSR is applied to avoid intersection of multiple paths when messages distributed through multi-path [21].

SR-MPOLSR protocol, the first path still employs OLSR forwarding scheme, maintaining the original routing cost. Transmitting of the second path employs source routing scheme, which reforms every block's header, adding a field identifying all the nodes path information from source node to destination [21].

1.2. QoS

Quality of Service (QoS) refers to many telephony and computer networks aspects allowing transport of traffic with special requirements. QoS was defined by ITU in 1994 in telephony. Quality of service comprises requirements on connections of all aspects like service response time, crosstalk, echo, interrupts, loss, signal-to-noise ratio, loudness levels, frequency response and others. In computer networking, QoS provides different priority to various applications, users or data flows, or guarantees specific performance level for data flows. QoS guarantees are required when network capacity is insufficient, especially for real-time streaming multimedia applications, as these require fixed bit rate and are delay sensitive and in network with limited resource [6] capacity.

MANET routing protocols like AODV, DSR, and TORA, were designed without considering routes QoS, as Adhoc networks QoS routing was studied only recently. QoS routing requires locating a route from source to destination, but it must satisfy end-to-end QoS requirement, regarding bandwidth and delay. QoS is more hard to guarantee in Adhoc networks than in other network types as wireless bandwidth is shared by adjacent nodes and network topology alters when nodes move needing much collaboration between nodes, both to establish routes and secure resources required for provision of QoS [7].

The following factors impact QoS:

a) Delay: Echo and talker overlap are problems due to high end-to-end delay in voice networks. Round trip delay has to be lesser than 50 ms to prevent echo. As VoIP has longer delays, such systems must overcome the need for echo control and implement a process for echo cancellation. ITU recommendation G.168 defines performance requirements currently needed for echo cancellers.

b) Jitter (Delay Variability): This is a variation of inter-packet arrival time introduced by variable transmission delay over a network. Removal of jitter requires collecting packets in buffers and holding onto them to allow slower packets to arrive on time and to be played in the right sequence. Jitter buffers cause more delay which removes packet delay variation when every packet transits the network.

c) Packet Loss and Out of Order Packets: IP networks do not guarantee packet delivery and that too not in order. Packets are dropped under peak loads and during congestion. Approaches which compensate packet loss include speech interpolation by re-playing last packet, and forwarding redundant information.

d) Bandwidth available: Maximum data transfer rate sustainable between two end points affects service quality. Techniques to minimize network congestion loss reduce available bandwidth for applications. With current media technologies transmission advances capacity is a reasonable assumption for a controlled, localized environment like a corporate LAN, but it is unrealistic across a global network like the Internet [8].

This study proposes a link quality based multipath OLSR for MANET which is compared to OLSR. The new algorithm calculates multiple routes on a link quality basis. Source data transmission is through multiple paths. The experiment includes 50 nodes distributed over 3 square kilometres. The rest of the study is organized as follows: section 2- literature survey, section 3 - methodology, section 4 - results and comparisons and section 5 - conclusion.

II. Literature Survey

An intrusion detection method for OLSR MANET protocol was proposed by Wang, et al., [9] which describes security threats to OLSR MANET routing protocol. The new intrusion detection was implied in the protocol definition which specifies correct OLSR routing update behaviour. Semantic properties based conflict checking was applied in all MANET nodes. Abnormal protocol semantics triggered intrusion alarms. OLSR felt that the new approach was possible in any MPR proactive MANET protocol.

Analysing non-equilibrium statistical behaviours within OLSR MANET routing protocol was proposed by Arora, et al., [10], where the proposed OLSR was a known proactive MANET routing protocol. Much of current OLSR research was based on packet-level. Simulation results were reported as averages computed across a conducted Monte Carlo runs set. The validity of averaging rests on the assumption that OLSR behaves, regarding its network-level QoS measures, as an equated stochastic process. This research explores how much of this presumption holds good for OLSR. The work revealed the degree to which OLSR exhibited non-equilibrium behaviours was influenced by adjusting run-time tuneable parameters.

