AN EFFECTIVE CONTROL OF HELLO PROCESS FOR ROUTING PROTOCOL IN MANETS

Dhirendra Kumar Sharma and Nitika Goenka

School of Computer Science, University of Petroleum and Energy Studies Bidholi Dehradun, 248007, India

ABSTRACT

In the mobile ad hoc network (MANET) update of link connectivity is necessary to refresh the neighbor tables in data transfer. A existing hello process periodically exchanges the link connectivity information, which is not adequate for dynamic topology. Here, slow update of neighbour table entries causes link failures which affect performance parameter as packet drop, maximum delay, energy consumption, and reduced throughput. In the dynamic hello technique, new neighbour nodes and lost neighbour nodes are used to compute link change rate (LCR) and hello-interval/refresh rate (r). Exchange of link connectivity information at a fast rate consumes unnecessary bandwidth and energy. In MANET resource wastage can be controlled by avoiding the re-route discovery, frequent error notification, and local repair in the entire network. We are enhancing the existing hello process, which shows significant improvement in performance.

KEYWORDS

Hello process, link change rate, hello interval, energy-saving application, neighbour table, virtual neighbour table, AODV routing protocol

1. INTRODUCTION

A mobile ad hoc network (MANET) is an infrastructure-less network where it can easily configure the whole network for communication. These applications are useful in military, rescue operations, and low-cost small-scale network setup [1]. In multi-hop architecture, intermediate nodes are involved to establish the path from source and destination node. Due to mobility, the position of the intermediate nodes with the source and destination keeps changing [2].

In this paper, we have only considered the reactive routing, protocol for our study and implementation of the proposed algorithm. In reactive routing source node establishes a route-by-route discovery process by broadcasting of Route Request (RREQ) packets in the network and after the certain time interval, destination unicast RREP packets to the source node. A route has a fixed lifetime, which is maintained by the route maintenance process [3].

However, the Ad Hoc On-demand Distance Vector (AODV) routing protocol has some disadvantages [4], in terms of bandwidth consumption. This phenomenon results in degradation of performance of a routing protocol with respect to increased overhead, end-to-end delay, less throughput, and packet delivery ratio. It occurs due to the transmission of additional control packets for the successful delivery of data packets. Importance of the hello process is to monitor the status of active route.

DOI: 10.5121/ijcnc.2021.13503

The existing routing protocols [5], transmit hello packets periodically, with a fixed time interval. In dynamic topology, high density of neighbor nodes requires a fast rate of hello packet transmission to maintain the neighborhood relationship. Similarly, a node having very few neighbours should transmit hello packets with a higher time interval. This dynamic change in the rate of transmission is not handled by any of the existing routing protocols. In [6] authors modify the rate according to the mobility factor of a node. Although it introduces the idea of a dynamically changing transmission rate, it still has the shortcomings of not considering the neighbor density. The authors propose a method in [7, 11] based on link change rate estimation for dynamic change the hello timer for reduction of the routing overhead.

In [8], wireless network updated link connectivity information gives best effort route discovery and route maintenance. A route has a fixed lifetime and expires when data transfer is interrupted or delayed due to link failure. In [9], a comparison has been performed to extract the neighbourhood information by the network layer (HELLO process) and link layer (link layer (LLF)) mechanism, which are the important parts of the route maintenance scheme.

Hello, process provides the link connectivity or neighbor node information by periodic exchange of hello messages. Link failure detection technique [10, 11, 12], has been developed to find link breaks on the active routes by counting the number of received hello messages from neighbour nodes. Slow response of the hello process is inadequate for active links and outdated links, which invokes huge packet, drops. Thus, an efficient technique is required in hello process, which helps to maintain link lifetime, neighbor table, routing table entries. In our proposed method, we consider the $RSSI_{th}$ value to adjust the refresh rate, which overall gives a good result

Contribution

- We have enhanced the existing Dynamic Hello/timer adjustment by cross-layer parameter,
- Link change rate (LCR) adjustment on the basis of virtual neighbour table (VNT),
- Route discovery process based on the basis Received Signal Strength Indicator (RSSI),
- Route maintenance works on availability of backup routes and position of link break.

2. RELATED WORK

As the hello packets are meant only for link connectivity management [13] and link failure detection [10]. In [14], reactive routing protocols, timers are used to control the routing mechanism, expiry of timers arise from the interruption of communication. Hello, process is a type of timer which is periodically initialized by node; its periodicity helps to extract neighborhood information. It is clear that complete restriction on the hello process causes the expiry of timers in hop-by-hop routing where routes are completely based on routing table and neighbour table. Source routing [15], is a beacon less and it updates their route cache by transfer of data packets when traffic increases in the network then huge contention increases the packet drop. This problem arises due to lack of neighborhood information which causes packet drop problems and it can be overcome by route repair techniques.

In [16], RSSI and link life time based reliable routing has been proposed to reduce the latency and overhead and packet drop ratio. In [17], a link lifetime prediction technique shows better performance in static or less mobility area. In dynamic topology better maintenance techniques are required to improve the performance of network.

A study over multi-hop route shows the performance of routing protocol become less effective due to unstable route; the route discovery greatly works in shortest route (2 to 3 hops). A simple signal strength-based technique helps to find the cause of the failure of the routing protocols in the unreliable networks [18]. Such type of neighbor discovery process helps to increase the performance of routing protocol in the certain scenarios. To increase the routing protocols consistency better maintenance approach is required.

A neighbor monitoring mechanism (NMM) [19], monitors the status of neighbor node's information by exchange of hello messages at a fixed rate. This method solves the unidirectional link problem in MANET. This scheme works better in static topology to monitor the various metrics of neighbour nodes. We found several advancement has done over protocols development for MANET. Main contributory work focused on performance improvement with lifetime enhancement [31, 32, 33].

In [20], a performance comparison has been done between a link layer feedback mechanism and neighbor discovery mechanism. These mechanisms are used to find the neighborhood information at a different layers. Link layer feedback mechanism gives only active neighbour nodes information and it is not used to update the lifetime of all links. neighbor discovery mechanism is used to obtain the neighbor hood information; it helps to gain the lifetime of all links and routes. Hello, process has an overhead problem but it can be controlled by different methods. In a static scenario hello process is controlled by assuming a large hello interval (2000ms) and result from less overhead. In AODV RFC [21], only active nodes are allowed to invoke the hello process so hello is controllable in some scenarios. We can understand the rest of the nodes are not allowed to start hello process; hence there is a huge improvement in the throughput and the lifetime of the network. Using original AODV, our implementation allows only the nodes, which have a routing table and alternate route table, to exchange hello messages. As the neighbor of all the nodes of an active route must have either received or forwarded RREQ or/and RREP packets, a routing table is created for them to keep the entries of forwarding/backward routes. Hence, all the members of an active route along with their neighbors are allowed to exchange hello packets and not others. Keeping track of the neighbors by the intermediate nodes helps in local repairs and hence reduces the number of rerouteing discoveries. This helps in reducing further the flow of other control packets, thereby reducing the routing overhead and improving the performance. If a node does not receive a control packet from a neighbor within a stipulated time, it assumes the loss of connectivity with it. Hence, a node always sends a HELLO packet every such time period if it has not sent any other control packet. HELLO_INTERVAL is the maximum time interval between two successive control packets. ALLOWED_HELLO_LOSS is the maximum number of hello intervals that a node waits to receive a hello packet from a neighbor before it confirms a loss of connection with it. In AODV, HELLO_INTERVAL is set with a value of 1000ms (1 sec) and ALLOWED_HELLO_LOSS with a value of 3. The utility of hello/beaconing is used to update the geographical position of mobile nodes in MANET. A greedy perimeter stateless routing (GPSR) [23], a periodic beaconing technique used to maintain the geographical position of neighborhood and helps to improve the routing decision.

