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Broadcasting Mechanism with Less Flooding Packets by Optimally Constructing Forwarding and Non-Forwarding Nodes in Mobile Ad Hoc Networks

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***Abstract*—**The conventional routing protocol designed for MANET fail to handle dynamic movement and self-starting behavior of the node effectively. Every node in MANET is considered as forward as well receiver node and all of them participate in routing the packet from source to the destination. While the interconnection topology is highly dynamic, the performance of the most of the routing protocol is not encouraging. In this paper, a reliable broadcast approach for MANET is proposed for improving the transmission rate. The MANET is considered with asymmetric characteristics and the properties of the source and destination nodes are different. The non-forwarding node list is generated with a downstream node and they do not participate in the routing. While the forwarding and non-forwarding node is constructed in a conventional way, the number of nodes in non-forwarding list is more and increases the load. In this work, we construct the forwarding and non-forwarding node optimally so that the flooding and broadcasting is reduced to certain extent. The forwarded packet is considered as acknowledgements and the non-forwarding nodes explicitly send the acknowledgements to the source. The performance of the proposed approach is evaluated in NS2 environment. Since the proposed approach reduces the flooding, we have considered functionality of the proposed approach with AODV variants. The effect of network density on the overhead and collision rate is considered for performance evaluation. The performance is compared with the AODV variants found that the proposed approach outperforms all the variants.

***Keywords*—**Flooding, Forwarded Nodes, MANET, Non-forwarding nodes, Routing protocols.

I. INTRODUCTION

WIRELESS moving dynamically and the network topology change rapidly. Routing protocols for ad hoc networks [1]-[4] can be divided into two categories and are table-driven and the on-demand routing, which is based on their operational characteristics. The up to date information is maintained in the table driven routing protocols and in contrast, the routes are created only when desired in on-demand routing protocols. Thus, the table-driven protocols maintains routing table in each node and is updated periodically. Naturally, while there is a change in the topology due to mobility of a node, the nodes in MANET propagates the message to all the nodes in the network for updating the routing information. These routing protocols differ in the method based on the topology of the network change information distributed across the network and in the number of routing-related tables. Well-known table-driven ad hoc routing protocols are the Destination-Sequenced Distance-Vector (DSDV) [5]-[7] routing algorithm is based on the classical Bellman-Ford Routing Algorithm with certain improvements; the Wireless Routing Protocol (WRP) [8] is a table-based distance-vector routing protocol and each mobile host in the network maintains a distance table, a routing table, a link-cost table and a packet re-transmission list; the Global State Routing (GSR) [9] uses a link state routing but improves it by avoiding the flooding of routing messages; the Fisheye State Routing (FSR) [10] is an improvement of the GSR to reduce its update messages.

On-demand routing protocols considered as slow in nature and up-to-date routes are not maintained at every mobile node. Instead, based on the requirement, the routes are created. A suitable route discovery mechanism is invoked for a datagram packet to be sent from the source to the destination. An example is the Ad hoc On-demand Distance Vector Routing (AODV) [11] which is an improvement of the DSDV algorithm. The number of broadcasts in AODV is minimized by creating routes on-demand compared to the DSDV, which maintains a list of all the routes. The Dynamic Source Routing Protocol (DSR) [12] is another on-demand routing protocol. The entries in the mobile node are updated based on the route cache as soon as it learns about new routes. The Temporally Ordered Routing Algorithm (TORA) [13] is a highly adaptive, efficient and scalable distributed routing algorithm based on the concept of link reversal. This approach is suitable for highly dynamic mobile, multi hop wireless networks and is a source-initiated on-demand routing protocol. During route discoveries, there are drawbacks in on-demand routing protocols. Flooding of route request packets consumes too much of the bandwidth and when a route is established, the path is not modified until it is broken. As a result, the packet is forwarded in an inferior route due to the node's mobility.

In MANET, the communication between nodes is accomplished via other nodes, which are called intermediate or forwarded nodes. It is well-known that one of the inherent characteristics of the multi hop MANET is that large interference area, where the mobile nodes overlap with each other. Each node in a MANET acts as a router to receive and forward packets for seamless communications between people and devices.