A fully distributed certificate authority implemented in an OLSR MANET was proposed by Dhillon, et al., [11] which described the approach where a PKI was coupled tight with an OLSR MANET at network layer level and OLSR control packets were leveraged to support security related activities also. It implemented a fully distributed CA integrating it with current OLSRv4 implementation. The implementation's intricate details were presented to develop insights into key aspects of the new solution.

A simple address auto configuration mechanism for OLSR was proposed by Clausen and Baccelli [12]. The mechanism aimed to solve simple, but common issues of one or more new nodes emerging in a current network. It proposed a solution allowing new nodes to acquire an address to participate in the network. The method was simple, both algorithmically and in network requirements. This was a partial solution to general auto-configuration problems. It was felt that the mechanism described here would satisfy requirements in many real-world situations.

Enhancing performance of OLSR in MANET was introduced by Loutfi and Elkoutbi [13] where authors suggested a version of the original OLSR protocol based on a new density parameter to enhance and adapt it during mobility. It was analysed and performance of protocols was compared based on density criterion, mobility and OLSR standard using NS-2 network simulator.

Assessing performance of AODV, DYMO, and OLSR routing protocols in context of large-scale denser MANETs was proposed by Arora, et al., [14]. These were interesting issues as large-scale adoption of smart phones provided a deployment platform for large-scale denser MANETs, specifically in urban cores and for non-cellular based network services.

AODV and OLSR routing protocols in MANET were proposed by Malekian, et al., [15] who described wireless and mobile technologies growth resulting in more research on scalability, performance, and compatibility of packet routing with minimal network changes. The new work reviewed two known MANET routing protocols i.e., AODV and OLSR routing protocols comparing them regarding performance.

MANET routing protocols performance investigation for mobility and scalability were proposed by Shrestha and Tekiner [16]. They focussed on performance investigation of reactive/proactive MANET routing protocols like AODV, DSR, TORA and OLSR. MANET is an Adhoc network with its functionality being based on 802.11 IEEE standards to communicate in discrete/disperse environments without a central management. Thus, the main investigation here was of MANET routing's discrete feature. Hence this presented a performance comparison of chosen MANET routing protocols of varied network sizes with increased area and node sizes to investigate routing process mobility and scalability.

A secure OLSR was suggested by Hong, et al., [17] where a OPLSR securing solution which applied wormhole detective mechanism and authentication to strengthen neighbour relationship establishment, also resorted to hash-chain and digital signature for routing packets protection.

Security Aware Optimized Link State (SA-OLSR) routing for MANETs proposed by Kannhavong, et al., [18] was based on exchanging acknowledgements between 2-hop neighbours when control traffic was received. This approach's advantage was that it protected against sophisticated attacks like link spoofing, colluding miss-relay attack and wormhole attack without location information or knowledge of total network topology. Simulation showed the new solution achieving higher packet delivery ratio compared to networks with standard OLSR in malicious nodes presence.

Simulation based performance comparison of MANET (proactive, reactive and hybrid) routing protocols was proposed by Rahman, et al., [19]. A simulation based analysis and performance study was performed on these routing protocols over MANET. AODV, and DYMO routing protocol (reactive), OLSR (proactive) and ZRP (hybrid) were considered for investigation and relative performances reported.

Collusion attack prevention in OLSR-based MANETs was proposed by Babu, et al., [20] by incorporating an information theoretic trust framework which ascertained presence of colluding attackers by evaluating and quantifying trust values based on uncertainty measures. Entropy functions represented uncertainty in node behaviour called CAP-OLSR. Simulation showed that CAP-OLSR efficiently detected colluding attackers and improved network nodes PDR. The protocol was advantageous as it did not need any time synchronization or location information and yet showed much improvement in PDR under various scenarios.

III. Methodology

In this study, multipath OLSR is proposed for MANET based on link quality and compared with OLSR. The proposed algorithm calculates multiple routes based on the link quality. Data transmission at the source is done through multiple paths. The experimental setup consists of 50 nodes distributed over three square kilometres.