In [11], a dynamic hello timer adjustment adjusts the hello timer on the basis of link change rate (LCR). The link LCR is computed by observation of neighbour table entries in which neighbor nodes are categorized into two parts; new neighbor, lost neighbor. Network awareness [22], information is required to monitor the overall network status; its objective is to highlight the self-adaptation strategies, of routing protocols for dynamic topology. In awareness strategies link duration and node density-based metric has been observed for adaptation in mobility. In the papers [29, 30], the authors show the utility of the hello message for wireless sensor network management. It is used for authentication and localization techniques.

We have studied the dynamic hello timer adjustment, and proposed a technique to enhance its performance in terms of hello timer, refresh rate (hello interval, and neighbor expiry by monitoring the status of neighbor nodes. Link change rate (LCR) has been used to estimate the refresh rate and neighbor expiry in dynamic topology. Its control over hello is lost when node density increases along the active routes and adjusts a very low refresh rate (0.000002s) along active route. Thus, all nodes invoke the exchange of hello message, which interrupts the communication. In [27, 28], the authors describe the significance of hello message for finding the link failure in the network which helps to avoid excessive packet loss.

Our proposed method overcomes such type of problem by using a cross-layer design (CLD). Our work is based on the original AODV routing protocol and we have made a modification to the hello process.

3. Overview of Link Connectivity Management and Problem Description

In link connectivity management, neighborhood information is exchanged by the hello process which is shown in figure 1. This process is useful to find the link failure in the network [10]. Routing/neighbor table entries are expired due to high contention in data transfer and timer expiry. Generally routing entries are updated by data transfer; heavy congestion and contention interrupt the update of link connectivity information. Neighbour table entries are periodically updated, this mechanism is not adequate for dynamic topology because nodes are not fixed at their position. Slow exchange of link connectivity information cause a high packet drop ratio in each attempt thus this occurrence results in degradation of performance in a network.

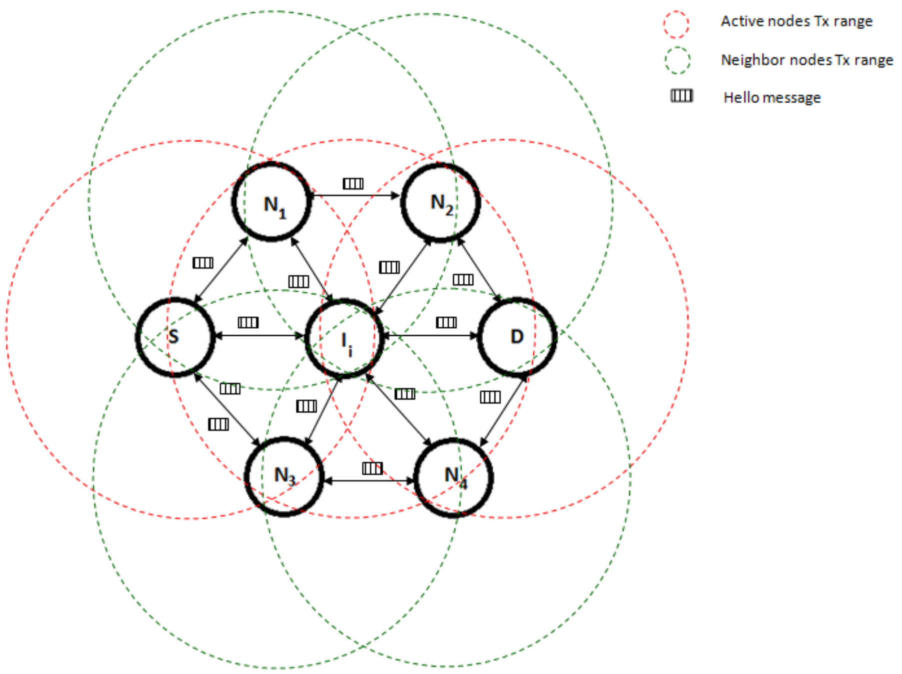

Figure 1: Hello process

In a network, the hello process is used for link connectivity management. It is initialized at a fixed rate and works better in static topology. In dynamic topology, a fixed refresh rate is not suitable to increase the lifetime of node entries in the neighbor table. A dynamic hello timer adjustment [11] method has been proposed to adjust the hello timer by adjusting the refresh rate and the link change rate (LCR). This dynamic adjustment of hello timer produces the significant results in low-density network. In a network, node density is non-uniform along the active route, in dynamic topology mobile nodes move, hence there is non-uniform node density distributed along the active route. Non uniform distribution of node density causes the a very low refresh rate at any point to overcome such type of problem we are proposing an algorithm to efficiently adjust the refresh rate. We are considering the basic concept of dynamic hello timer adjustment and assuming the RSSI range for node selection and refresh rate evaluation. In figure 2, a cross-layer design (CLD) technique shows the RSSI (physical layer metric) to network layer which is used in proposed algorithm.

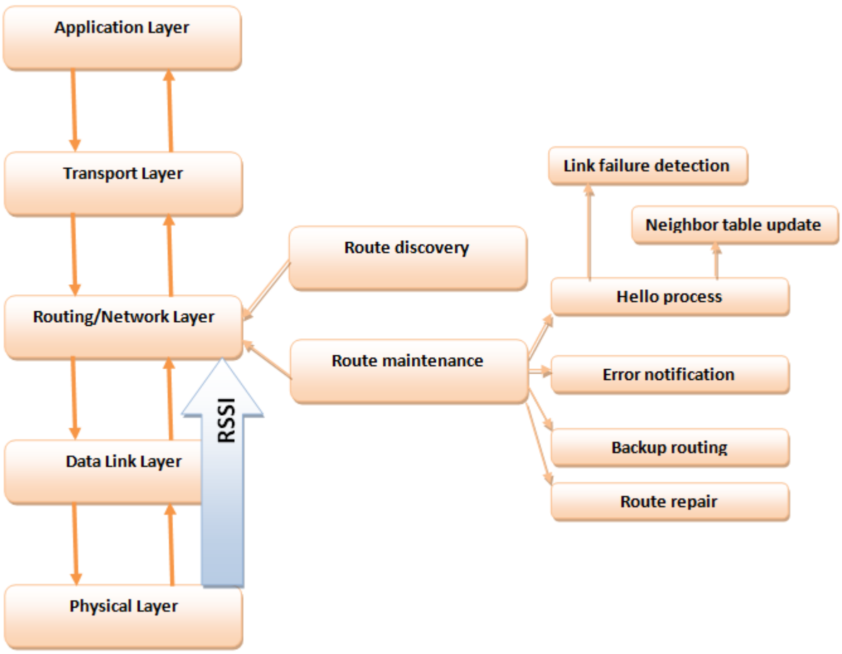

Figure 2: Cross-layer design; Exchange of Physical layer metric (RSSI) to network layer

4. System Model

This section describes the utility of the overhearing process for the formation of an alternate route table (ART). In the proposed work we have considered ART entries are formed by overhearing unicast RREP packets and update by data transfer. We are using the CLD technique to enhance the hello process by use of physical layer metrics. By link change rate (LCR) we are monitoring and evaluating the neighbor nodes and refresh rate.

4.1. Cross-Layer Design

In multi-hop route timers (route, neighbor) expiry affects the overall performance which can be improved by cross-layer design (CLD) (as shown in figure 2). In [26], cross layer design technique has been proposed for access point selection to enhance the performance of the network. CLD technique motivates us and designs an efficient technique for the hello process which is used to overcome route timeout, packet life timeout, neighbor table entries timeout issues.

4.2. Overhearing

In a network, an overhearing region is one where neighbors nodes are able to easily overhear the packets to form the alternate route table. To illustrate the overhearing region we are assuming a mathematical model to describe the region where node effectively overhears the packets without any loss. An the analytical model, we are simply using a trigonometric formula for illustration of the overhearing region.