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In addition to the earlier mentioned application domains, the MANETs can be effectively used in well-known popular fields say battlefield communications, emergency services, disaster recovery, environmental monitoring, personal entertainment and mobile conferencing [14], [15]. The MANET is considered as a unstable network and this is due to the fact that random movement of nodes, power drain of nodes, appearance and disappearance of nodes. Due to these random characteristics, the links between nodes may break frequently. As a result, there is a large number of control messages from all the nodes in MANET is generated periodically. This makes it to difficult to update the connection state of the nodes. Thus, it is imperative that protocols uses the medium to transmit the signals should try to minimize the use of limited bandwidth resources and reduce the traffic. An effective message distributing mechanism is essential for transmitting packets throughout the network. In the entire wireless network, the broadcasting message is sent for understanding the topology information of the network. This broadcasting message is sent as flooding message and most of the routing protocol use this flooding mechanism to broadcast data and control packets over the entire network, which will be used identifying the source-destination combination [16]. The well-known and simple broadcasting mechanism is blind flooding [17]; where each node is allowed retransmit the packet to the neighboring nodes. The rebroadcasting process by the nodes continued till all the nodes have a copy of the packet. The flooding scheme ensures that the shortest path between various source-destination combinations is identified and used for passing the topology packets. However, it is understood that the characteristics flooding mechanism propagates a large number of packets in MANETs and thus causes network congestion. This also can be referred to as the broadcast storm problem [18] and various approaches is discussed in [19], [20]. In addition, The Multi-Point Relaying (MPR) [21]-[24] techniques are proposed to reduce the flooding of control packets and the Self-Healing and Optimizing Routing Technique (SHORT) is proposed in [25]. The MPR utilizes the concept of SHORT, RAPLF routing protocol is proposed for mobile ad hoc networks. RAPLF not only reduces flooding in ad hoc networks and also automatically maintains the shortest path for improving the network performance.

In general, these broadcast protocols can be categorized into three classes such as probability-based methods, area-based methods and neighbor knowledge methods. The probability-based methods uses similar techniques as basic flooding and the difference is that each node rebroadcasts packets based on a threshold value of probability value. While this mechanism is suitable for dense network, the performance is not encouraging on sparse network. In area-based methods, the distance between the current node and the destination is considered for the rebroadcasting process. While the distance between current and destination node pair long, the retransmission process is started to cover larger area. However, area-based methods fail to understand the availability of a node in additional area that leads to inefficient broadcasting. The neighbor knowledge methods are further classified as self-pruning methods and neighbor-designated methods While a node in the neighbor-designated methods transmits packet with a specification to denote, which one of its one-hop neighbors should forward the packet and in self-pruning methods, the receiving node will decide whether the or not to transmit the packet by itself.

In this work, we propose effective broadcasting mechanism for reducing the flooding for MANET, for improving the retransmission rate. The number of forwarding nodes is always selected by keeping optimum in mind. The information about the non-forwarding nodes also maintained and the broadcasting is performed. For the analysis the symmetric structure of MANET is considered and the upstream node that has initiated the broadcast packet transmission is considered as the source node. A downstream node designated by the current node for forwarding the broadcast packet is considered as forwarding node. A non-forwarding node is a downstream node, which is not designated to forward the packet. Essentially, the status of the node changes for each transmission of packet and a forwarding node in the current view may be non-forwarding node. A TAG is attached to the forwarding and non-forwarding nodes and based on whether it has received the broadcasting packet or not, the node is marked and unmarked. The effect of missed broadcasting over the network is measured and accordingly the content of one hop and two hop neighbors updated for effective retransmission of the packet. The rest of the paper is organized as follows. The recent literature is received in the next section. In Section III, the proposed work is explained. The experimental result is presented in Section IV and we conclude the paper in the last section.

II. Literature Review

In MANET, each mobile host can freely move around and the network topology is dynamically changing. To send a datagram, a source host broadcasts a route discovery packet to the network. All neighboring nodes receiving this packet will rebroadcast this packet until it reaches the destination. It will have large flooding overhead, poor network performance and undesirable battery power consumption. To improve network performance, Routing with Adaptive Path and Limited Flooding (RAPLF) is designed for mobile ad hoc networks [26]. However this approach performs well only in packet delivery rate and flooding overhead. It is observed that as the mobility of nodes increases, the performance of existing cluster based routing protocols tends to deteriorate rapidly. Although many mobility based clustering schemes have been proposed to address this problem, majority of these proposals assume the movement of nodes follows group mobility. A cluster based routing protocol FASTR is proposed, which utilizes mobile backbone to mitigate the impact of node mobility for networks with high node mobility and low group mobility [27]. This approach eliminates the delay caused by cluster head election and enables nodes to start communication immediately after joining a cluster.