3.1. Dijkastra Algorithm

Multi-path strategy

Let G= (V, E) denote Adhoc network, V - set of nodes; E - set of links. Assume all network links are duplex, i.e. (a, b) belong to E, thus (b, a) belongs to E. As a sequence, when dealing with two nodes, say source node S and destination node D, a path set is obtained.

Usually, multi-path includes independent, convolved and mixed nodes. Independent multi-path is split into node independent and link independent. Node-independent multi-path uses a non-intersection criterion requiring no shared nodes between source and destination nodes. Link-independent multi-path states that shared intersection nodes can exist without being shared among links. Multi-path refers to a criterion that different paths share one or more links. Mixed multi-path is a mixture of both multi-path types. Among them, node-independent multi-path possesses most independence, as every node in node-independent multi-path is independent, in addition to links.

Generally, multi-path uses network resources proportional to degree of path independence. Meanwhile, bandwidth and network throughput can be enlarged, and package loss rate lowered by reducing congestion. Also probability of paths interaction is less as shared physical resources are not common in such networks.

This study proposes an algorithm described as follows, based on node-independent multi-path strategy. First, locate a shortest path using Dijkstra algorithm, copy the topology. Next, delete internal nodes off it. Third, seek a second shortest path using Dijkstra algorithm. This strategy is called multi-Dijkstra algorithm. Higher is the node density, the more paths to choose from. It should be understood that non-MPR nodes are restricted to distributing controlling message blocks by MPOLSR routing protocol, but are still permitted to distribute datagram as routing nodes. MPR nodes and non-MPR nodes share same routing nodes position in Dijkstra algorithm.

An analysis of node-independent multi-path algorithm referring to Fig. 4 is as follows.

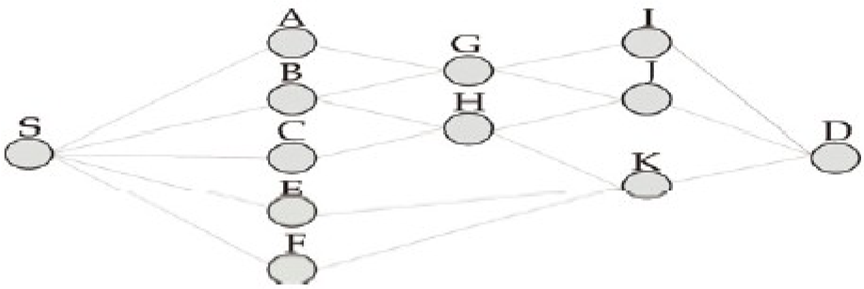

Fig. 4: Node-independent Multi-Path arithmetic

A, B, C, D, E, F, G, H, I, J, K represent network nodes. First, two shortest paths are obtained, namely S-E-K-D and S-F-K-D, through use of Dijkstra algorithm, with S as source node. Consider path S-E-K-D, apply Dijkstra algorithm again, exclude internal nodes E and K, obtain eight shortest paths namely S-A-G-I-D, S-A-G-J-D, S-B-G-I-D, S-B-G-J-D, S-B-H-J-D, S-B-H-K-D, S-C-H-J-D and S-C-H-K-D. Consider path S-A-G-I-D, apply Dijkstra algorithm, exclude internal nodes A, G and I, four shortest paths are got, namely S-B-H-J-D, S-B-H-K-D, S-C-H-J-D and S-C-H-K-D.

Consider path S-B-H-J-D, apply Dijkstra algorithm, and exclude nodes B, H and J. There is no extra path to choose till this step. There are at most three multi-paths from source node S to destination node D in the network. Datagram transmits after multi-path selection requiring load allocation. Algorithms for dispatching include: deficit round-robin, weighted round-robin, rate-controlled scheduling and virtual clock and others. Weighted round-robin algorithm is used here. As only two multi-paths are used for transmission, load distribution in shortest path chosen in first Dijkstra run shares 2/3 of total, while shortest path in second Dijkstra run shares 1/3. Due to the amount of jumps, second path must be bigger or equal to the first, the first path shares more load under similar circumstances.