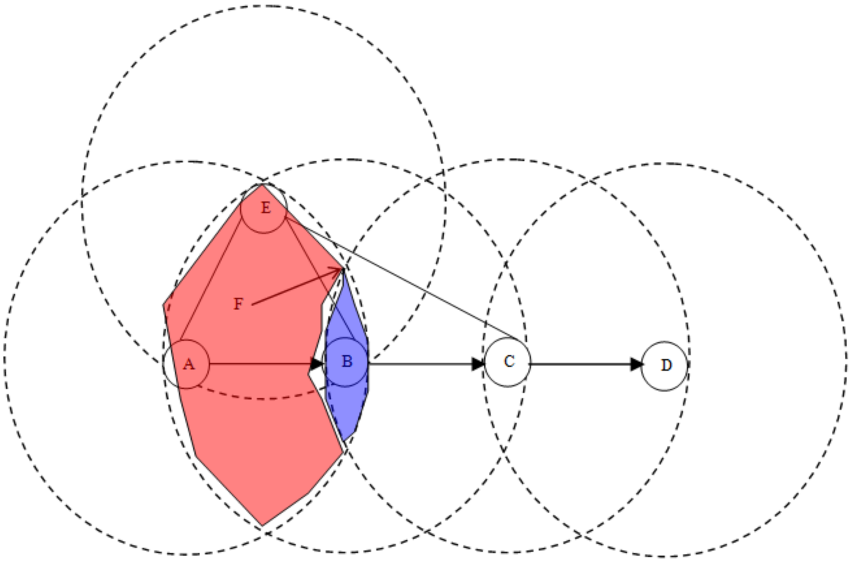

Figure 3: Overhearing region

Above figure 3, shows that routing starts from source node A to destination node D on selected path, which is a set of nodes (A, B, C, D). We assumed that all nodes have equal transmission range and multi-hop routing is used to deliver the data packets. As shown in the figure we consider that node E starts the overhearing along the active route (A to D). Here neighbors node E has alternate paths and updates its timeout by overhearing of data packets as discussed in Ad Hoc On-Demand Distance Vector Backup Routing (AODV-BR) [24]. The Use of alternate paths does not provide assurance of delivery of packets, because neighbor node may be standalone and start to drop the packets. We observe one of the serious problems is to keep the order of nodes in neighbor table. The normal update process only adds and resets the timeout of the existing entries in neighbor table. This type of method is successful for updating the timeout of entries, but does not give assurance for effective neighbor nodes, that handle the delivery of packets in link break situations.

We observe that overhearing happens when node E resides in the red colored region (assumed to be twice the area of the triangle). In the figure, at point F we observe that node E is able to overhear from nodes A, B, C simultaneously. The blue shaded region is the maximum overhearing region in the above figure.

In figure 3, we assume that connection of nodes form an equilateral triangle and AB, BC and CA are sides of triangle. The overhearing area $A_{OH}^{A,B}$ is calculated as:

$$\Delta ABC = \frac{1}{4}\sqrt{(AE^2 + AB^2 + BE^2)^2 - 2(AE^4 + AB^4 + BE^4)}$$
$$A_{OH}^{A,B} = 2 \times \Delta ABC \quad \text{, Heron's formula [25]} \qquad (1)$$

For equilateral triangle,

$$\Delta ABC = \frac{\sqrt{3}r^2}{4}$$
$$A_{OH}^{A,B} = 2 \times \Delta ABC \qquad (2)$$

$$\text{if } (BE, AE) \le r, \text{ and } AB < r, \text{ for isosceles triangle,}$$
$$\text{let } (AE = BE) \le r \text{ and } AB \text{ is the } n^{th} \text{ part of } r$$
$$(AB = r/n,\ 0 < n < \text{finite number}) \text{ then,}$$
$$\text{Area of } \Delta ABC = \frac{AB\sqrt{4AE^2 - AB^2}}{4},$$
$$A_{OH}^{A,B} = 2(r/n)^2\sqrt{4n^2 - 1}$$

4.3. Example

We assume a network where all mobile nodes are randomly placed and can move in any direction. A mobile node starts the data transmission when routes are available otherwise starts route discovery. Route discovery and route maintenance processes are considered in reactive routing protocols. In the further section, we are describing the processing of route reply (RREP) packets at the source node. Route maintenance process is shown in the flowchart of figure 12, which clearly shows the use of backup routing, local repair, and re-route discovery process.

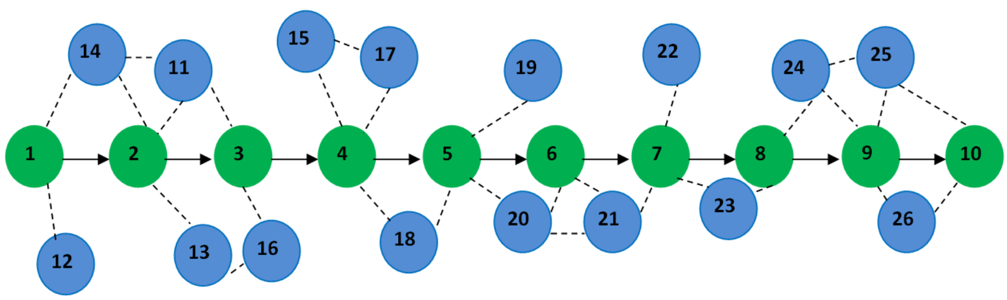

Figure 4: Data transfer over multi-hop route from source node 1 to destination node 10

In figure 4, source node 1 establishes route of 9 hops to destination node 10, all selected intermediate nodes are green and neighbour nodes are blue. In link failure, upstream node selects the neighbour node from their neighbour table to continue the data transfer.

Table-I. LCR and refresh rate as figure 4

Node Id	Neighbour node Id	Number of neighbour node	Maximum average Link change rate (LCR_{max})	Initial Refresh rate (r)
1	2, 12, 14	3	6	1 s
2	1, 2, 11, 13, 14	5	10	1 s

3	2, 4, 16, 17	4	8	1 s
4	3, 5, 15, 17, 18	5	10	1 s
5	4, 6, 18, 19, 20	5	10	1 s
6	5, 7, 20, 21	4	8	1 s
7	6, 8, 21, 22, 23	5	10	1 s
8	7, 9, 23, 24	4	8	1 s
9	8, 10, 24, 25, 26	5	10	1 s
10	9, 25, 26	3	6	1 s

4.4. Link Change Rate

In [11], the authors explain the evaluation of link change rate (LCR) and assume that its measurement reflects the mobility. There are two types of counters (new-link counter and lost-link counter) assumed in neighbor table (NT) that find the number of new neighbor nodes and lost neighbor nodes. An average LCR value has been computed by the EWMA filter method to control the maximum changes in refresh rate (r). In multi-hop route such type of process causes the contention problem and increases the delay. It works better in case of low node density and mobility. An Increase in node density at any point (hop) of the route extensively affects the overall performance of MANET. Our proposed method uses the physical layer metric for control of LCR which gives better response in highly dense network and multi-hop routs.