The service discovery is an important task and is affected by network disconnection due to mobility of a node. A distributed directory based service discovery protocol (SDP) for MANET is proposed, which works by electing the top-K directory nodes considering rich resources [28]. An effective strategy for establishing connectivity among the partitioned segments is proposed by deploying the least count of Relay Nodes (RNs) [29]. Finding the optimal number and position of RNs is NP-hard and thus pursued the heuristics. An optimized relay node placement algorithm is proposed using a minimum Steiner tree on the Convex hull (ORC). ORC strives to identify Steiner Points (SPs) in which relays are populated such that the segments will be connected with the least number of relays. A Mobile Ad-hoc Network has limited and scarce resources and thus routing protocols in such environments must be kept as simple as possible. The Simple Ant Routing Algorithm (SARA) [30] is proposed for optimizing overheads. During the route discovery Controlled Neighbor Broadcast (CNB) mechanism is used where node broadcasts a control message (FANT) to its neighbors. However, only one of them rebroadcast this message. During the route maintenance phase, the data packets are used to refresh the path of active sessions and thus the overhead is reduced. Finally, the number of nodes used to recover the route is reduced and the repair phase is enhanced. Thus, the algorithm tries to find a new path between the end nodes of broken link rather than finding a new path. The deeper search is failed while the broadcast mechanism is used. The approach is tuned for optimal performance by simulation results. It is noticed that SARA is good only for TCP traffic and however requires more time to discover the routes. Focusing on the Optimized Link State Routing (OLSR) protocol, an IDS mechanism to accurately detect and isolate misbehavior node(s) in OLSR protocol based on End-to-End (E2E) communication between the source and the destination is proposed [31]. The collaboration of a group of neighbor nodes is used to make accurate decisions. A broadcasting attackers list is created for neighboring nodes and their participation is avoided by other nodes from the routing table. This procedure allows the source node effectively select other trusted path to its destination. The mobility, traffic and node density are considered as main network conditions, which significantly affect the performance of routing protocols. Most of the routing protocols have concentrated on a specific scenario of network to develop routing protocol and none can handle various network scenarios. Therefore, there is no existing protocol that can work well in all different networking scenarios. The characteristics of several different classes of routing protocols are reviewed and most of current routing protocols assume homogeneous networking conditions where all nodes have the same capabilities and resources. Extensive studies simulations for DSR, AODV, LAR1, FSR and WRP in homogenous and heterogeneous networks are presented that consist of different nodes with different resources [32]. A Modified Dynamic Source Routing Protocol (MDSR) [33] to detect and prevent selective black hole attack and it drops the data packet selectively. This system is used for identifying the malicious node and used in intrusion detection system applications.

Routing in MANET is responsible for selecting and forwarding packets along optimal paths. Various routing protocols have been proposed in literature and few are found to be efficient for sparse network. Position-based routing and forwarding is considered to be suitable for improving the performance of the existing MANET routing strategies. The basic operation mode of geographic forwarding, which is greedy forwarding [34] is focused and provides extensive receiver of geographic forwarding technique. The network partitioning causes performance degradation of mobile ad hoc network and the data replication approach is being used for improving this issue. It is assumed that all the mobile nodes share their memory space and however some of them may share the resources partially. A replica allocation strategy is proposed in the presence of selfish nodes, that takes into account both selfish behavior and node distance [35].The routing in ad hoc network is performed by nodes with limited resources; load should be efficiently distributed through the network. As a result, the performance of the network degrades sue to congestion. Unfortunately, load-balancing is a critical deficiency in MANET shortest-path routing protocols and this is due to the fact that nodes in the centre is loaded heavily [36]. A routing metrics are provided, which considers the degree of centrality for both proactive and reactive routing protocols.