Two paths interchanging frequency is important for transmission efficiency. Due to path switching frequency, throughput, average delay and package loss rate improve greatly. For network layer, an optimal strategy is distributing message taking datagram as minimum unit through two paths in turn. Nonetheless, for higher layer protocol like TCP protocol, it will be named congestion due to much disordered datagram. Also, it leads to excessive sorting delay [21]. From this multi-Dijkastra algorithm the end-to-end delay was increased but our link quality delay be decreased then another algorithm is used for the diminishing the delay i.e. Floyd's algorithm.

3.2 Floyd's Algorithm

When solving practical transportation problems, it is often necessary to calculate the shortest path between all pairs of nodes in a transportation network. If the network has n nodes, then the Dijkstra algorithm must be applied n times, taking a different node each time as the starting node. This is a lengthy process. Hence, Dijkstra algorithm is rarely used to determine the shortest path between all pairs of nodes; instead Floyd's algorithm is used.

This algorithm works by updating two matrices D_k and Q_k, n-times for an n-node network. The matrix D_k, in any iteration k, gives the value of the shortest distance (time) between all pair of nodes (i, j) as obtained till the k^{th} iteration. The matrix Q_k has q^k_{ij} as its elements. The value of q^k_{ij} gives the immediate predecessor node from node i to node j on the shortest path as determined by the k^{th} iteration. D_0 and Q_0 give the starting matrices and D_n and Q_n give the final matrices for an n-node system. The first task is to determine D_0 and Q_0. D_0 is taken up first. The element d_{ij} of matrix D_0 are defined as follows.

If a link (branch) exists between nodes i and j the length of the shortest path between these nodes equals length l (i, j) of branch (i, j) which connects them. Should there be several branches between nodes i and node j, the length of the shortest path d^0_{ij} must equal the length of the shortest branch, i.e.

$d^0_{ij}= \min [l_1 (i, j), l_2 (i, j)\ldots l_m (i, j)]$

Where m is the number of branches between node i and node j.

It is clear $d^0_{ij}=0$ when i = j. In the case when there is no direct link between node i and node j, we have no information at the beginning concerning the length of the shortest path between these nodes. So we treat them as though they were infinitely far from each other, that is,

$d^0_{ij} = \infty$

Elements q^0_{0j} of the predecessor matrix Q_0 are defined as follows:

First, we assume that $q^0_{0j} = i$, for $i \neq j$, i.e. that for every pair of nodes (i, j) for $i \neq j$, the immediate predecessor of node j on the shortest path leading from node i to node j is actually node i. After defining D_0 and Q_0 the following steps are used repeatedly to determine D_n and Q_n.

Step 1: Let k=1.

Step 2: We calculates elements d_{ij}^k of the shortest path length matrix found after the k-th passage through the algorithm D_k using the following equation

$$d_{ij}^k = \min [d_{ij}^{k-1}, d_{ik}^{k-1} + d_{kj}^{k-1}]$$

Step 3: Elements q_{ij}^k of predecessor matrix Q_k found after the k-th passage through the algorithm are calculated as follows:

$$q_{ij}^k =< \frac{q_{kj}^{k-1}, \text{for } d_{ij}^k \neq d_{ij}^{k-1}}{q_{ij}^{k-1}, \text{otherwise}}$$

Step 4: If k = n, the algorithm is finished. If k < n, increase k by 1, i.e. k=k+1 and return to Step2.

Let us now look at the algorithm in a little more detail. In step 2, each time we go through the algorithms we are checking as to whether a shortest path exists between nodes i and j other then the path we already know about which was established during one of the earlier passages through the algorithm. If we establish that $d_{ij}^k \neq d_{ij}^{k-1}$, i.e. if we establish during the k-th passage through that the length of the shortest path d_{ij}^k between nodes i and j is less than the length of the shortest path d_{ij}^{k-1} known previous to the new shortest path is:

$d_{ij}^k = d_{ik}^{k-1} + d_{kj}^{k-1}$

It is clear that in this case node k is the new immediate predecessor node to j, and therefore:

$q_{ij}^k = q_{kj}^{k-1}$

This is actually done in the third algorithmic step. It is also clear that the immediate predecessor node to node j does not change if, at the end of Step 2, we have established that no other new shortest path exists. This means that

$q_{ij}^k = q_{kj}^{k-1}$ for $d_{ij}^k = d_{ij}^{k-1}$

When we go through the algorithm n times (n is the number of nodes in the transportation network), elements d_{ij}^n of final matrix D_n will constitute the shortest path going from node i to node j.

