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Improved Performance of Mobile Adhoc Network through Efficient Broadcasting Technique

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Abstract-In Mobile Ad hoc Network to find a destination through a traditional flooding needs to send a route request to each and every node in the system. Traditional broadcasting using flooding causes the Redundancy, Network Congestion and Contention in the Network and thereby degrading the performance of the network. This is known as broadcast storm problem. In this report, various broadcasting techniques have been discussed and a new technique which gives the solution to the broadcast storm problem has been proposed. Proposed technique select the next appropriate node for forwarding the route request packet based on the node degree and the knowledge of at most 2-hop from the given node. Proposed technique also uses the node velocity as the parameter to find the next best node to select. The proposed technique will give better result in Redundancy, Network Congestion and Contention in the network. Bandwidth consumption will also less in the proposed technique which enhance the network life.

***Keywords*—**Broadcast, Mobile Adhoc Network MANET) , Redundancy, Network Congestion, Contention

I. INTRODUCTION

Wireless communication is currently one of the fastest growing technology in mobile computing devices and wireless technology. Mobile devices like laptops, personal digital assistants, and mobile phones have become very lightweight today to carry very easily now. Wireless communication networks have many advantages networks. Major advantage of wireless networks is to allow anywhere/anytime connectivity. Wireless networks can be deployed in areas without a pre-existing wired-communication infrastructure or where it is difficult to lay cables. For example, in many places where it is difficult to carry out cable installation wireless network is used. Wireless network is more cheaply than the wired network makes wireless networks a good option in the area which are less developed. Further, setup of the wireless network is flexible and provides instantaneous communication. For Instance, mobile user can immediately connect to the internet in any area like railway station, airport etc. There are two type of wireless network defines by the IEEE 802.11 standard: infrastructure-based and infrastructure less-based (or ad hoc) networks. The infrastructure-based networks having special nodes that called access points (APs), which are connected via existing wired LANs. The APs are used to communicate with between mobile nodes and the wired network.

II. ROUTING AND BROADCASTING IN MANET

One of the most significant challenges in MANETs is to providing efficient routing protocols [1, 2]. In MANETs, packet travels from source to destination via intermediate nodes by forwarding it from one node to the next. The MANET protocols are classified in to three categories based on the routing information update mechanisms employed and route discovery: proactive (or table driven), reactive (or on-demand driven) and hybrid. Proactive routing protocols make up-to-date information about the route from each and every node in the network. Whenever topology of the network updates it propagated throughout the network. Reactive routing protocols establish routes only when they are needed. In these protocols when a source node requires a route to a destination, source node sends the route request packet by flooding. The destination is replied by the route replay packet to the source node. Third type is a hybrid routing protocol that attempts to combine the best features of proactive and reactive algorithms.

In the broadcasting a source node sends the same packet to all the nodes in the network. In multi-hop MANETs, intermediate nodes needed in the broadcasting operation by retransmitting the packet to other remote nodes in the network. Broadcasting operation uses the valuable network resources such as node power and bandwidth. Hence, it is important to carefully choose the intermediate nodes so as to avoid redundancy in the broadcasting process.
Several broadcasting approaches have been suggested in the literature that including probabilistic, counter-based, location-based and neighbour-knowledge-based approaches [7, 8].

III. RELATED WORK

The broadcast storm problem will cause the serious redundancy collision and contention. This avoided by reducing the number of nodes that forwarded the RREQ packets. Significant amount of research work is done to avoid the broadcast storm problem. Ni et al. [7] classified the broadcast algorithm in to two categories: probabilistic and deterministic. William and Camp [3] have compared the performance of several proposedBroadcast approaches including the probabilistic, counter-based, area based, neighbour-designated and cluster-based. The following sections provide a brief description of each these approaches.