Flooding technique is considered as a simple and direct approach to broadcast a message from one node to another node in the MANET. Most of the well-known ad hoc routing protocols of MANET use flooding to ensure that all nodes receive the source message and it is assumed that the reachability of this approach is approximately up to 100% [37], [38]. However, the flooding mechanism increases the number of packet and is unsuitable for MANETs [39]. Route discovery in wireless mobile ad hoc networks with adjusted probabilistic flooding [40], A new A New Probabilistic Broadcasting Scheme for Mobile Ad hoc On-Demand Distance Vector (AODV) Routed Networks [41]. Performance evaluation of an efficient counter-based scheme for mobile ad hoc networks based on realistic mobility model is proposed [42]. It is debated that the broadcasting operation without using flooding technique can minimize the BSP and improve the MANETs performance in terms of low collision, overhead and end-to-end delay. Among various schemes, a fixed probabilistic scheme is the first probabilistic approach and is considered as the base for all later dynamic probabilistic schemes. Every node receives a broadcast message for the first time and rebroadcasts it to all the nodes in the network with a certain value of probability, regardless of the density level of current node [43], [44]. However, the degree of density is not and a new probabilistic broadcasting scheme for mobile Ad hoc On-Demand Distance Vector (AODV) Routed Networks. The authors have demonstrated that while the probabilistic scheme considers the degree of nodes density, it will outperform the fixed probabilistic scheme [45].A probabilistic broadcasting algorithm has been developed, which divides the

MANET into four levels of density such as sparse, medium sparse, dense and high dense. A specific forward value is assigned for each level. The density information is collected by broadcasting HELLO packets every second for 1-hop to construct a neighbor list at each node. Then, the node can decide the current level by comparing its neighbor list with average network neighbors. This scheme opens up a promising approach towards optimal probabilistic broadcasting. However, manipulating the levels for comparing neighbor consumes more energy.

In the counter-based mechanism, a counter variable is maintained to calculate and store the number of received messages. The node will rebroadcast the message while the value of the counter is less than a predefined threshold within a period of Random Assessment Delay (RAD) time. However, this scheme is not suitable for the applications that have a very high speed movement like Vehicular Ad hoc Networks VANETs. Recently, the merits of the probabilistic model and counter approach has been proposed, which solves the BSP in MANETs based on realistic mobility model and Performance evaluation of an efficient counter-based scheme for mobile ad hoc networks based on realistic mobility model [46]. In the distance-based scheme, the distance between two hosts is always calculated and compared with a threshold. If the distance is very small, i.e. less than a threshold, the broadcast message will not be rebroadcasted. This is due to the fact that the additional coverage will be very small. In case, if the distance exceeds certain threshold, the packet is rebroadcasted because the additional coverage will be significant. In contrast, in the locations-based scheme, a host receives a broadcast message for the first time. The additional coverage provided by the host will be initialized and compared with a predefined coverage threshold for deciding the broadcast operation. However, this scheme requires additional hardware, say, GPS (Global Positions System) to find the location of the hosts. In addition, the power consumption along the cost for using GPS is considered a critical issue in wireless network [47].

The authors [48] have considered the issue of efficient broadcasting in mobile ad hoc networks using network coding and directional antennas. It has focused on reducing the number of transmissions in each forwarding node. This study has focused on the multiple sources and message broadcast application. In each forwarding node, some of the received messages are combined for transmission. This coding approach has reduced the total number of transmissions considerably compared to broadcasting using the same forwarding nodes without coding. The directional antennas have been deployed and exploited for further reducing the energy consumption. A node equipped with directional antennas can divide the omni-directional transmission range into several sectors and turn some of them on for transmission. In their approach, locally identified forwarding nodes only transmit the broadcast message to the restricted regions. It is observed that the location dissemination consumes time, LAROD routes packet with partial knowledge of geographic position. A beaconless strategy has been used with a position-based resolution of bids during packet forwarding procedure. It maintains a local database of node locations, which is updated using broadcast gossip combined with routing overhearing. The authors have evaluated the algorithms in real time application, i.e., unmanned aerial vehicles deployed in a reconnaissance scenario.

The protocol is designed in such a way that it allows each node to decide whether to support energy-efficient routing or conserve its own energy. Also, the broadcasting power of beacon messages for mobile nodes dynamically adjusted. They have proved that any reconstruction and change of broadcasting radius converge in four and five beacon intervals.

