Minimizing Link Failure in Mobile Ad Hoc Networks Through QOS Routing

S. Senthil Kumar

Abstract Routing in dynamic networks often suffers from link failure issues through mobile ad hoc networks (MANET), frequent link breaks that occur in the path due to unrestricted node mobility, and node failures which violate the quality of service (QOS) requirements. This paper proposes a location-based routing for route maintenance based on localization of link failure. It takes decision based on location of failure link of source route. The link failure minimizing technique using Robust Location-based Routing Protocol achieves better packet preserving and increases the number of delivered packets to destination compared to the conventional AODV.

Keywords Mobile ad hoc network · Link failure mechanism
Efficient routing · Signal strength

1 Introduction

Decentralized network architecture consists of mobile nodes, and the infrastructure is formed by the synchronization of mobile wireless devices in the "ad hoc" mode operation. MANETs are comprehensively used for moving ahead relevance appliances and remain as a promising technology. The nodes in the network used over links are independent nodes that are bandwidth constrained. Since the nodes are mobility in nature, the network topology changes rapidly and unpredictably over time. All nodes are independent that can take decisions on the subject of the operations along with the nodes individually and in a decentralized manner.

The signal strength varies as the routes are no longer static in MANETs; hence, the network may detach at any instance. The link between them exists only when the node is strong enough to receive the recognized signal. A link which stays alive

S. Senthil Kumar (✉)
Department of Computer Science and Engineering, Guru Nanak Institute of Technology, Ibrahimpatnam, India
e-mail: harisen1234@yahoo.co.in

H. S. Saini et al. (eds.), *Innovations in Computer Science and Engineering*,
Lecture Notes in Networks and Systems 32,
https://doi.org/10.1007/978-981-10-8201-6_27

at one instant may possibly not survive in the subsequent moment since the link exists only when a node can take delivery of a sufficiently strong recognizable signal from its neighbour. Based on the power present in the transmitted signal, the strength of the received signal, the distance between the two nodes, the barriers between them and the various number of paths in which the signals travel due to reflection are all measured.

An ad hoc network consists of multiple “nodes” that are connected by “links”. Links are inclined by the node’s resources and behavioural properties [1]. The functioning network must be able to deal with this dynamic restructuring since links can be connected or detached at any time, hence a functioning network, rather in a way that is timely, proficient, reliable, strong, and scalable. The network must permit any of the two nodes to communicate the information via other nodes.

2 Related Works

Unicast routing protocol was designed for wired networks. Local Unicast Routing Control Agent (L-URCA) is the designed protocol co-located with each router, and with dynamism updates, the Optimal Shortest Path First (OPSF) link costs to re-route highly congested message passage or highly utilized links. The Optimized Link State Routing(OLSR) Protocol was developed, and every node selects a set of its neighbour nodes as “multipoint relays”, and the control traffic is reduced by minimizing the number of retransmissions.

Fisheye State Routing (FSR) is an intrinsic [2] hierarchical routing protocol developed for maintaining the accurate link information about the neighbour nodes by estimating the pixels of focal point.

Dynamic Source Routing Protocol is a reactive protocol proposed here each packet carries the full address from source to destination. But this increases the overhead carried out by packet and thus in turn increases as network size increased. This leads to DSR to consume high bandwidth [3]. DSR performed better for small network size.

Ad hoc on-demand vector (AODV) [4] was proposed to overcome the degradedness of DSR. The data packet from the source contains destination address in order to reduce the routing overhead, and this protocol is highly adaptable to highly dynamic networks.

An angle-aware broadcasting algorithm was proposed to address the broadcast storm problem [5–7]. This algorithm calculates the number of rebroadcast probability dynamically, based on the angles covered by a node concerning its neighbours without going for latter’s knowledge information.

Genetic algorithm (GA) is an optimizing tool derived from the swarm optimiser, and its key factors determine the performance of GA [8]. This algorithm has fine-designed architecture of chromosomes and operators that build an intelligent algorithm. Multicasting routing minimizes the parameters of network by delivering the data with minimum delay and less bandwidth consumption.

Fault-Tolerant Routing Algorithm (FTRA) was proposed to address the problem of fault-prone nodes which degrades the network performance. The FTRA [9] is alienated into six stages: initialization of nodes, path selection among them, pheromone deposition (dropping RReq), confidence calculation, evaporation and negative reinforcement (availability of path). However, the number of iterations is more and that it increases the energy consumption of nodes.

