Effective Usage of Rebroadcast Delay to Minimize Routing Overhead in MANET

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Abstract: Broadcasting is effective data dissemination mechanism for route discovery in Mobile Ad-hoc Network (MANET). Although it has many benefits, it also causes some problems such as the broadcast storm problem, which is pertaining to redundant retransmission, collision, and contention. Many techniques have been proposed to solve them but none of them guarantees the lowest bound. To overcome broadcast storm problem and reduce routing overhead, proposed system minimizes routing overhead using rebroadcast delay and rebroadcast probability. It also considers Nodes having highest energy will broadcast the RREQ packets to its neighbors. This system is implemented over the MANET network and simulated using Network Simulator (NS2). This project contributes that neighbor nodes of the failed link take the backup in case of link failure so as to decrease the number of retransmissions and minimizes routing overhead, also helps in improving the routing performance.

Keywords: Mobile Ad-hoc Network, neighbor coverage, routing overhead, link failure.

Introduction

A wireless ad-hoc network has features such as self configuring, self-maintenance and the deficiency of the need for fixed network infrastructures or centralized administration and inexpensive deployment. Nodes communicate with each other directly or through intermediate nodes. In MANET a node can act both as a host or a router. A traditional wired network doesn't exhibit these features. A MANET system is a group of mobile (or temporarily stationary) devices which need to provide the ability to stream voice, data and video between arbitrary pairs of devices utilizing the others as relays to avoid the need for infrastructure. They dynamically change locations to form a network to exchange information. It doesn't rely on pre-existing infrastructure. Because of the dynamic nature of nodes routing is a challenging issue in mobile ad hoc network.

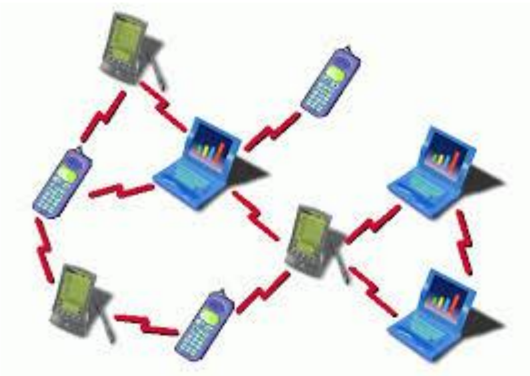

Fig 1.Mobile Ad-hoc Network

Routing protocols are categorized into two categories Proactive and Reactive routing protocols. Ad-hoc On-demand Distance Vector Routing (AODV) [9], Dynamic Source Routing (DSR) [10] is reactive routing protocol. A node in reactive routing protocol minimizes routing overhead. They minimize it by only sending routing information as soon as the communication is initiated between them.

Conventional routing protocols use flooding technique to find route. In flooding source node broadcast a packet to all its neighbors. It causes redundant retransmission of RREQ and causes broadcast storm problem. Effective technique for route discovery is broadcasting. Broadcasting algorithms are classified into four categories such as simple flooding, probability-based, area-based and neighbor-knowledge methods. Neighbor-knowledge method's performance is better than the others [11].

Due to mobile nature of nodes in MANET, continuously link breakage problem occur which causes path failures and finding of route. It leads to increase in routing overhead, increase in delay and reduction in packet delivery ratio. Hence, minimization of routing overhead in route discovery is an important problem in MANET.

Broadcasting optimization by controlling number of rebroadcast is motivation of the proposed system. To utilize the neighbor coverage knowledge efficiently, rebroadcast delay determines the rebroadcast order. To minimize the redundant retransmissions and to keep network connectivity and connectivity factor is used to determine how many neighbors should covered by transmission. Routing performance is improved using rebroadcast probability which reduces the number of RREQ packet broadcasting which improves the. In this way performance is increased [1].

An important contribution of this project is: If node is identified in the dense area, the node will not broadcast the RREQ packets. Thus nodes having highest energy will broadcast the RREQ packets to its neighbors. And in case of link failure, Source node has to discover another path to send the packet. In proposed system neighbor nodes of the failed link takes the backup and starts to send the packet.