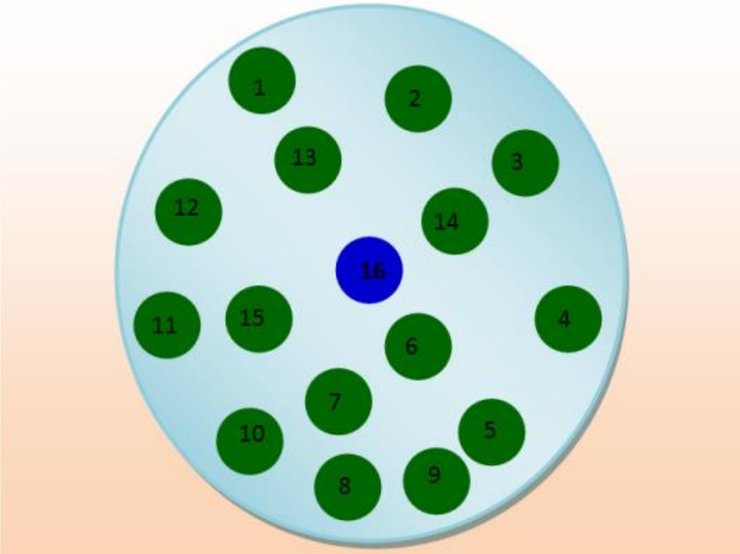

Figure 5: High node density around active node 16

Our proposed method objective is to control the LCR value by advantage of the cross-layer design. We have taken the range of RSSIth value for the selection of mobile nodes to forward the packets. We assume that a node can transmit up to maximum distance but after that distance RSSI becomes weak and the receiver cannot receive from the sender site.

In figure 6, RSSI range determination has a valid reason, a weak link has a possibility to be broken in less time. High RSSImax node selection provides the high data transfer up to a fixed rate but it increases the length of the route, such type of scenario already explained in the route discovery process. RSSImax only works better when the destination node exists inside the transmission area of the source node. We have considered RSSI rage for the evaluation of proposed methods.

Received Signal Strength Indicator (RSSI):

RSSI stands for Received Signal Strength Indicator which indicates the received signal quality. This RSSI value between any two nodes indicates the receiving capacity. This parameter is exchanged by the exchange of hello messages to update the status of neighbor nodes. By using a cross-layer approach, an exchange of RSSI has been performed to network layer which improve update of neighbor table entries so, there is a selection of nodes on the basis of RSSIth and RSSImax.

Table-II: RSSI values

Quality of Link	RSSI (dB)
High/Strong	-55
Medium/threshold	-75
Weak	-85

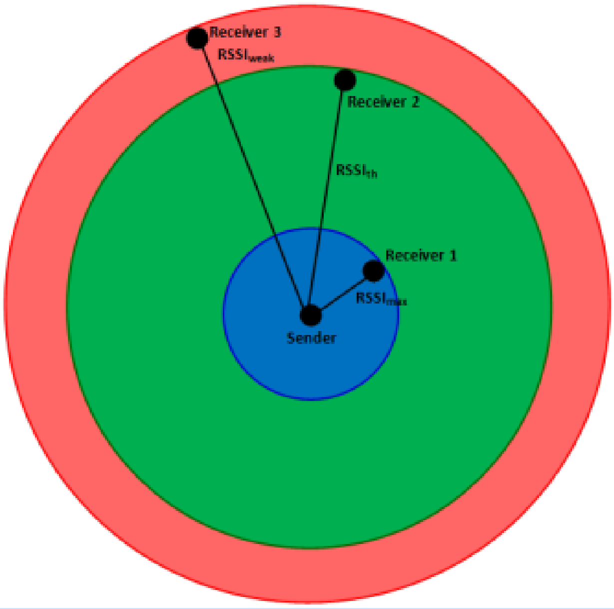

Figure 6: RSSI range for node selection

5. DESCRIPTION OF LCR CALCULATION

Our proposed method uses the existing LCR technique, which selects neighbor nodes by measuring RSSI value. We are using the LCR technique of dynamic the hello timer adjustment [11], by assuming the $RSSI_{th}$, which is exchanged by hello process. In figure 8, 9, and 10, we have modified the header of the hello message format to exchange the RSSI value and update in the virtual neighbour table (VNT) and neighbor table (NT). The complete hello process is shown in the flowchart of figure 7.

The proposed algorithm assumes the RSSI of mobile node for node selection in neighbour table entries.

1. Receive Hello message
2. Check Node_ID and RSSI
   - 2.1 if $RSSI < RSSI_{min}$
     - 2.1.1 Stop
   - 2.2 else
     - 2.2.1 if $RSSI > RSSI_{th}$
       - 2.2.1.1 Node_ID and RSSI stored in VNT
         - 2.2.1.1.1 if old node

2.2.1.1.1.1 Increment counter c and store RSSI
2.2.1.1.2 calculate LCR
2.2.2 else
2.2.2.1 Node_ID and RSSI stored in NT

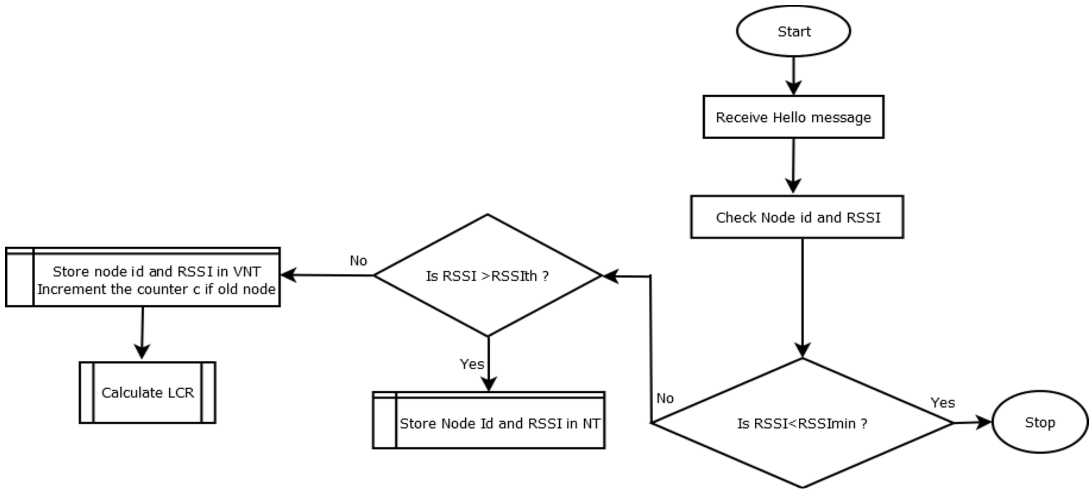

Figure 7: Flow chart of hello process to update neighbour table

Figure 7, shows neighbor table update process when the mobile node receives a hello message, which has RSSI value. This value is checked by neighbor node before updating the NT. Less RSSI value compare to minimum RSSI value for selection of neighbor node in NT. If RSSI value is very low then NT will not updated with low RSSI node Id, because it will cause loss during data transfer.

TYPE	Reserved	Hop Count	Destination ID	Destination sequence number	Source ID	Lifetime	Timestamp	RSSI Value

Figure 8: Hello packet header format

Neighbor ID	Expiry Time (seconds)	Sequence Number	$RSSI_{th}$

Figure 9: Virtual neighbour table (VNT)

Neighbor ID	Expiry Time (seconds)	Sequence Number	RSSI

Figure 10: Modified neighbour table (NT)

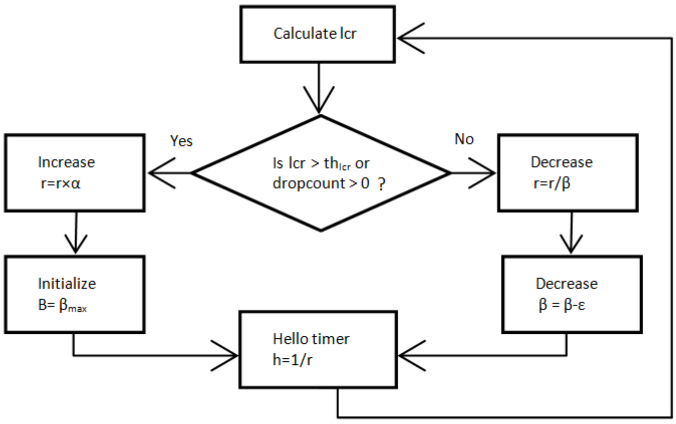

Figure 11: Refresh rate calculation (α>1, β<1) [11]

Figure 11, illustrates about the estimation of refresh rate (r), which starts as first calculating the link change rate (lcr) then compared to lcr threshold (th_{lcr}). An Increase in th_{lcr} value proceeds to update the refresh rate for updating the hello interval. In another way refresh rate (r) is reduced by dividing it with β. Overall figure 11 shows the adjustment of refresh rate, which is used in the proposed method. We have modified the hello message to exchange the RSSI value of the mobile node. We have not increased the size of the hello message to exchange the RSSI value. These values are in neighbor table, during backup routing and local repair process. We consider $\alpha>1$, $\beta<1$ from the existing dynamic hello method for evaluation [11].