Based on the above discussion, it is noticed that most of the above mentioned protocols is applicable in multi-point MANET and all of them tries to minimize the number of messages. However, to handle this issue it is observed that lot of energy is consumed or special hardware is required. Thus, it is imperative that a protocol is required to reduce the number of messages during broadcasting to avoid flooding. In this paper, we propose a novel approach is proposed, which uses subset nodes for forwarding the broadcast messages so that the flooding is reduced considerably. Also, the effect of the message failure due to mobility of the node and transmission error is also handled. Each node is marked with a TAG to identify whether the node has received the broadcast packet. The performance of the approach is ported with variants of AODV and found that the performance is encouraging.

III. Problem Statement & Proposed Work

A. Problem Statement

The proposed approach can be understood effectively by clearly introducing the problem. The proposed broadcasting approach is discussed by using Fig. 1, which is asymmetric MANET with large number of nodes.

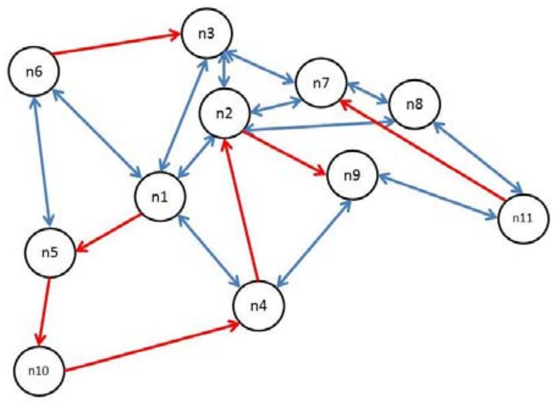

Fig. 1 A Sample MANET with large number of one and two hop neighbors

In the above Fig. 1, there are eleven nodes and each of them has its own first and second hop neighboring list. The blue and red color link denotes the bidirectional and unidirectional flow of packets. For understanding the issue, we consider $N_1(s)$ and$N_2(s)$ as the first and second hop neighboring node list to *s* respectively. The list of nodes in the $N_1(s)$ is in the transmission range of *s* and the list of nodes in $N_2(s)$ is not in the transmission range of *s* and uses any node *v* in the transmission range as forwarding node or constructs a list of forwarding nodes.

For identifying the forwarding and non-forwarding nodes of a given source node, the Fig. 2, presented below is applied over the MANET. In this case, the algorithm is applied on the network shown in Fig. 1 for obtaining the forward node list with source node as 1; we get the neighboring information of each node.

In Fig. 3, the first hop neighbor obtained from Fig. 1 is presented. The nodes having labels 1 to 11 are nodes in the sample MANET and we have considered node 1 as the source node *(s)*. Similarly, $N_2(s)-N_1(s)$ is presented for the sample MANET shown in Fig. 3. In Fig. 4, the $HS(s)=N_1(s)-s$ is depicted for all the eleven nodes of the sample MANET and $N_2(s)-N_1(s)$ extracted from Fig. 1 is depicted in Fig. 5.