Related Work

Conventional techniques to minimize routing overhead associated in route discovery:

Z. Haas, J.Y. Halpern, and L. Li proposed Gossip-based Ad-hoc Routing Method. Gossiping uses percolation theory. In high density network, there is limitation in gossip-based approach. Gossiping can save 35% message overhead other than flooding and also it can be used in almost any routing algorithm [2]. Robust Broadcast Propagation (RBP) protocol is proposed by *Stann et al.* which provides reliability for flooding in wireless networks. Reliable broadcasting is purpose of this algorithm. It provides more reliable broadcast by reducing the frequency of upper layer which improves the overall performance of flooding [6]. Dynamic Probabilistic Route Discovery Protocol (DPR) *is discovered by J.D. Abdulai, M. Ould-Khaoua, L.M. Mackenzie, and A. Mohammed*. In this approach, Node calculates forwarding probability according to the set of neighbors covered by the transmission and the characteristic of its node density .DPR gives high performance but in most cases, route discovery gives problem [3]. *Alireza Keshavarz-Haddad, Vinay Ribeiro, Rudolf Riedi* approached a scheme named as Dynamic Reflector Broadcast (DRB) and Dynamic Connector- Connector Broadcast (DCCB).It uses small number no of nodes. It guarantees full reachability [4].*Wei Peng Xi-Cheng Lu* proposed Scalable Broadcast Algorithm (SBA).Aim of this algorithm is to avoid unnecessary rebroadcasts by using information about local topology and duplicate broadcasts [5]. *Kim et al.* approaches a probabilistic broadcasting scheme based on coverage area and neighbor confirmation. Rebroadcast probability is set by using coverage area, and uses the neighbor confirmation to guarantee reachability [7].

Proposed Work

To minimize routing overhead proposed system uses rebroadcast delay and rebroadcast probability. The neighbor coverage based probabilistic rebroadcast protocol (NCPR) combines both neighbor coverage and probabilistic methods. Rebroadcast delay is needed in order to successfully utilize the knowledge about neighbor coverage, and to obtain the rebroadcast order. Then accurate additional coverage ratio is acquired. Connectivity factor verifies how many neighbors should receive the RREQ packet, for maintaining the network connectivity and reducing the redundant retransmissions. After that, Rebroadcast probability is established by combining the additional coverage ratio and the connectivity factor, for reducing the number of retransmissions of the RREQ packet and to improve the routing performance.

I. Architecture

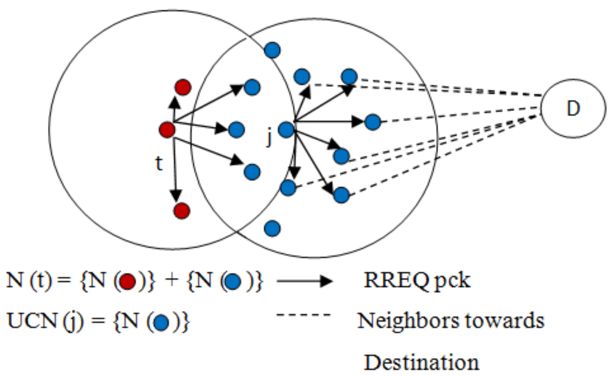

Fig 2.Architecture of system

Every node in the network sends the beacon packets to each node in the transmission range. When a node receives the beacon packet it will reply including its information. Every node updates its neighbor list very often. After initialization of route discovery process, source node sends the RREQ packet to its neighbors.

A node which receives the RREQ packet, it compares the neighbor list with its sender neighbor list. And, it determines the common neighbors. If node n_j has more neighbors which are not covered by the RREQ packet from t, if node n_j rebroadcasts the RREQ packet, packet can reach more additional neighbor nodes in the network. Rebroadcasting is done based on nodes which are not able to receive the broadcast packet and known as Uncovered Neighbors Set.