3.3. Link Quality Metrics

The most promising of parameters is link quality which defines a link and devices ability to support traffic density for the connected period. Link state amongst two neighbors can be affected by parameters like distance, battery power and mobility. The second parameter in route selection is the number of connections over same path to select paths with fewer connections (traffic) as route to save intermediate nodes resources over the path by distributing network traffic to other nodes and consequently increasing system life as also end to end delay.

Link quality evaluation

Equation **(1)** provides reception power $\mathbf{P_r}$ for a signal transmitted with power $\mathbf{P_t}$ at a distance **d**:

$$P_r = P_t \times G_r \times G_t \times \frac{\lambda^2}{(4 \times \pi \times d)^2} \qquad (1)$$

Where

$\mathbf{P_r}$= received power, $\mathbf{P_t}$= transmitted power, $\mathbf{G_t}$= antenna gain of the transmitter, $\mathbf{G_r}$= antenna gain of the receiver, **λ** = wavelength, **d** = distance.

From this equation, evaluating link quality according to received signal strength is descriptive for other network factors like:

The battery power: this is important as a node with less energy in its battery has limited transmission range affecting links quality with its neighborhood.

The distance: reception power is comparative to distance between nodes as whenever distance increases, link quality decreases.

The mobility: The link amongst two nodes is affected by nodes' mobility in the way that link quality decreases whenever neighbors go away from each other and increases when they come closer[22].

Throughput

It is a network dimensional parameter providing the fraction of channel capacity for useful transmission, selects a destination at start of simulation i.e., information on whether data packets were correctly delivered to destinations.

Mathematically, it is defined as:

Throughput= N/1000

Where N is number of bits received successfully by destinations [23].

End to End delay

The average time for a data packet to reach a destination is end to end delay. This includes all delays by buffering during route discovery latency and queuing at interface queue. This metric is calculated by subtracting time at which first packet was transmitted by source from time at which first data packet arrived at destination.

Mathematically, it is defined as:

Avg. EED=S/N

Where S is sum of time spent to deliver packets for each destination, and N is number of packets received by all destination nodes [24].

Routing Overhead

Nodes often change location within network in wireless ad-hoc networks. This generates some stale routes in a routing table leading to unnecessary routing overhead. Usually, it is the number of routing protocol packets generated during simulation and is defined as [25]:

$$Routing\ overhead = \sum_{i}^{n} OVERHEAD$$

Where overhead is control packet number generated by node i. Generation of an important overhead decreases protocol performance.

IV. Results and Comparisons

4.1. Results

In this study, multipath OLSR is proposed for MANET based on link quality and compared with OLSR. The proposed algorithm calculates multiple routes based on the link quality. Data transmission at the source is carried out through multiple paths. The experimental setup is implemented in OPNET and consists of 50 nodes distributed over three square kilometres.The results obtained are represented from figure 5–8.