A. Counter-Based Methods

In this technique, when any node in the network receives a broadcast packet, it initiates a random assessment delay (RAD). When the RAD expires, the node counts the number of time receiving the same broadcast packet. If the counter does not exceed a threshold value C, the node rebroadcast the packet otherwise node simply discard the packet. The counter value is the main parameter in this technique. Ni et al. [7] have demonstrated that broadcast redundancy associated with simple flooding can be reduced while maintaining comparable reachability in a network of 100 nodes, each with 500m transmission range placed on an area between 1500m x 1500m and 5500m x 5500m by using a counter based scheme with the value of C set to 3 or 4.

B.Area-Based Methods

This method is based on the additional coverage area. If additional coverage area is more than the node rebroadcast the RREQ packet otherwise node discards the RREQ packet. This additional coverage area is determined using the location-based method or distance-based method. If two nodes are not far away from each other, additional coverage area of the node that rebroadcast the RREQ packet is quite low [7]. In the ideal scenario, the node is located boundary of the transmission range of the source node; additional coverage area provided by that node is 61%, as in paper [8].
In the distance based scheme [7], the node compares the distance between itself and each neighbor node that previously forwarded a packet. Upon reception of packet, the node is initiated a random assessment

delay (RAD) and wait some time for redundant packets. When the RAD expires, distance from the entire sender nodes are checked to see is any node is closer than the predefined threshold value. If the node is closer than the threshold value, the node is not rebroadcast. This method requires knowledge of the geographic locations of its neighbours to make a rebroadcast decision. A parameter like signal strength is used to find the distance between to the source of a received packet. In thismethod if GPS is available, node is easily finding destination location and includes their location information in each packet transmitted. This method does not economies the number of broadcast packets because the node still rebroadcast the packet if none of the transmission distances are below a given distance threshold even if node receive a broadcast packet many times.

In the location based method [7, 8], each node is known its own position relative to other nodes with the use of GPS. Whenever a node rebroadcast a RREQ packet it includes it location information in the header of the packet. When the neighbour node receives the RREQ packet, it calculates the additional coverage area based on the location information in the header if it were to rebroadcast. If additional coverage area is less than the predefined threshold, the node will discards the packet and all the future reception is also discarded. Otherwise the node initiated the RAD, receives the redundant packets during the RAD, calculate the additional coverage area and compare with the threshold.

C. Neighbor Knowledge Based Methods

These schemes [3, 7, 9] maintain the neighbor information via periodic exchange of"hello" packets. The main objective is to determine the subset of nodes which forward the RREQ packet. Below are some various neighbor-knowledge-based schemes.

1. Forwarding Neighbors Schemes

In forwarding neighbors schemes, the sender proactively selects a subset of its 1-hop neighbors as forwarding nodes [10]. These 1-hpp neighbors are selected using a connected dominating set (CDS) algorithm and the identifiers (IDs) of the selected forwarding nodes are piggybacked on the broadcast packet as the forwarder list. Before forwarding the packet, each forwarding node in turn designates its own list of forward nodes. Example of the forwarding neighbor's schemes is Dominant Pruning algorithm [11]. To decrease the redundancy, the number of forwarding nodes should be minimized. However the optimal solution requires the node know the entire topology of the network.

2. Self-Pruning Schemes

In the self-pruning scheme [4, 6, 10], each node selfly determine its own status as a forward node or non-forward node, after the first copy of a RREQ packet is received or after several copies of the RREQ packet are received. In the self-pruning scheme [4, 6, 10], each node must have at least 2-hop neighbourhood information. 2-hop neighbourhood information is collected via a periodic exchange of "hello" packets among neighbouring nodes. Each node piggybacks its list of known 1-hop neighbours in the headers of "hello" packets. Each node also construct a list of its 2-hop and 1-hop neighbours that will covered by the broadcast which node is received the broadcast packet. If node will reach the additional node it rebroadcasts the packet.