II. Rebroadcast Delay

To find the route between the source and destination the RREQ packet is broadcasted. Because of the broadcast nature of an RREQ packet, nodes can receive duplicate RREQ packet from its neighbors. In order to adequately exploit the neighbor knowledge every node should set a rebroadcast delay. Node transmission order is determined by rebroadcast delay. If node n_j has more neighbors uncovered by the RREQ packet, it means that if node n_j rebroadcasts the RREQ packet, that packet can reach more additional neighbor nodes. In the proposed work, Uncovered Neighbors set Un (n_j) of node n_j is calculated.

$$T_p(n_j) = \frac{N(t) \cap N(n_j)}{|N(t)|} \qquad (1)$$

When node s sends an RREQ packet, all its neighbors n_j; j = 1; 2; . . . ; receive and process the RREQ packet. Assume that node n_j has the largest number of common neighbors with node s then node n_m has the lowest delay. Once n_m rebroadcasts the RREQ packet, there are more nodes to receive it, because a node n_j has the largest delay. Timer is set according to the rebroadcast delay. When a node receives the duplicate RREQ packet before expires the timer, it adjusts the UCN list.

III. Neighbor Knowledge and Rebroadcast Probability

There is no need to adjust rebroadcast delay. Final UCN set is obtained when the timer of the rebroadcast delay expires. Final UCN set nodes are the nodes that need to receive and process the RREQ. If any node does not sense any duplicate RREQ packets from its neighborhood then its UCN set can't changed, which is the initial UCN set. Final UCN set is used to set the rebroadcast probability.

Rebroadcast Probability is composed of two factors Additional coverage ratio and connectivity factor.

Additional coverage ratio:

$$Ad(n_j) = \frac{|U(n_j)|}{|N(n_j)|} \qquad (2)$$

Coverage Ratio= Number of nodes that are additionally covered by this rebroadcast / Total number of neighbors of node n_j.

Nodes which are additionally covered by this rebroadcast need to receive and process the packet. As Ad_a increases, more nodes will be covered by this rebroadcast. Thus more nodes need to receive and process the RREQ packet so the rebroadcast probability should be set to be higher.

Connectivity factor:

$$C_f(n_j) = \frac{N_c}{|N(n_j)|} \qquad (3)$$

Where N_c = 5.1774 log n, and n is the number of nodes in the network, If |N (n_j)| is greater than N_c then node n_j is in the dense area of the network. Then only part of neighbors of node n_j forwarded the RREQ packet could keep the network connectivity. And when |N (n_j)| is less than N_c, C_f (n_j) is greater than 1. That means node n_j is in the sparse area, then node n_j should forward the RREQ packet in order to approach network connectivity. Rebroadcast probability Pre (n_j) of node n_j is obtained by combining additional coverage ratio and connectivity factor:

$$P_{re}\,(n_j) = C_f\,(n_j)\,.\,Ad_a(n_j) \qquad (4)$$

The parameter C_f is inversely proportional to the local node density. It means that if the local node density is low, rebroadcast probability is increased by parameter C_f. It will then increase the reliability of the NCPR in the sparse area. Due to high local node density, the parameter C_f could further decrease the rebroadcast probability. And further it increases the efficiency of NCPR in the dense area. So density adaptation is added by parameter C_f to the rebroadcast probability.

If rebroadcast probability is less than the threshold value, the node will not broadcast the RREQ packets, because the node is identified the dense area. Suppose due to the mobility of nodes are moving into another location, in that situation the packets can't reached to the destination. Therefore to solve this issue, this project contributes a nodes having highest energy will broadcast the RREQ packets to its neighbors.

IV. Solution for Link Failure Problem

Due to mobility if node moves into another location, link failure occurs. Then source node has to discover another path to send the packet. Proposed system contributes to solve this problem. In this case, neighbor nodes of the failed link take backup starts to send the packet. It saves the time required for discovering another path.