5.1. Route Discovery and Route Maintenance

In our work route is established by broadcasting of RREQ packets to nodes which are available in neighbour table and virtual neighbour table. It means RREQ packets are broadcasted to $RSSI_{th}$ and $RSSI_{max}$ nodes.

The route maintenance process is initialized when a route may be broken or expired due to topological changes and huge back-off. Usually, an error notification process is used that initializes the re-route discovery [21]. This error notification system is only significant for short-span networks. In a large scale network, better route maintenance techniques are required which have the capability to locally repair [63] the broken route in stipulated time. Our proposed route maintenance improves the existing method and gives better results in a long-hop multi-hop route. In link break situation we are using the backup routing, local repair and error notification as shown in figure 12. The Backup routing process is initialized when neighbor table nodes have alternate route for the destination node. Local repair is started when alternate routes are not available and neighbor table have new entries. When backup routing and local repair process fail then an error notification is initialized by the upstream node to inform source node.

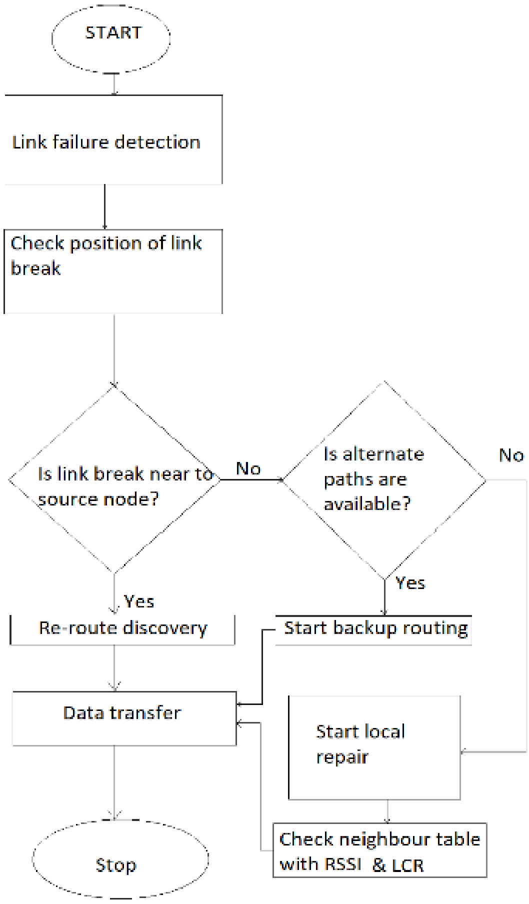

Figure 12: Improved route maintenance process in MANET

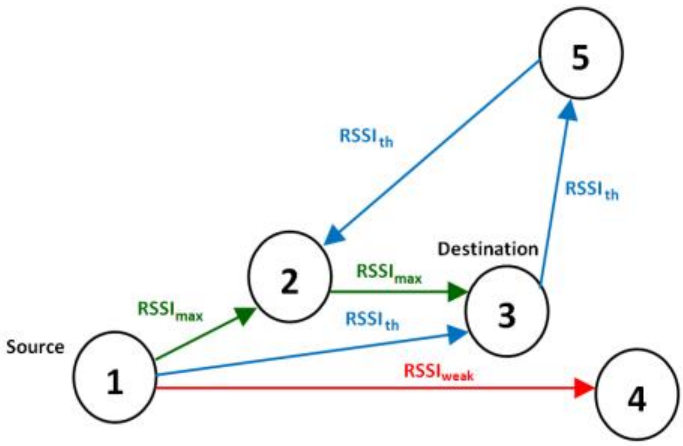

Figure 13 (a) Node selection for route discovery

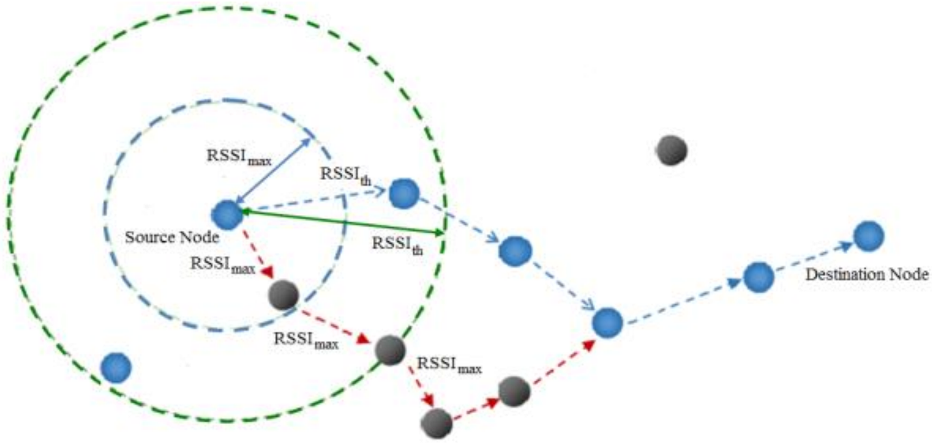

Figure 13(b): Multi-hop route discovery in MANET

Example:

Figure 13(a), shows the detailed description of RSSI quality which helps for node selection, process. In this section we are describing the route discovery process on the basis of our proposed methods. Basically, the route discovery process is modified by introducing a RSSI (RSSIth, RSSImax) parameter for forwarding of control packets. When a source node wants to send the data to the destination node then it starts the route discovery process as shown in figure 13(b). Mobile nodes directly discard Low an RSSI packets; this mechanism reduces flooding of control packets in the network. The source node only receives single-hop RSSImax RREP packet from destination node, otherwise receives multi-hop RSSIth unicast RREP packet. This type of RREP packet processing decreases the route length in MANET, which is clearly shown in figure 13(b).

6. PERFORMANCE EVALUATION

We have used the original AODV [21], routing protocol to study the effect of the proposed algorithm. The Proposed method hello process gains better performance in MANET. We have performed extensive simulations by network simulator (ns2.34) to measure the performance of our proposed method in multi-hop route and compared to the existing method of routing protocols (AODV-BR [24], AODV [21]). We have taken two scenarios where the route length is 10 hops and 15 hops for data transfer. We have considered IEEE standard 802.11 MAC layer protocol for data transfer.

Table III: Simulation parameter

Parameter	**Value**
Simulation time	1200s
Topology size	1200*800 m^2
Number of mobile nodes	100
MAC type	MAC 802.11
Radio propagation model	Two ray ground
Transmitter Range	100m
Size of packet	512 Bytes
Transmitter power	0.281W
Receiver threshold	$7.69113*10^{-8}$ W
Traffic type	CBR (2Mbps)
No of CBR	5

Initial Hello interval	1000msec
Speed	1 to 10 m/s
Mobility pattern	Random way point
Route length	10 and 15 hops

6.1. Result and Discussion

In this section we are describing the simulation result; we have observed the effect of the proposed method by considering the AODV routing protocol. We have implemented the proposed algorithm and compared it to the existing routing protocols method. We have analyzed the results by considering the following parameters which are compared with existing methods; available backup routes, no of the error message generated by the upstream node on a route, number of route repair attempts, link failure probability, number of link breaks, and performance metric as throughput.

