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A Review on Effective Mechanism to Reduce Routing Overhead in Mobile Ad Hoc Network

Prof. Ambarish R. Bhuyar, Prof. Sumaiyya Z. Khan

Department of Information Technology, Sipna College of Engineering & Technology, Amravati, India.

Abstract: As the results of advances in wireless communication technology, portable computers with wireless interfaces can communicate among themselves. It is argued that future wireless network will be converged to be more easily reconfigurable situations such as Mobile Ad hoc network (MANET). MANET is a special type of wireless mobile network in which mobile hosts can communicate without any aid of established infrastructure and can be deployed for many applications such as battlefield, disaster relief and rescue, etc. In mobile ad hoc networks (MANETs), the network topology changes frequently and unpredictably due to the arbitrary mobility of nodes. This feature leads to frequent path failures and route reconstructions, which causes an increase in the routing control overhead. The fundamental mechanism for route discoveries is broadcasting in which the receiver node blindly rebroadcast the first received route request packet unless it has route to the destination. This mechanism incur retransmission which causes overhead and decrease the packet deliverance ratio and increase the end delay, which cannot be avoided. In this review paper we have described reducing routing overhead in mobile ad hoc network using probabilistic rebroadcast mechanism. In which rebroadcast delay is introduced to determine the neighbour coverage knowledge which will help in finding accurate additional coverage ratio and rebroadcast order. We also described connectivity factor to provide node density adaptation. By combining the additional coverage ratio and connectivity factor, rebroadcast probability is determined. The approach can signify improvement in routing performance and decrease the routing overhead by decreasing the number of retransmission.

Keywords: Mobile ad hoc networks, broadcasting, network connectivity, dynamic networks, routing overhead, Probabilistic Rebroadcast.

1. INTRODUCTION

The MANET is a special type of wireless mobilenetwork in which mobile host can communicatewithoutany aid of established infrastructure and can be deployedfor many applications.In a MANET, a mobile host isfree to move around and may communicate with otherhosts at any time. When a communicating partner iswithina host’s radio coverage, they can communicate directly in asingle-hop fashion. Otherwise, a routeconsisting of severalrelaying hosts is needed to forward messages from thesource to the destination in amultihop fashion.One of thefundamental challenges of MANETs is the design ofdynamic routing protocolswith good performance andlessoverhead.To supportmultihop communication in a MANET, a mobile host hastowork as a router and cooperate with other hosts to findroutes and relay messages. Routing has been studiedintensively under a MANET environment (e.g., unicast[2], [3], [6], [8], [9], [10], [13], [18], multicast [4], [7],andgeocast [11]).Many routing protocols, such as Ad hoc Ondemand Distance Vector Routing (AODV) [1] and Dynamic Source Routing (DSR) [2], have been proposed for MANETs.The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks.AODV is capable of both unicastand multicast routing.AODV is an on demandalgorithm, meaning that it builds routes betweennodes onlyas desired by source nodes. It maintains these routes as longas they are needed by thesources[19].The Dynamic SourceRouting protocol (DSR) is a simple and efficient routingprotocol designedspecifically for use in multi-hop wirelessad hoc networks of mobile nodes. DSR allows the networkto becompletely self-organizing and self-configuring, without the need for any existing network infrastructure oradministration [20].

The above two protocols are on-demand routingprotocols, and they could improve thescalability ofMANETs by limiting the routing overhead when a newroute is requested [3].However, due to node mobility inMANETs, frequent link breakages may lead to frequentpath failures and route discoveries, which could increasethe overhead of routing protocolsand reduce the packetdelivery ratio and increasing the end-to-end delay [4]. Thus,reducingthe routing overhead in route discovery is anessential problem.