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Implementation and Performance Evaluation

A. Simulation Model and Parameters

NS-2 (v2.35) is used to implement proposed protocol. Each and every node moves to a random selected destination in mobility model with a random speed from a uniform distribution. Parameters used in this model are as under:

Table 1.Simulation Parameters

Software for simulation	Network simulator 2.
Channel	Wireless
Simulation run time	50 seconds
Traffic Type	CBR
Packet size	1024bytes
Speed	1m/s to 10 m/s
Routing Protocol	AODV
Propagation model	TwoRayGround
Network Interface Type	Wireless Physical
Queue Type	Drop Tail
MAC Type	Mac/802.11
Antenna Type	Omni Antenna

B. Performance Metrics

MAC collision rate: The average number of packets dropped resulting from the collisions at the MAC layer per second.

Normalized routing overhead: Total packet size of control packets (RREQ, RREP, RERR, and Hello) /Total data packets packet size delivered to the destinations.

Packet delivery ratio: Number of data packets successfully received by the CBR destination /Number of data packets generated by the CBR sources.

Average end-to-end delay: The average delay of successfully delivered packets from source to destination. It contains all possible delays from the CBR source nodes to destination nodes.

C. Results

MAC collision rate: Compared with the AODV protocol, the NCPR protocol reduces the MAC collision rate by about 93.37 percent on the average. Under the same network conditions, the MAC collision rate is reduced by about 60.66 percent when the NCPR protocol is compared with the DPR protocol. This is the main reason that the NCPR protocol could improve the routing performance.

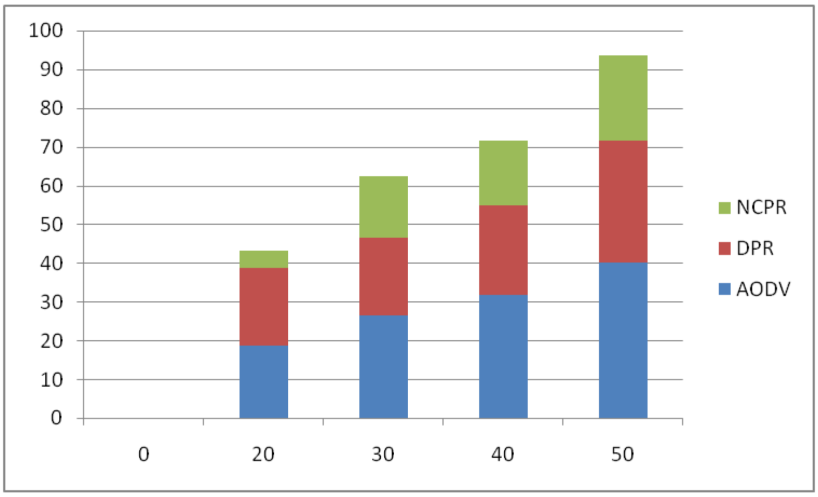

Fig 3.Comparison of Mac-Collision Rate

Normalized routing overhead: On average, the overhead is reduced by about 52.38 percent in the NCPR protocol compared with the conventional AODV protocol. Under the same network conditions, the overhead is reduced by about 26.59 percent when the NCPR protocol is compared with the DPR protocol.