3 Location-Based Routing Algorithm

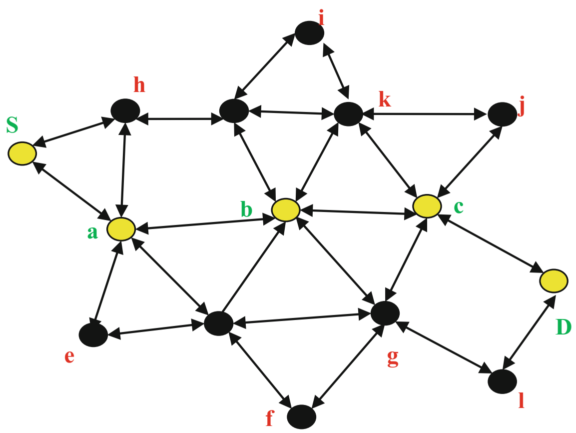
The link failures can be minimized by using the proposed algorithm named Robust Location-Based Routing Protocol (RLBRP). This protocol implements the end-to-end connectivity by means of estimating the signal reachability by validating the transmission range. The data transmission range purely depends upon the node's communication range.

Determination of availability of link between the nodes is done by considering node's communication range and data transmission range. Based on the signal strength, the strongly connected nodes are selected in the network for relaying the information. The decentralized MANET architecture is shown in Fig. 1. The coloured nodes from source to destination indicate strong link among them, and the path S-a-b-c-D between the nodes is chosen for the effective data transmission.

(i) Nodes Communication Range

Determining the communication range between the nodes is difficult since the nodes are highly movable in the MANET environment. Generally, the communication range between the nodes is determined by calculating the distance between them, but the nodes move randomly and the location changes continuously. Probable prediction of availability of nodes to some extent in the same communication range is identified by continuously sending the route request message. The communication range and the path quality are determined by taking the average of

Fig. 1 MANET architecture



number of nodes present in the environment and their communication distance between them:

$$C_R(N) = \sum_{i=0}^{n} Si \oplus Di \qquad (1)$$

where

$C_R(N)$ Communication range between nodes
S_i Source node (i)
D_i Destination node (i)

The signal strength of the nodes is determined by calculating the distance between them based on their location. To identify the signal strength, it is mandated to calculate the transmission level of each individual node. The transmission range or broadcast range of a node is directly proportional to the received signal strength of the respective node which is given in Eq. 2. The flow chart of the proposed link failure minimizing technique is given in Fig. 2.

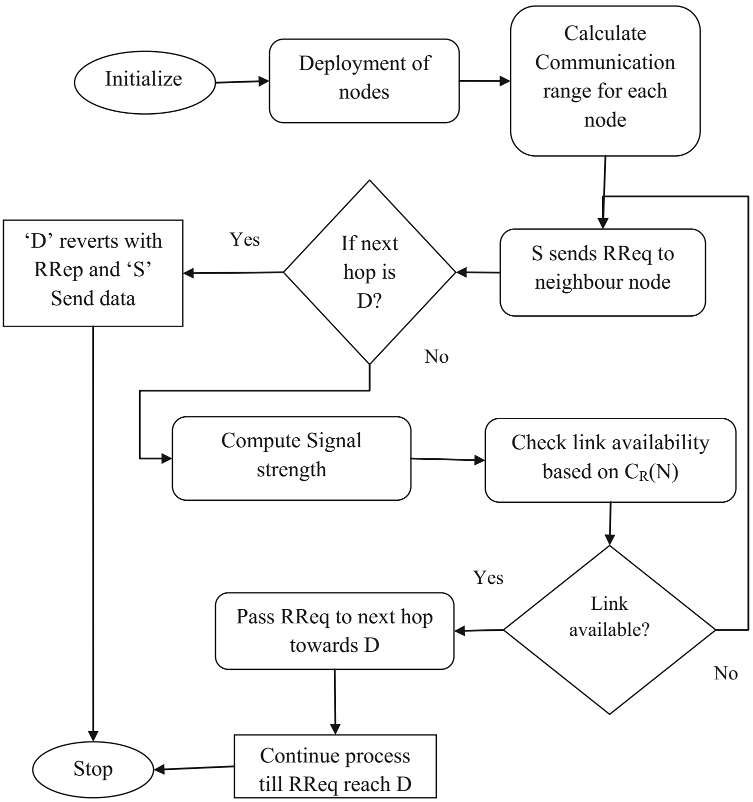


Fig. 2 Flow chart for minimizing link failure technique

$$Signal\,strength \propto C_R(N) \tag{2}$$

(ii) Link Quality and Data Transmission
The link between the nodes is determined by calculating the distance between the nodes. Low congested and high-bandwidth path gives a high path quality, and determining those routes is not quite easy since the nodes broadcast the route request to all of its neighbours. The node which sends route reply in prior is listed as less congested path. The particular neighbour node may be so closest to the source and destination. The intermediate nodes which are selected as next hop should be towards the destination, and the high-bandwidth nodes are chosen for the data transmission in order to improve the link quality.

4 Simulation Results

The performance of the proposed system is analysed with the metrics delivery rate and delay. The simulator used for simulating the RLBRP with the conventional scheme is Network Simulator (NS-2) that is extensively used for research in many areas of networking. In MANET, it is possible to discretely analyse the events in a network scenario by using the NS-2 tool.