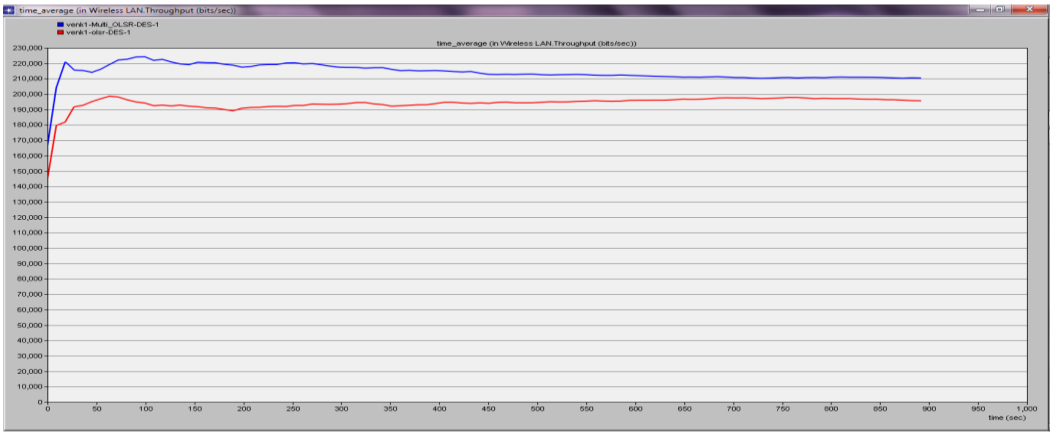

Fig 5: Throughput in bits/sec

From fig 5 it is shown that the proposed Multi OLSR Throughput increases from the normal OLSR method by an average of 9.44 %.

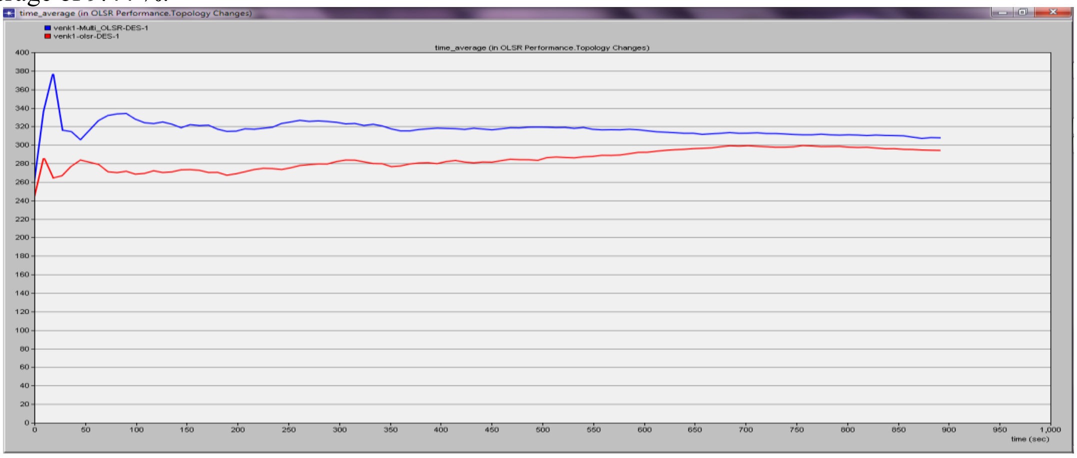

Fig. 6: Topology changes

From Fig. 6 it is shown that the proposed Multi OLSR Topology changes increases from the normal OLSR method by an average of 10.39 %.

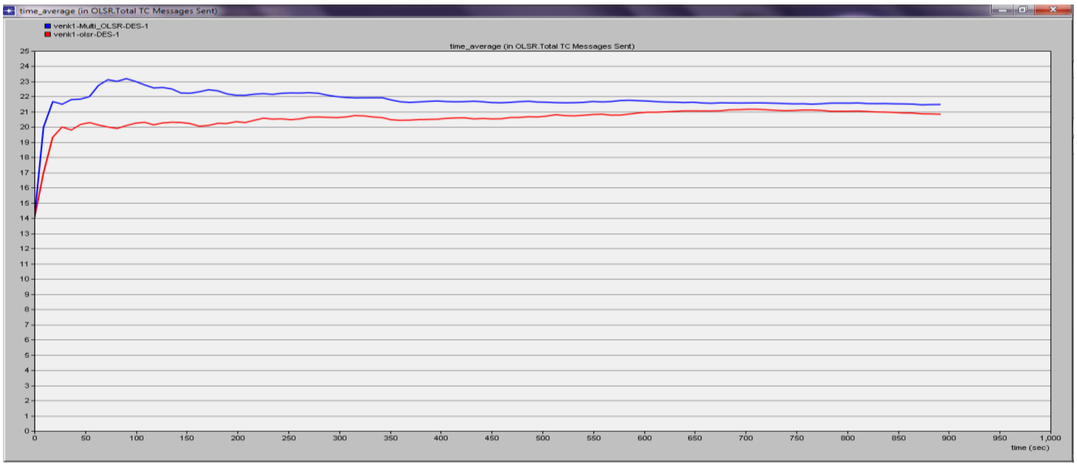

Fig. 7: Total TC messages sent

From Fig.7 it is shown that the proposed Multi OLSR Total TC messages sent increases from the normal OLSR method by an average of 5.56 %.