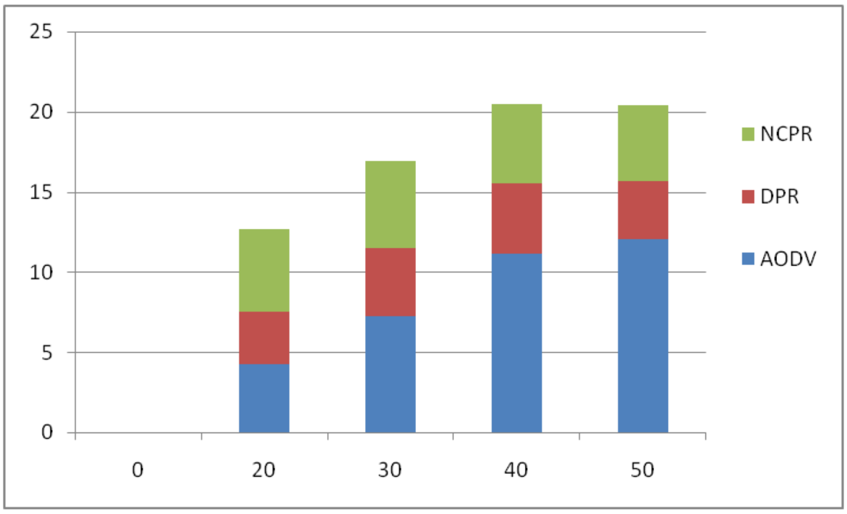

Fig 4. Comparison of Normalized Routing Overhead

Packet delivery ratio: The Packet Delivery Ratio of NCPR is very much greater than AODV & slightly greater than DPR. On average, the packet delivery ratio is improved by about 52.05 percent in the NCPR protocol when compared with the conventional AODV protocol. And in the same situation, the NCPR protocol improves the packet delivery ratio by about 37.25 percent when compared with the DPR protocol. The comparison is done by changing the number of nodes.

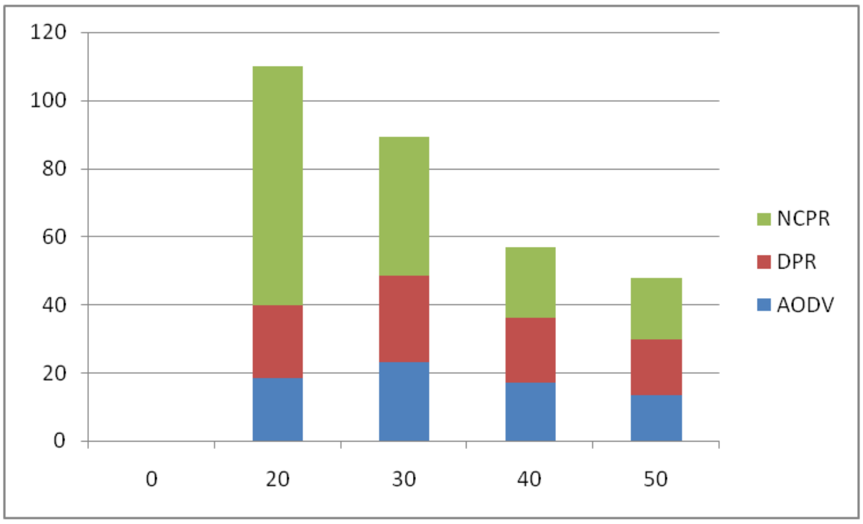

Fig 5 . Comparison of Packet Delivery Ratio

Average end-to-end delay: The comparison is done for end to end delay for MANET with three different protocols namely AODV, DPR and NCPR. For NCPR also the delay increases as the number of nodes increases gradually. Reducing the redundant rebroadcast can decrease the delay. On average, the end-to-end delay is reduced by about 65.82 percent in the NCPR protocol when compared with the conventional AODV protocol. Under the same network conditions, the delay is reduced by about 46.71 percent when the NCPR protocol is compared with the DPR protocol.