3. Scalable Broadcast Algorithm (SBA)

Scalable Broadcast Algorithm requires that each node must have at least 2-hop neighbourhood information. 2-hop neighbourhood information is collected via a periodic exchange of “hello” packets among neighbouring nodes. [9]. Each “hello” packet contains the list of known neighbours and the node’s identifier. Each node is having the neighbor imformation and identity of the node from which the packet is received that allows a node to determine if it would reach additional nodes by forwarding the broadcast packet.

4. Multipoint Relaying Algorithm

In the Multipoint Relaying Algorithm, each node selects the subset of 1-hop as a Multipoint Relays (MPRs) that is sufficient to cover its 2-hop neighbors. When the packet is broadcasting only the MPRs are responsible for forwarding the broadcasting packet. The MPRs are selected of the given node using some heuristics using 2-hop neighbor information. 2-hop neighbourhood information is collected via a periodic exchange of “hello” packets among neighbouring nodes. Each “hello” packet contains the sender’s ID and its list of neighbours.

D. Cluster-Based Methods

In cluster-based broadcast methods [3,7] , the network is divided in to group of clusters. In the cluster, one node is the cluster head that is responsible for forwarding packets and selecting forwarding nodes on behalf of the cluster. Two clusters are connected by gateway nodes. In cluster-based broadcast methods, overhead is associated with formation and maintenance of clusters. Therefore, the cost criterion for broadcasting is the total number of transmissions (number of nodes that forward the broadcasting packet).

E. Probabilistic Based Methods

Probabilistic broadcasting is one of the simplest and most efficient broadcast techniques that have been suggested [8] in the literature. In this method, each node forward the broadcast packet based on some probability. To determine the probability, Sasson et al. have suggested percolation theory for the MANETs and the random graphs. Sasson et al. have claimed that when probability value $Pc < 1$ (where Pc as a forwarding probability), all the nodes in the network will receive a broadcast packet. Value of Pc is different in the different MANET topologies, so that there is no mathematical method for estimating Pc. Many methods are used a predefined value for Pc.

Main advantage of the probabilistic broadcasting over the other broadcast methods [3, 7, 9, 10] is its simplicity. However, the simulation results shown that these methods are good to reduce the effects of the broadcast storm problem [7]. The disadvantage of probabilistic broadcasting is the algorithm has poor reachability in the MANETs which are sparse network. This poor reachability is due to some forwarding probability at every node in the network.

Cartigny and Simplot [14] have suggested a probabilistic method where the probability p is computed from the local density n. To achieve high reachability, the authors have introduced a fixed value parameter k. Each node in the network computes its forwarding probability based on the efficiency parameter k which is compute locally so that these schemes has locally uniform.

Dynamic probabilistic scheme suggested by the Zhang and Agrawal [15] using a combination of probabilistic and counter-based approaches. This scheme is based on the number of duplicate packets received at the node and based on that the forwarding probability computes. The number of neighbours of the node does not the same as the value of the packet counter at a node.

In paper [13], the network topology is logically partitioned into sparse areas and dense areas using the local neighbourhood information. In the sparse areas are assigned the high forwarding probability and dense areas are assigned low forwarding probability.

IV. COMPARISON OF METHODS:

The comparison of all the schemes with the performance Metrics Reachability (Re), Saved Rebroadcast (SRB) and AverageLatency is given below.

Reachability (RE): the number of mobile hosts receiving the broadcast message divided by the total number of mobile hosts that are reachable, directly or indirectly, from the source host.

Saved Rebroadcast: (SRB): (r - t)/r, where r is the number of hosts receiving the broadcast message, and t is the number of hosts actually transmitted the message.

Average latency: the interval from the time the broadcast was initiated to the time the last host finishing its Rebroadcasting.