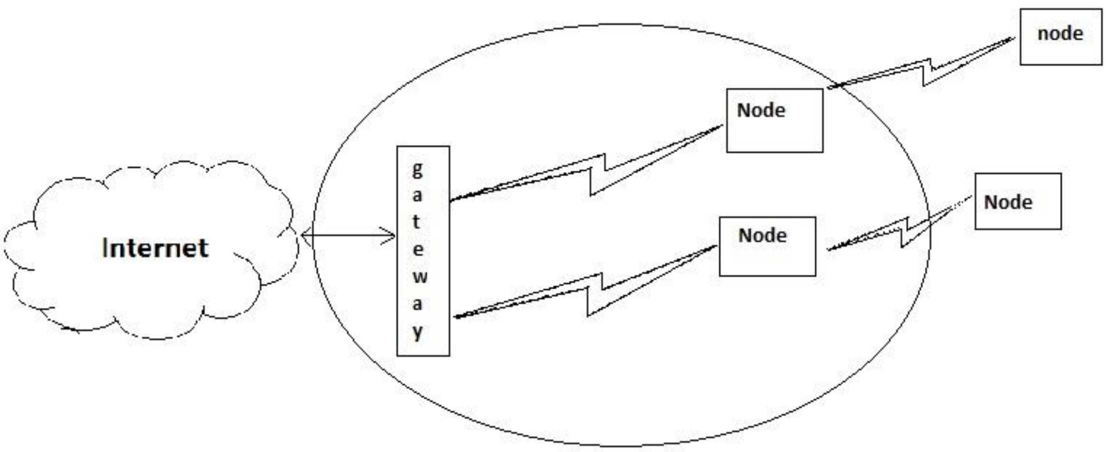

Figure 1.1: Simple diagram of MANET

2. Literature Review and Related Work

Broadcasting is an effective mechanism for routediscovery, but the routing overhead associated with thebroadcasting can be quite large, especially in high dynamicnetworks [9]. Ni et al. [5] studied the broadcasting protocolanalytically and experimentally, and showed that therebroadcast is very costly and consumes too much networker source. The broadcasting incurs large routing overheadand causes many problems such as redundantretransmissions, contentions, and collisions [5]. Thus,optimizing the broadcasting in route discovery is aneffective solution to improve the routing performance.Haas et al.[10] proposed a gossip based approach,whereeach node forwards a packet with a probability. Theyshowed that gossip-based approach can save overheadcompared to the flooding. However, when the networkdensity is high or the traffic load is heavy, theimprovementof the gossip-based approach is limited [9]. Kim et al. [8]proposed a probabilistic broadcastingscheme based oncoverage area and neighbour confirmation. This schemeuses the coverage area to set theirbroadcast probability,and uses the neighbour confirmation to guarantee reachability. Peng and Lu [11]proposed a neighbour knowledgescheme named Scalable Broadcast Algorithm (SBA). Thisscheme determinesthe rebroadcast of a packet according tothe fact whether this rebroadcast would reach additionalnodes.

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Abdulai et al. [12] proposed a Dynamic ProbabilisticRoute Discovery (DPR) scheme based on neighbourcoverage. In this approach, each node determines theforwarding probability according to the number of itsneighbours and the set of neighbours which are covered bythe previous broadcast. This scheme only considers thecoverage ratio by the previous node, and it does notconsider the neighbours receiving the duplicate RREQpacket. Thus, there is a room of further optimization andextension for the DPR protocol. Several robustprotocolshave been proposed in recent years besides the aboveoptimization issues for broadcasting. Chen et al.[13]proposed an AODV protocol with Directional ForwardRouting (AODV-DFR) which takes the directionalforwarding used in geographic routing into AODVprotocol. While a route breaks, this protocol canautomatically find the next-hop node for packet forwarding.

Keshavarz-Haddad et al. [14] proposed twodeterministic timer-based broadcast schemes: DynamicReflector Broadcast (DRB) and Dynamic Connector-Connector Broadcast (DCCB). They pointed out that theirschemes can achieve full reach ability over an idealisticlossless MAC layer, and for the situation of node failureand mobility, their schemes are robustness. Stann et al. [15]proposed a Robust Broadcast Propagation (RBP) protocolto provide near-perfect reliability for flooding in wirelessnetworks, and this protocol also has a goodefficiency.They presented a new perspective for broadcasting: not tomake a single broadcast more efficient butto make a singlebroadcast more reliable, which means by reducing thefrequency of upper layer invokingflooding to improve theoverall performance of flooding. The proposed protocol seta deterministic rebroadcastdelay, but the goal is to makethe dissemination of neighbour knowledge much quicker. One of the earliestbroadcast mechanisms is flooding,where every node in the network retransmits a message toits neighboursupon receiving it for the first time. Althoughflooding is extremely simple and easy to implement, it canbe verycostly and can lead to serious problem, named asbroadcast storm problem, which is characterized byredundantpacket retransmissions, network bandwidthcontention and collision. Ni et al. [5] studied the floodingprotocolanalytically and experimentally and showed that arebroadcast can provide only 61% additional coverage atmost and only 41% additional coverage in average over thatalready covered by the previous transmission. So,rebroadcasts are very costly and should be used withcaution.