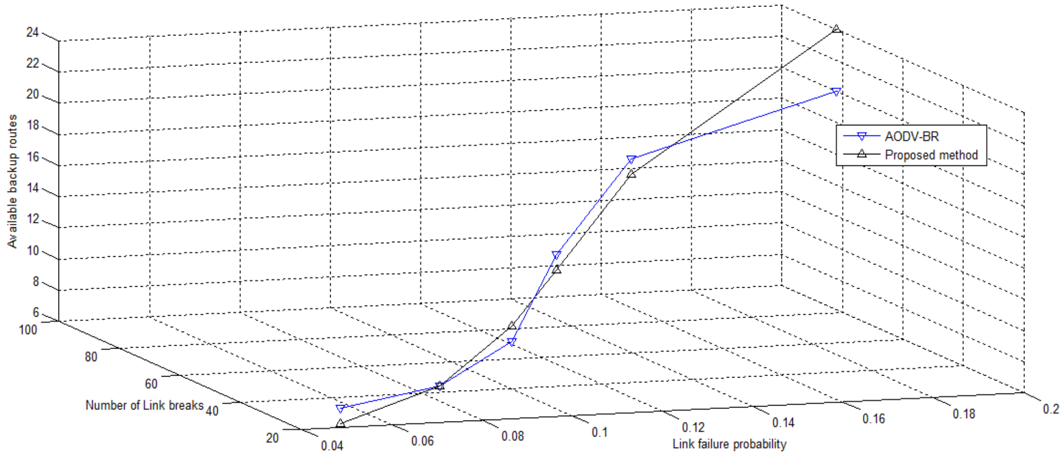

Figure 14. Comparison of Number of backup routing Vs Link failure probability

Scenario 1:

In this scenario, we have to assume a route length of 10 hops in which the size of the packet 512 Byte and there is a random number of link breaks on active route. In the simulation scenario source node starts a data transfer with data rate of 2 Mbps. The available backup routes are compared with respect to link failure probability and number of link breaks. the Figure shows the significant improvement of the proposed method over the AODV-BR [11] routing protocol in which the number of available backup routes with respect to link failure probability and the number of link breaks [10].

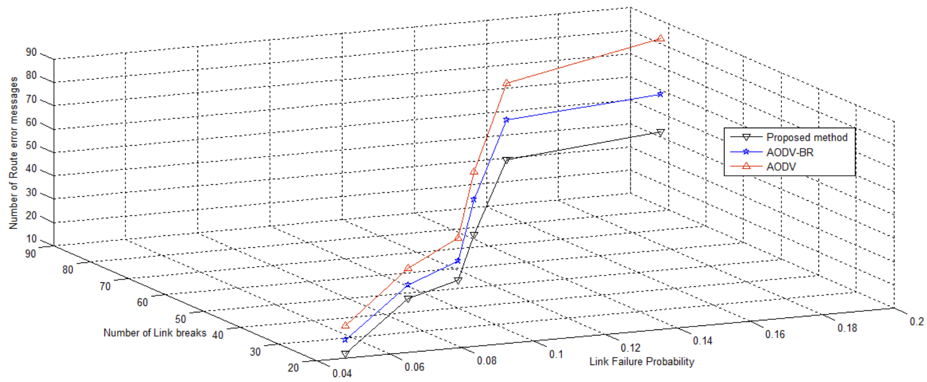

Figure 15: Comparison of Number of Error message generate Vs Link failure probability

Figure 15 shows the comparison of the number of the error messages generated when link failure probability and the number of link breaks increases. In figure we obtain that proposed method generated smaller number of error messages with respect to AODV-BR and AODV routing protocols.

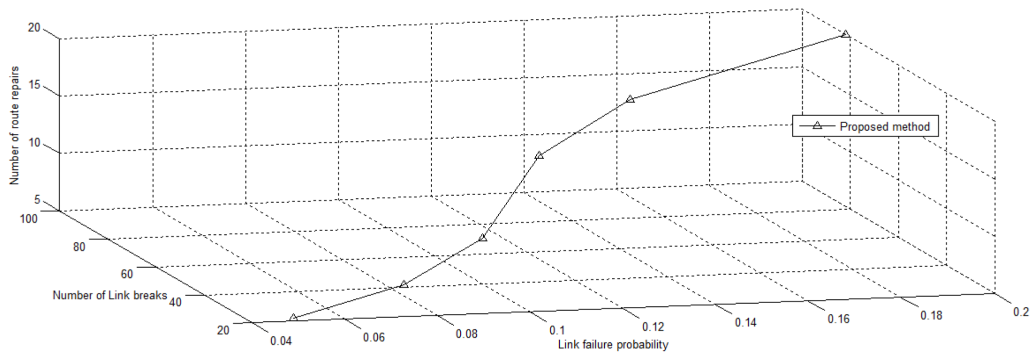

Figure 16: Comparison of Number of route repair Vs Link failure probability

Figure 16 shows the functionality of route the repair that is only enabled in the proposed method because existing method only works when the link breaks closest to the destination node. In our proposed work, a route repaired because of the position of the link break. Figure 16 shows the proposed method behavior with respect to link failure probability and the number of route repairs over the active route.

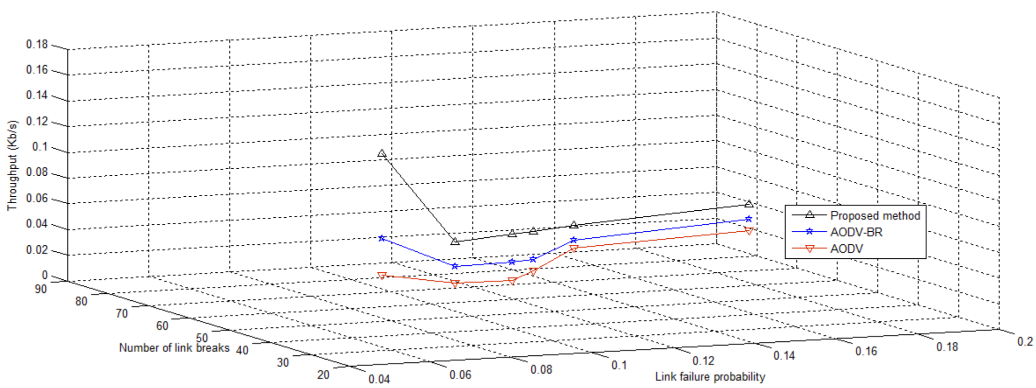

Figure 17: Comparison of Throughput Vs Link failure probability

Figure 17 shows the improvement in throughput of proposed method over 10 hop multi-hop route, and AODV-BR and AODV have less throughput.

Scenario 2

In this scenario, we have to consider route length 15 hops in which the size of the packet is a change to 512 Byte and there is a random number of link breaks on the active route. In the simulation scenario source node starts the data transfer with data rate 2 Mbps.