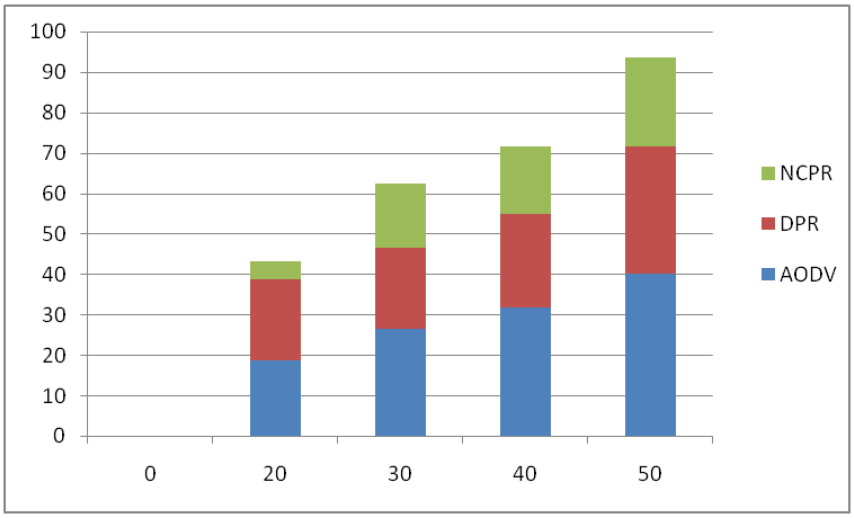

Fig 6.Comparison of End-to-end Delay

Conclusion

Broadcasting is a fundamental data dissemination mechanism for various Manets' application. An arbitrary node movement in MANET leads to link breakage, path failure and route discoveries. It causes a number of rebroadcasts between nodes and causes routing overhead. Because of less redundant rebroadcast, this system mitigates the network contention and collision, so as to decrease end-to-end delay and increase the packet delivery ratio. The experimental result shows that this system has good performance over other methods. Furthermore this system reduces routing overhead, end-to-end delay and increases the packet delivery ratio, thus performance is improved.

References

[1]. En Bo Wang, Jing Jing Xia, and Dan Keun Sung Xin Ming Zhang, "A Neighbor Coverage-Based Probabilistic Rebroadcast for Reducing Routing Overhead in Mobile Ad Hoc Networks," *IEEE TRANSACTIONS ON MOBILE COMPUTING*, vol. 12, MARCH 2013.

[2]. J.Y. Halpern, and L. Li Z. Haas, "Gossip-Based Ad Hoc Routing," *proc.IEEE INFOCOM*, vol. 21, pp. 1707-1716, 2002.

[3]. M. Ould-Khaoua, L.M. Mackenzie, and A. Mohammed J.D. Abdulai, "Neighbour Coverage: A Dynamic Probabilistic Route Discovery for Mobile Ad Hoc Networks," in *Proc. Int'l Symp.Performance Evaluation of Computer and Telecomm. Systems (SPECTS'08)*, 2008, pp. 165-172.

[4]. V. Ribeirox, and R. Riedi A. Keshavarz-Haddady, "DRB and DCCB: Efficient and Robust Dynamic Broadcast for Ad Hoc and Sensor Networks," *Proc. IEEE Comm. Soc. Conf. Sensor, Mesh and Ad Hoc Comm. and Networks (SECON '07)*, pp. 253-262, 2007.

[5]. W. Peng and X. Lu, "On the Reduction of Broadcast Redundancy in Mobile Ad Hoc Networks," in *Proc. ACM MobiHoc*, 2000, pp. pp. 129-130

[6]. J. Heidemann, R. Shroff, and M.Z. Murtaza F. Stann, "RBP:Robust Broadcast Propagation in Wireless Networks," in *Proc. Int'l Conf. Embedded Networked Sensor Systems (SenSys '06)*, 2006, pp. 85-98.

[7]. Kim, Q. Zhang, and D.P. Agrawal, "Probabilistic Broadcasting Based on Coverage Area and Neighbor Confirmation in Mobile Ad Hoc Networks," *Proc. IEEE GlobeCom*, 2004.

[8]. S.Sindhuja, and S.Vidhya, "Enabling Efficient Rebroadcast for Reducing Routing Overhead in MANET," *International Journal of Technology Enhancements And Emerging Engineering Research, Vol 2, Issue 6*.

[9]. E. Belding-Royer, and S. Das C. Perkins, "Ad Hoc On-Demand Distance Vector (AODV) Routing," in *IETF RFC 3561*, 2003.

[10]. Y. Hu, and D. Maltz D. Johnson, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR) for IPv4 ," *IETF RFC 4728*, vol. 15, pp. 153-181, 2007.

[11].B. Williams and T. Camp, "Comparison of Broadcasting Techniques for Mobile Ad Hoc Networks," in Proc. ACM MobiHoc, 2002, pp. 194-205.