3. BRODCASTING

In Mobile Ad Hoc Network nodes are movingcontinuously due to node mobility in MANETs, frequentlinkbreakages may lead to frequent path failures and routediscoveries, which could increase the overhead of routingprotocols and reduce the packet delivery ratio andincreasing the end-to-end delay [4]. Thus, reducing therouting overhead in route discovery is an essential problem.The conventional on-demand routing protocols usefloodingto discover a route. They broadcast a Route REQuest(RREQ) packet to the networks, and thebroadcastinginduces excessive redundant retransmissions of RREQpacket and causes the broadcast stormproblem [5], whichleads to a considerable number of packet collisions,especially in dense networks.

The Broadcast Storm Problem:

A straight-forward approach to perform broadcast is byflooding. A host, onreceiving a broadcast packet for thefirst time, has the obligation to rebroadcast the packet.Clearly, this costs ntransmissions in a MANET of n hosts.In a CSMA/CA network, drawbacks of flooding include:

1. Redundancy: When a mobile host decides torebroadcast a broadcast packet to its neighbours,all of itsneighbours might already have heard thepacket

2. Contention: After a mobile host broadcasts apacket, if many of its neighbours decide torebroadcast thepacket, these transmissions (whichare all from nearby hosts) may severely contendwith each other.

Broadcasting is a special routing process oftransmitting a packet so that each node in a networkreceives a copyof this packet. Flooding is a simpleapproach to broadcasting with no use of global information;in flooding, a broadcast packet is forwarded by every nodein the network exactly once. Simple flooding ensuresthecoverage; the broadcast packet is guaranteed to be receivedby every node in the network providing there isno packetloss caused by collision in the MAC layer and there is nohigh speed movement of nodes during thebroadcastprocess. (Fig. 3.1) shows a network with six nodes. Whennode v broadcasts a packet as shown in Fig.3.1b, allneighbouring nodes, u, w, x, and y, receive the packet dueto the broadcast nature of wirelesscommunication media.All neighbours will then forward the packet to each other.Apparently, the twotransmissions from nodes u and x areunnecessary. Redundant transmissions may cause thebroadcast stormproblem [18] in which redundant packetscause contention and collision.

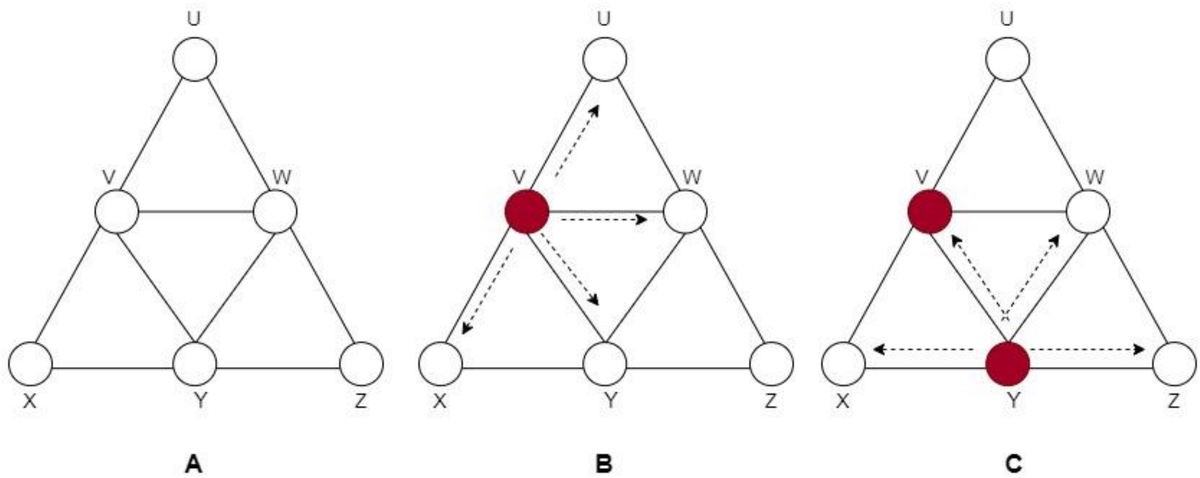

Figure 3.1:- Representing Broadcast Strom Problem

4. Possible Solution

In MANET the network topology frequently changes causing routing overhead due to dissemination of routing control packet such as RREQ. During route discovery traditional on-demand routing protocols produce a large amount of routing traffic by blindly flooding the entire network with RREQ packet. Recently, the issue of reducing the routing overhead associated with route discovery and maintenance in on demand routing protocols has attracted increasing attention.

In this paper we propose probabilistic rebroadcastmechanism which combines both neighbour coverage andprobabilistic methods.