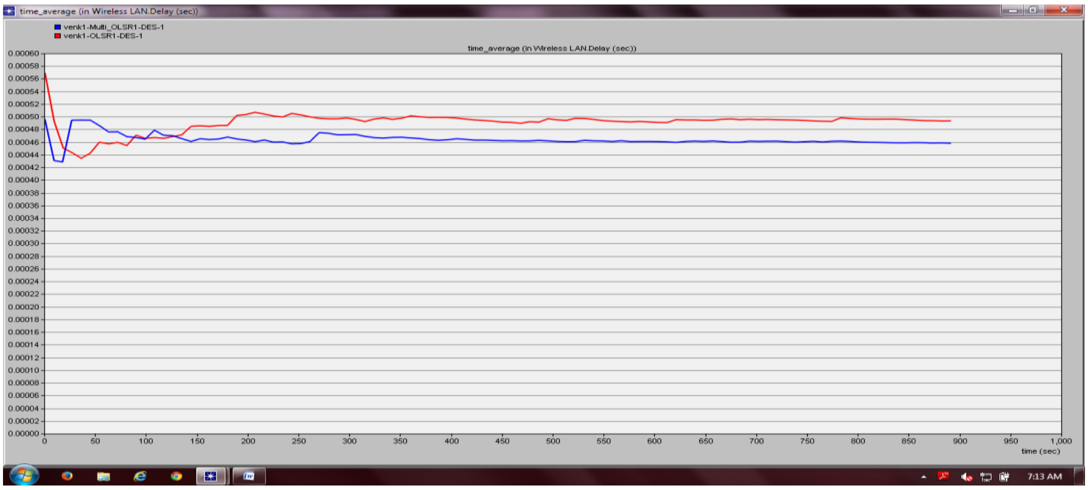

Fig. 8: End-End delay

From Fig. 8 it is shown that the proposed Multi OLSR End-End delay decreases from the normal OLSR method by an average of 5.76 %.

4.2. Comparisons

Comparisons between the SR-MPOLSR and Multi-OLSR are shown in Table 1.

Parameters				
Time(sec)	Packet delivery ratio(packets/sec)		Average Delay(msec)	
	SR-MPOLSR	Multi-OLSR	SR-MPOLSR	Multi-OLSR
100	0.50	25.64	60	0.461
200	0.60	25.43	38	0.463
300	0.64	25.86	40	0.472
400	0.66	25.92	39	0.465
500	0.68	25.81	45	0.461
600	0.70	26.02	50	0.460

Table 1: Comparisons between SR-MPOLSR and Multi-OLSR

From the Table 1 it is evident that Multi-OLSR has high Packet delivery ratio and low average delay comparing with SR-MPOLSR.

V. Conclusion

MANETs will expand their presence in future communication environments. Support for QoS will thus become an important and desirable MANET component. Though difficult, it is interesting and challenging to design and develop MANETs QoS provisioning techniques. OLSR is a pure link state protocol's optimization version. Topological changes are caused by flooding topological information to all network hosts. This study proposes link quality based multipath OLSR for MANET which is compared with OLSR. The new algorithm calculates multiple routes based on link quality. Source data transmission is through multiple paths. The experiment consists of 50 nodes distributed over 3 square kilometres. Multi-OLSR method improves packet delivery ratio and diminish the delay as compared with SR-MPOLSR technique. This proposed Multi OLSR increases throughput, topology changes, total TC message sent and decreases the end-to-end delay by calculating the average and compared with OLSR. Further work need to be carried out to study the effect of proposed algorithm under different node pause times. Work also can be extended for different mobility models.

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