The simulation results in the paper [7,3] shows that in the small map, a small probability P is sufficient to achieve the high Reachability where as a large P is needed if host distribution is sparse. In the counter based schemes, Reachability is around same when the counter value is greater than or equal to 3. Distance based scheme provide better Reachability but not much rebroadcast is saved as compare to the counter based scheme. This is also cause the higher broadcast latency than the counter based scheme. The reason that the distance-based scheme saves less among of rebroadcasts than the counter-based scheme does is as follows. In the distance-based scheme, a host may have heard a broadcast message so many times but still rebroadcast the message because none of the transmission distances are below a given distance threshold. Performance of the location-based scheme is best among all the other methods because it utilizes the exact information to calculate the additional coverage. It provides high levels of reachability, while remaining a good amount of saving. Even in sparse maps, it still provides a relatively higher level of saving. Because of the saving, the broadcast latency is also the best among all schemes.

V. PROPOSED WORK

The proposed idea to solve the broadcast storm problem is explained below: In the proposed scheme, all the nodes have knowledge of their neighbors within two hops. To solve the broadcast storm problem, broadcasting should be done in such a way so that number of redundant packets received by a node can be reduced. Suppose source node S wants to communicate with the node X in the network and initiate the Route Request. In the proposed scheme, Source node S has the knowledge of his appropriate neighbor nodes set. A node based on its node degree, its neighbor set and velocity is chosen as an intermediate node to forward the route request packet. Four examples of these scenarios are given below.

Scenario 1:

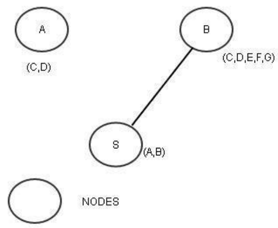

Figure 1 Nodes in MANET.

Source node S checks the node degree of all the neighbor nodes. In above figure 3.1 node B is having the highest node degree 7. Node B having the neighbor set (C,D,E,F,G) is compared with the neighbor set of node A excluding the sender node S and the neighbor of S. Neighbor set of A is subset of the neighbor set of B. Any additional node is not reachable by node A. So Node A is not selected by source node S for forwarding route request.

Scenario 2:

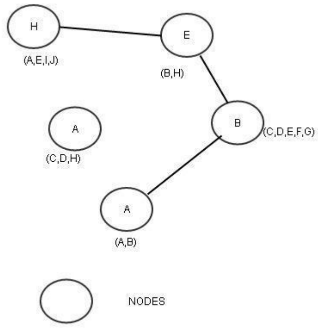

Figure 2 Nodes in MANET.

In this scenario, only one neighbor node of node A is different from the neighbor nodes of node B (i.e. Node H). Node H can be covered by the node E (neighbor node of B), So in this case node A is not selected for forwarding the route request.

Scenario 3:

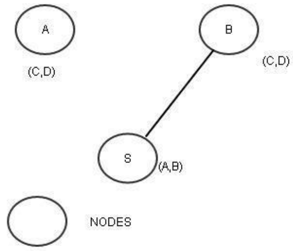

Figure 3 Nodes in MANET.

In this scenario, neighbor set of node A and node B is exactly the same. In this case the node velocity of the two nodes is taken in to consideration and the node with less velocity is selected to forward the route request. Node velocity can be find out from the below method suggested by G. Kalpana and Dr. M Punithavelli in his paper [16]. The average speed of a node can be obtained by estimating cumulative value of last n movements. Then, the average speed is symbolized mathematically as below.
avg S = D (t)/n

Where, D is the distance covered by the node at time t.
Scenario 4:

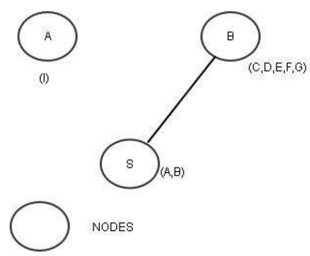

Figure 4 Nodes in MANET.

In this scenario only one neighbor node of the A is different from neighbor nodes of B (node I) which is not reachable through the neighbor of node B even. So we simply ignore this node assuming that node I is not an intermediate node in between the source and destination. In a network, if the maximum node degree is greater than or equal to five and less than or equal to ten, then at most two node can be ignored by the this algorithm.