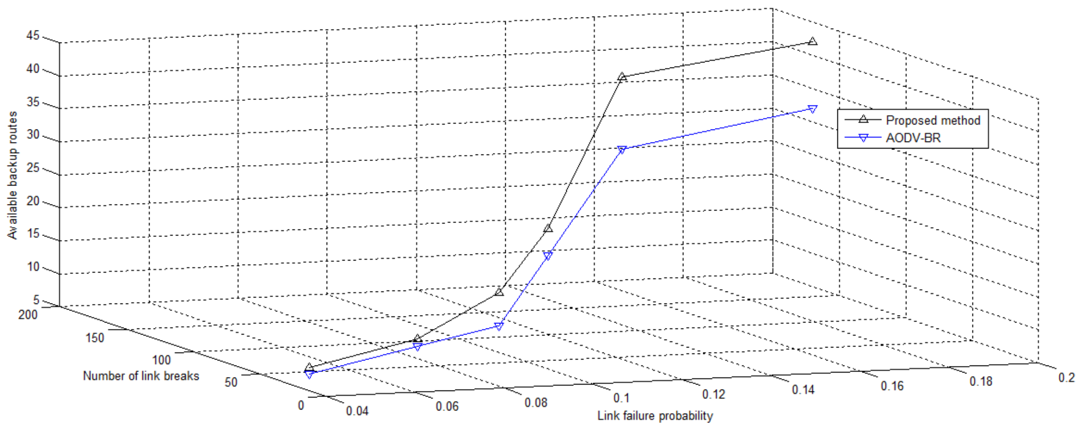

Figure 18: Comparison of Number of backup routing Vs Link failure probability

Figure 18, shows the significant improvement of proposed method when route length increased to 15 hops. It is compared to AODV-BR routing protocol by considering following parameters; number of available backup routes with respect to link failure probability and number of link breaks.

In figure 19, shows the comparison of number of error message generated by proposed method and AODV-BR and AODV routing protocols. There is significant reduction in error message generation by proposed method which is due use of fresh backup routes.

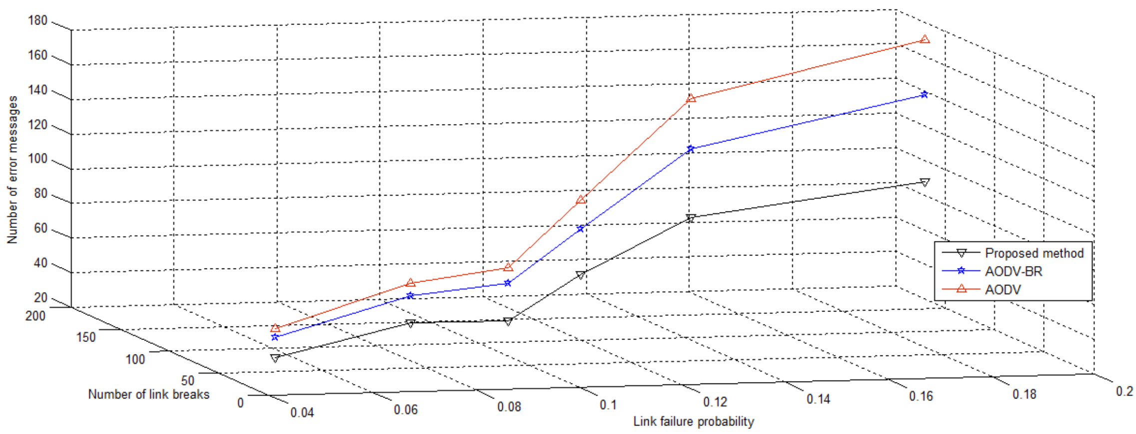

Figure 19: Comparison of Number of Error message generate Vs Link failure probability

In figure 20, shows use of the route repair process by the proposed method it only happens due to the unavailability of backup routes. Here it shows behavior with respect to number of routes the repair and link failure probability. Local route repair invokes when backup routes are not available. It only happens when neighbour nodes density along active routes are very low.

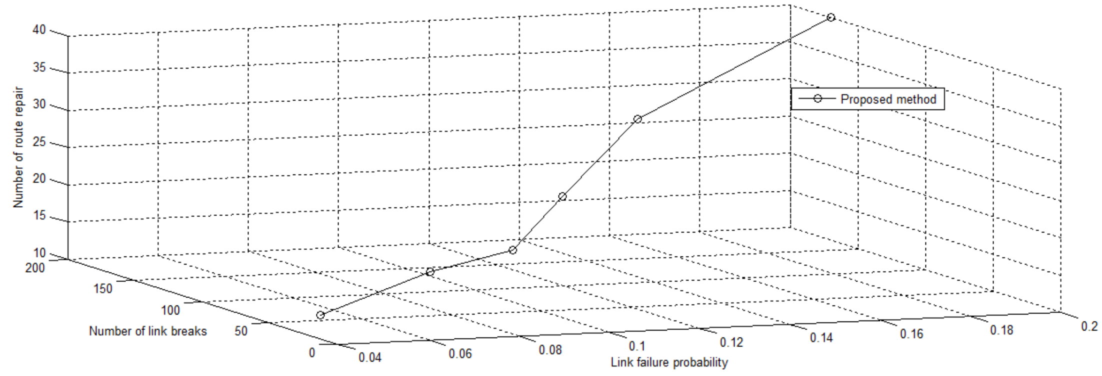

Figure 20: Comparison of Number of route repair Vs Link failure probability

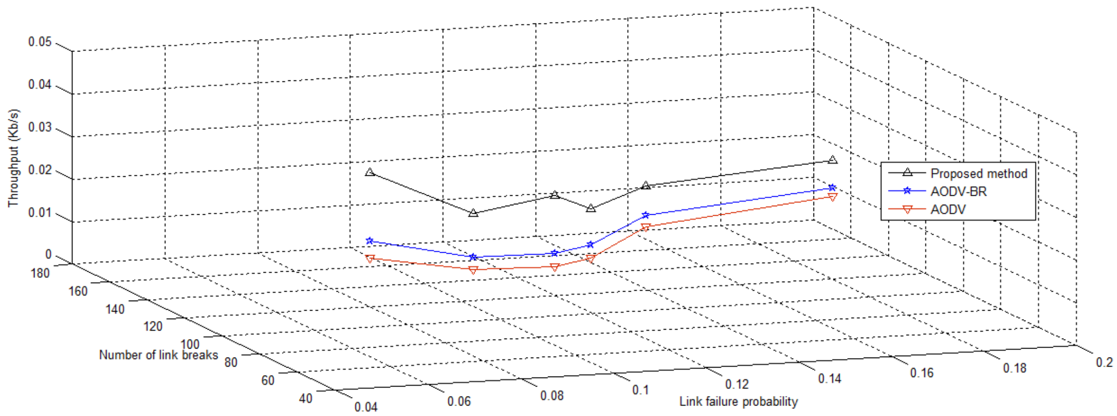

Figure 21: Comparison of Throughput Vs Link failure probability

The results in figure 21, show the improvement of throughput by the proposed method and compared to the AODV-BR and AODV routing protocol. We have observed that in a dense network the performance of the proposed method.

7. CONCLUSIONS

In mobile ad-hoc network link connectivity information is obtained by the hello process. Link timeout or neighbour timeout, route timeout are the problems which that degrade the overall performance of the network. These timeout issues can be overcome by applying various techniques at layer 2 (Data Link) and layer 3 (Network). In general, a link indicates the existence of neighbour node inside the coverage area of the node. Hello process is an important part of route maintenance, which is followed in several routing protocols. Its periodicity shows the utilization in a network to obtain the up-to-date neighbour node's information. In dynamic topology, existing hello process lacks the update of the link lifetime (neighbour lifetime) and route lifetime. In this work, we have considered the existing work, which is the dynamic adjustment of hello timer. The Major limitation of dynamic the hello is very low refresh rate (hello interval) which is evaluated based on high link change rate (LCR) value. The reason behind high LCR is due to consideration of all neighbour nodes, which are in proximity, and exterior area of a node. We have the proposed an algorithm based on of $RSSI_{th}$ to control the

LCR and achieve efficient refresh rate. Implementation of proposed method has been done in AODV routing protocol and compared to the existing schemes. Our results show the a significant improvement over existing routing protocols (AODV-BR and Original AODV).

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] I. Chlamtac, M. Conti and J. J.-N. Liu, “Mobile ad hoc networking: imperatives and challenges”, Ad hoc networks, vol. 1, no. 1, pp. 13-64, 2003.

[2] De Couto, Douglas SJ, et al, "Performance of multihop wireless networks: Shortest path is not enough", ACM SIGCOMM Computer Communication Review 33.1 (2003): 83-88.