1. Uncovered Neighbours Set and Rebroadcast Delay: when node receives anRREQ packetfrom its previous node, it can use theneighbour list in the RREQ packet to estimate howmany its neighbourshave not been covered by theRREQ packet from previous node. If node has moreneighbours uncovered by theRREQ packet fromprevious node, which means that if node rebroadcaststhe RREQ packet, the RREQ packetcan reach moreadditional neighbour nodes. To quantify this, wedefine the UnCovered Neighbours (UCN) setofnode.The rebroadcast delay is to determine the forwardingorder. The node which has more commonneighbourswith the previous node has the lower delay. If thisnode rebroadcasts a packet, then more commonneighbours will know this fact. Therefore, thisrebroadcast delay enables the information that thenodes havetransmitted the packet spread to moreneighbours, which is the key to success for theproposed scheme.

2. Neighbour Knowledge and Rebroadcast Probability: thenode which has a larger rebroadcast delay may listento RREQ packets from the nodes which have lowerone. For example, if node *'ni'* receives a duplicateRREQpacket from its neighbour *'nj'*, it knows thathow many its neighbours have been covered by theRREQpacketfrom*'nj'*. Thus, node *'ni'* could furtheradjust its UCN set according to the neighbour list inthe RREQ packetfrom*'nj'*. When the timer of therebroadcast delay of node '*ni'* expires, the node obtainsthe final UCN set. Thenodes belonging to the finalUCN set are the nodes that need to receive andprocess the RREQ packet. Note that,if a node doesnot sense any duplicate RREQ packets from itsneighbourhood, its UCN set is not changed,which isthe initial UCN set.

We define the additional coverage ratio of node *'ni'*thismetric indicates the ratio of the number of nodes thatareadditionally covered by this rebroadcast to the total numberof neighbours of node *'ni'*. The nodes that areadditionallycovered need to receive and process the RREQ packet.Xue and Kumar [16] derived that if eachnode connects tomore than *5.1774log n* of its nearest neighbours, then theprobability of the network beingconnected is approaching1 as *'n'* increases, where *'n'* is the number of nodes in thenetwork. Then, we can use*5.1774log n* as the connectivitymetric of the network. We assume the ratio of the numberof nodes that need toreceive the RREQ packet to the totalnumber of neighbours of node is *Fc(ni)*. In order to keepthe probability ofnetwork connectivity approaching 1, wehave a heuristic formula: $|N(ni)|.Fc(ni)\geq 5.1774\log n$. Then,wedefineminimum*fc(ni)* as a connectivity factor, which is

$$\mathrm{Fc(ni)} = \frac{Nc}{|N(ni)|}$$

Where $Nc=5.1774\log n$, and *n* is the number of nodes in thenetwork. We can observe that when *|N(ni)|*isgreaterthan*Nc*, *Fc(ni)* is less than 1. That means node *ni* is in the densearea of the network, then only part ofneighbours of node *ni*forwarded the RREQ packet could keep the networkconnectivity. And when *|N(ni)|* is less than *Nc*, *Fc(ni)*isgreater than 1. That means node ni is in the sparse area ofthe network, then node *ni* should forward the RREQpacketin order to approach network connectivity.Combining theadditional coverage ratio and connectivityfactor, we obtainthe rebroadcast probability of node.

5. Application

1. The Mobile Ad Hoc network can be used where theoperation are often spontaneouswith little or no fixedinfrastructure, such operation requires acommunication whichare spontaneous and networkcan be establish when and where required.
2. The mobile Ad Hoc network can be used as an crisesmanagement application these arise, for example,as aresult of natural disaster where the entirecommunication infrastructure is disarray. Restoringcommunication quickly is essential. By using MobileAd Hoc network, an infrastructure can be setup inhours instead of days/week required for wire linecommunication.
3. The Mobile Ad Hoc network can be used in anunknown territory where an infrastructure network isalmost impossible. In such situation, the ad hocnetwork having self-organizing capability can beeffectively used.
4. The Mobile Ad Hoc network is used in Army wherethe message is need to be transmitted to remotenodeaway from the base station, with the help ofintermediate nodes.

6. Conclusion

In this review paper we proposed to reduce the routingoverhead in MANET byintroducing probabilistic rebroadcast mechanism based on neighbour coverageknowledge which includesadditional coverage ratio andconnective factor. The paper focus on mechanism that willhavegood performance when the network is in high densityor the traffic load is high. The proposedsolution willgenerate less rebroadcast traffic that used to occurs inflooding. Because of lessredundant rebroadcast, it will mitigate the network collision andcontention;this will increase the packet delivery ratio andreduce the average end to end delay. Althoughthe networkis in high density or the traffic is heavily loaded, thesystem will have goodperformance.

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