V. SIMULATION RESULTS

The simulation was performed using the NS-2 simulator. The result generated after performing simulation with different parameters, the trace file was analyzed with the help of the awk script.

Simulation Parameters

Table 1 Simulation Parameters

Simulation Parameter	Value
Simulator	NS-2 (v 2.34)
Topology size	1500m * 300m

Number of nodes	25,50, and 75
Bandwidth	2 mbps
Interface queue length	50
Traffic type	CBR
Packet size	512 Bytes

a. Comparison Matrices:

Three metrics are used to compare performance of the AODV with the conventional broadcasting and AODV with reduced broadcasting such as packet delivery ratio, end-to-end delay and throughput.

Packet Delivery Ratio:

It is calculated as the ratio between the total numbers of data packet received by the destination node to the number of data packets send by the source node during the time period of the simulation.

Packet delivery Ratio of AODV with the conventional broadcasting and AODV with reduced broadcasting is shown in Figure 4.2. A figure 4.2 result shows that with the
increasing number of nodes, PDR also increased using the proposed broadcastingmethod.

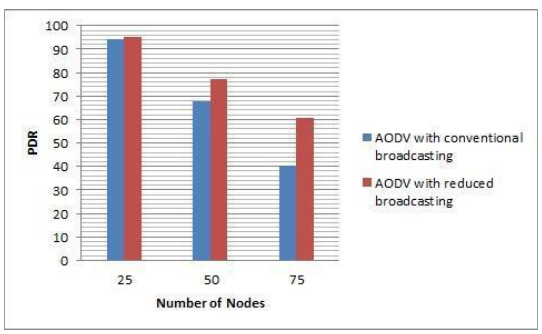

Figure 5 Packet Delivery Ratio

Average End-to-End Delay:

The average end-to-end delay is a measure of average time taken to transmit each packet of the data from source to destination. Network congestion is indicated by higher end-to-end delays.

Average End-to-End Delay (in seconds) of the AODV with the conventional broadcasting and AODV with reduced broadcasting is shown in Figure 4.3. The result indicates a reduction in end-to-end delay by using the proposed broadcasting method.

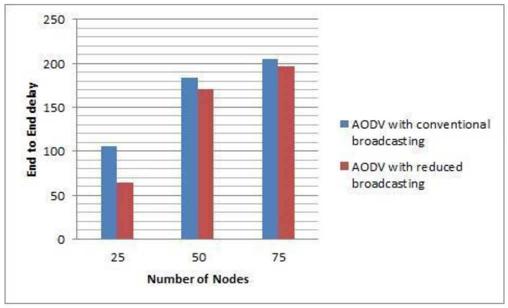

Figure 6 End-to-End Delay

Throughput:

Throughout is a rate of successfully transmitted data packets in a unit time in the network during the simulation. Figure 4.4 shows the throughput comparison of AODV with the conventional broadcasting and AODV with reduced broadcasting. Throughput is increased with the reduced broadcasting method.

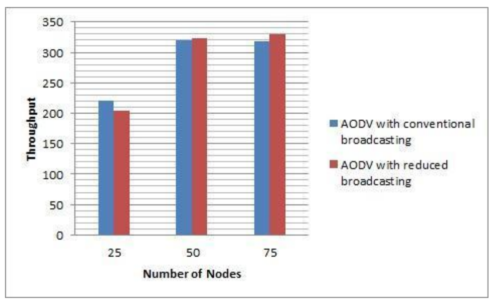

Figure 7 Throughput

VI. CONCLUSION

The proposed technique for forwarding the route request reduces the redundancy and network congestion of the Mobile Ad-hoc network. Simulation Results show that performance of AODV with the proposed broadcast technique gives good results in terms of packet delivery ratio, end-to-end delay and throughput. Simulation results show that number of route request sent by the proposed approach is far less than the conventional broadcasting. Therefore the proposed technique reduces the redundancy a lot and in turns bandwidth consumption is also reduced in the MANET.

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