[3] Chin, Kwan-Wu, et al, "Implementation experience with MANET routing protocols", ACM SIGCOMM Computer Communication Review 32.5 (2002): 49-59.

[4] Danyang, Qin, et al, "Routing timer self-adaptive regulating algorithm based on MIMD loop control for MANET", Communications and Networking in China (CHINACOM), 2011 6th International ICST Conference on. IEEE, 2011.

[5] Chakeres, Ian D., and Elizabeth M. Belding-Royer, "The utility of hello messages for determining link connectivity", Wireless Personal Multimedia Communications, 2002. The 5th International Symposium on. Vol. 2. IEEE, 2002.

[6] Oliveira, Rodolfo, et al, "The Impact of Node's Mobility on Link-Detection Based on Routing Hello Messages", Wireless Communications and Networking Conference (WCNC), 2010 IEEE. IEEE, 2010.

[7] Tseng, Yu-Chee, Sze-Yao Ni, and En-Yu Shih, "Adaptive approaches to relieving broadcast storms in a wireless multihop mobile ad hoc network", Computers, IEEE Transactions on 52.5 (2003): 545-557.

[8] Paul, Amrita Bose, and Sukumar Nandi, "Impacts of refresh interval parameters on M-OLSR performance for Wireless Mesh Networks", TENCON 2009-2009 IEEE Region 10 Conference. IEEE, 2009.

[9] Mostajeran, Ehsan, and Rafidah Md Noor, "Performance comparison of AODV based on Link layer feedback and neighbor discovery methods in MANET", Wireless Technology and Applications (ISWTA), 2012 IEEE Symposium on. IEEE, 2012.

[10] Valera, Alvin, and Hwee-Pink Tan, "Analysis of hello-based link failure detection in wireless ad hoc networks", Personal Indoor and Mobile Radio Communications (PIMRC), 2012 IEEE 23rd International Symposium on. IEEE, 2012.

[11] N. Hernandez-Cons, S. Kasahara, and Y. Takahashi, “Dynamic hello/timeout timer adjustment in routing protocols for reducing overhead in manets", Computer Communications, vol. 33, no. 15, pp. 1864{1878, 2010.

[12] Ramachandran, B., and S. Shanmugavel, "Received signal strength-based cross-layer designs for mobile ad hoc networks", IETE technical review 25.4 (2008): 192-200.

[13] Chakeres, Ian D., and Elizabeth M. Belding-Royer, "The utility of hello messages for determining link connectivity", In Wireless Personal Multimedia Communications, 2002. The 5th International Symposium on, vol. 2, pp. 504-508. IEEE, 2002.

[14] Chin, Kwan-Wu, John Judge, Aidan Williams, and Roger Kermode, "Implementation experience with MANET routing protocols", ACM SIGCOMM Computer Communication Review 32, no. 5 (2002): 49-59.

[15] Johnson, David B, "The dynamic source routing protocol for mobile ad hoc networks", draft-ietf-manet-dsr-09. txt (2003).

[16] C.-W. Chen, C.-C. Weng, and Y.-C. Kuo, “Signal strength based routing for power saving in mobile ad hoc networks," Journal of Systems and Software, vol. 83, no. 8, 2010, pp. 1373-1386.

[17] Dapeng, Wu, et al, "On-demand reliable routing mechanism for MANET based on link lifetime predicting", Wireless Communications, Networking and Mobile Computing, 2008. WiCOM'08. 4th International Conference on. IEEE, 2008.

[18] De Couto, Douglas SJ, et al, "Performance of multi-hop wireless networks: Shortest path is not enough", ACM SIGCOMM Computer Communication Review 33.1 (2003): 83-88.

[19] Wang, Zhen-zhong, Jian-de Lu, and Jia-jia Tang, "Neighbor monitoring mechanism to solve unidirectional link problem in MANET", Wireless and Mobile Communications, 2007. ICWMC'07. Third International Conference on. IEEE, 2007.

[20] Han, Seon Yeong, and Dongman Lee, "An adaptive hello messaging scheme for neighbor discovery in on-demand MANET routing protocols", Communications Letters, IEEE 17.5 (2013): 1040-1043.

[21] Perkins, Charles, Elizabeth Belding-Royer, and Samir Das, ”Ad hoc on-demand distance vector (AODV) routing”, No. RFC 3561. 2003.

[22] Paillassa, Beatrice, Cholatip Yawut, and Riadh Dhaou, "Network awareness and dynamic routing: The ad hoc network case", Computer Networks 55.9 (2011): 2315-2328.

[23] Alsaqour, Raed, et al, "Dynamic packet beaconing for GPSR mobile ad hoc position-based routing protocol using fuzzy logic", Journal of Network and Computer Applications 47 (2015): 32-46.

[24] Lee, Sung-Ju, and Mario Gerla, "AODV-BR: Backup routing in ad hoc networks", In IEEE Wireless Communications and Networking Conference (WCNC. 2000), vol. 3, pp. 1311-1316.

[25] Dunham, W. "Heron's formula for triangular area." Journey Through Genius: The Great Theorems of Mathematics. Wiley, New York (1990): 113-132.

[26] Sundaresan, Karthikeyan, and Konstantina Papagiannaki, "The need for cross-layer information in access point selection algorithms", Proceedings of the 6th ACM SIGCOMM conference on Internet measurement. ACM, 2006.

[27] A. Naushad, G. Abbas, Z. H. Abbas, and L. Jiao, “A novel faster failure detection strategy for link connectivity using hello messaging in mobile ad hoc networks,” IJAHUC, vol. 32, no. 2, pp. 75–98, 2019.

[28] Banga S., Arora H., Sankhla S., Sharma G., Jain B, "Performance Analysis of Hello Flood Attack in WSN", Proceedings of International Conference on Communication and Computational Technologies. Algorithms for Intelligent Systems, Springer, pp. 335-342, 2020.

[29] Vignesh, C.C., Sivaparthipan, C.B., Daniel, J.A. et al, "Adjacent Node based Energetic Association Factor Routing Protocol in Wireless Sensor Networks", Wireless Personal Communication, (2021).

[30] Muhammad K. Khan, Muhammad Shiraz, Qaisar Shaheen, Shariq Aziz Butt, Rizwan Akhtar, Muazzam A. Khan, Wang Changda, "Hierarchical Routing Protocols for Wireless Sensor Networks: Functional and Performance Analysis", Journal of Sensors, pp. 1-18 pages, 2021.

[31] Priyanka Pandey and Raghuraj Singh, "An Efficient and Stable Routing Algorithm in Mobile Ad Hoc Network", International Journal of Computer Networks & Communications (IJCNC), Vol. 13(4), pp. 21-37, 2021.

[32] Gyanendra Kumar Pallai, Meenakshi Sankaran and Amiya Kumar Rath, "Self-Pruning based Probabilistic Approach to Minimize Redundancy Overhead for Performance Improvement in MANET", International Journal of Computer Networks & Communications (IJCNC), Vol. 13(2), pp. 15-36, 2021.

[33] Amir J. Majid, "Scenarios of Lifetime Extension Algorithms for Wireless Ad Hoc Networks", International Journal of Computer Networks & Communications (IJCNC), Vol. 12(6), pp. 83-97, 2020.

AUTHORS

Dhirendra Kumar Sharma working as Assistant Professor-SG at SCS, University of Petroleum and Energy Studies Dehradun. He did Ph.D (CSE) from Indian Institute of Technology (ISM) in 2016. His research interest in protocols development for ad hoc networks, wireless sensor networks, UAV communication.

Nitika Goenka working as Assistant Professor at SCS, University of Petroleum and Energy Studies Dehradun. Her area of Specialization Software Development (JAVA, Web Services) and Testing (Groovy), Compute vision.