The traffic model is Constant Bit Rate (CBR), and the number of nodes is 30 with corresponding transmission range 250 m. The antenna model used here is omnidirectional type so that the node can access the data in all directions.

4.1 Packet Delivery Rate

Packet Delivery Rate (PDR) is the measure of the successful packet delivery ratio. The ratio between the sent packets and received packets gives the successful PDR, and it is derived using Eq. 3:

$$Pkts\,Rcvd = \frac{No\,of\,pkts\,sent}{No\,of\,pkts\,rcvd} \tag{3}$$

The greater value of PDR means the improved performance of the proposed protocol. It is clearly shown in Fig. 3.

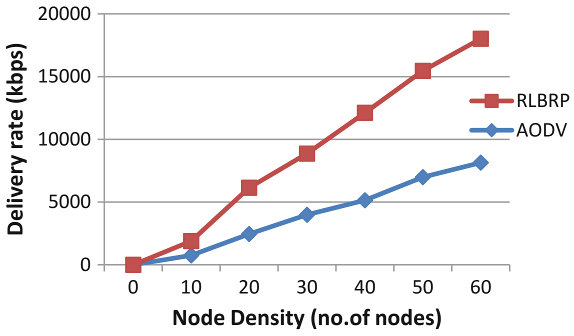


Fig. 3 Packet delivery rate

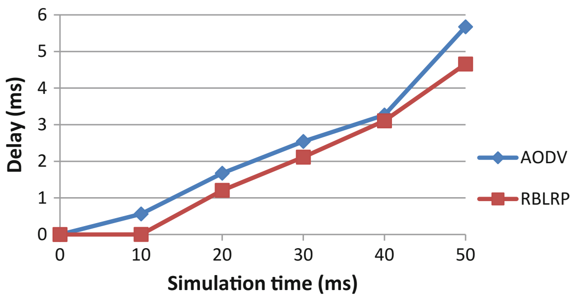


Fig. 4 Average delay

4.2 Average Delay

The time difference taken for the current packets received and the previous packet received gives the average delivery delay of packets. It is measured by Eq. 4:

$$Avg\,Delay = \frac{Pkts\,Recvd\,Time\ -\ Pkts\,Sent\,Time}{Time} \tag{4}$$

Figure 4 demonstrates the performance of delay with respect to the simulation time. The result shows that the RLBRP has minimum delay when compared to the existing scheme.

5 Conclusion

Recurrent link failures occurred in the route might cause due to unrestricted mobility of node and node breakdown due to insufficient energy which violate the quality of service (QOS) requirements. This issue can be overcome by using this proposed RLBRP. Location-based routing algorithm is used in the RLBRP scheme in which route maintenance is utilized based on localization of link failure. It takes decision based on location of failure link from the source route. The proposed algorithm may achieve better packet preserving and increases the delivered packets' quantity to destination and performance of DSR.

References

1. E. M. Royer and C. E. Perkins, "Multicast Operation of the Ad-hoc On-demand Distance Vector Routing Protocol", in Proc. ACM MOBICOM, pp. 207–218, Aug. 1999.
2. Pei, Guangyu, Mario Gerla, and Tsu-Wei Chen. "Fisheye state routing: A routing scheme for ad hoc wireless networks." In Communications, 2000. ICC 2000. 2000 IEEE International Conference on, vol. 1, pp. 70–74. IEEE, 2000.
3. Torkestani J. A., Meybodi M. R, "A link stability-based multicast routing protocol for wireless mobile ad hoc networks", Journal of Network and Computer Applications, Volume 34 Issue 4, July, 2011.
4. C. E. Perkins and E. M. Royer, "Ad-hoc On-demand Distance Vector Routing", in Proc. IEEE WMCSA, pp. 90–100, Feb. 1999.
5. M. Mauve, H. FüBler, J. Widmer, and T. Lang, "MobiHoc Poster: Position-Based Multicast Routing for Mobile Ad-Hoc Networks," Mobile Computing and Communications Review, USA, 7: 3 (2003).
6. Shen, C. C., & Jaikaeo, C. (2005). Ad hoc multicast routing algorithm with swarm intelligence. Mobile Networks and Applications, 10(1), 47–59.
7. Baker, M.R, Akcayol, M.A, "A Survey of Multicast Routing Protocols in Ad-Hoc Networks", Gazi University Journal of Science, 24(3), 451–462.
8. Baburaj, E., & Vasudevan, V. "An Intelligent On Demand Multicast Routing Protocol for MANETs" In Emerging Trends in Engineering and Technology, 2008. ICETET'08. First International Conference pp. 214–217, 2008.
9. Misra, S., Dhurandher, S. K., Obaidat, M. S., Verma, K., & Gupta, P. "A low-overhead fault-tolerant routing algorithm for mobile ad hoc networks: A scheme and its simulation analysis", Simulation Modelling Practice and Theory, 18(5), 637–649, 2010.