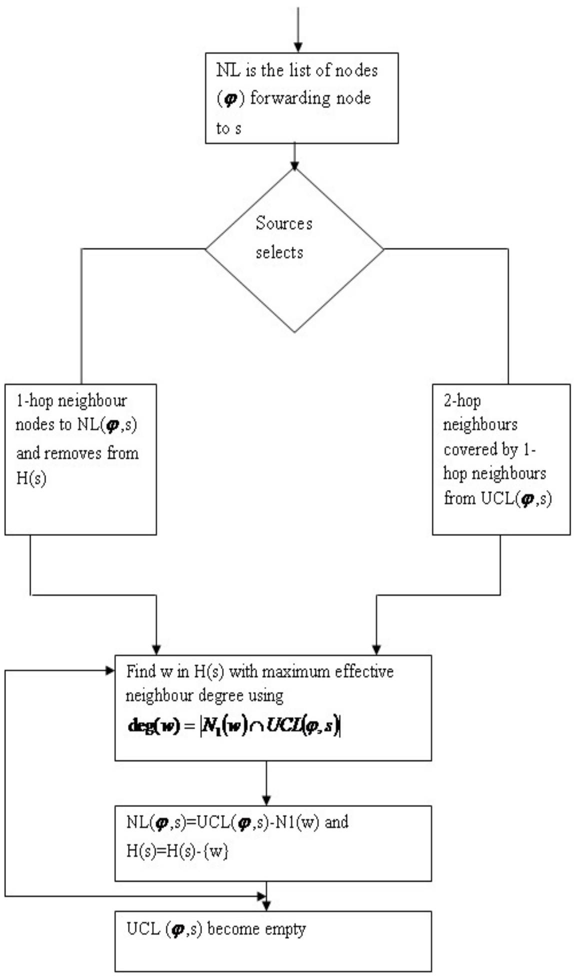

Fig. 2 Flowchart for Finding Forward Node

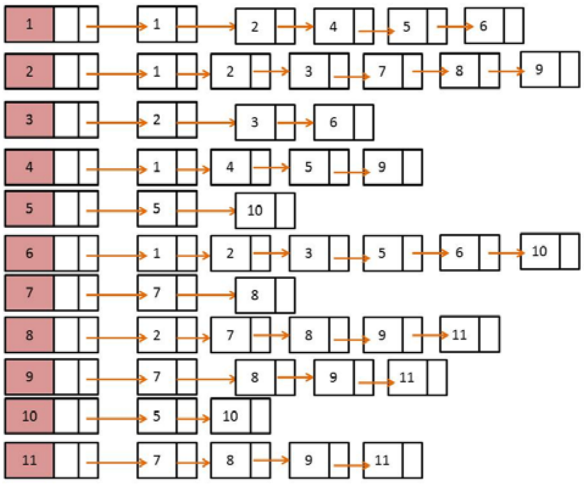

Fig. 3 The First Hop Neighbour Obtained from Fig. 1

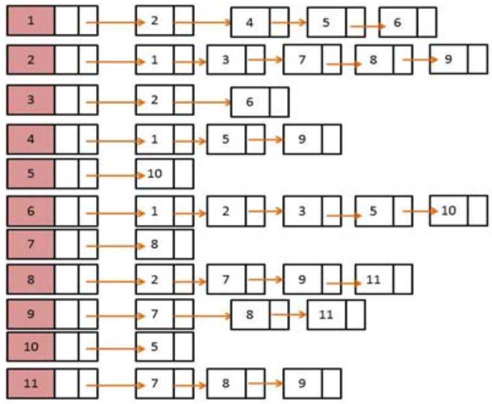

Fig. 4 The $HS(s)=N_1(s)-s$ for the MANET present in Fig. 1

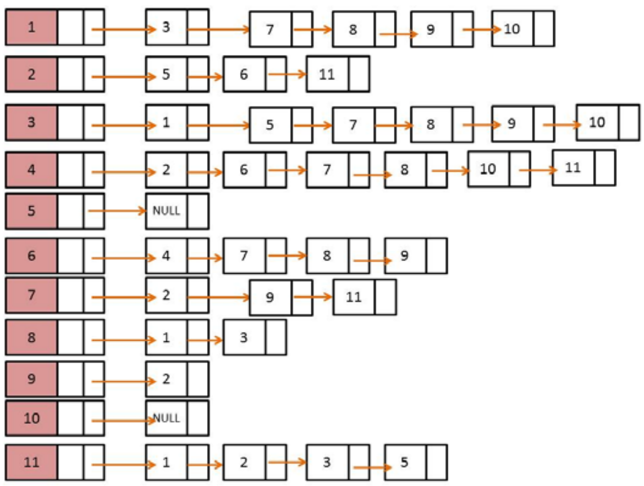

Fig. 5 $N_2(s)-N_1(s)$ extracted from Fig. 1

It is well-known that $N_1(1)$ receives the packet directly. Further, $UCL(\varphi,1)=N_2(1)-N_1(1)-1=\{3,7,8,9,10\}$ and the forward node list for node 1 is $NL(\varphi,1)=\{5,2\}$. As a result,

$$UCL(1,2)=N_2(2)-N_1(2)-N_1(1)-N_1(NL(\varphi,1))$$

and

$$NL(1,2)=\{8\}.$$

While considering node 5, all the two hop neighbors are considered and covered. Therefore, based on the calculations and the output of Figs. 3-5, the total number of forwarding nodes for the entire nodes in the sample MANET is present in Figs. 1, 3, 6 and 9. It is noticed that the source node 1 is also included in the forward list. It is noticed that some of the two hop neighbors of the intermediate forwarding node may be already considered by the source node. This process increases the flooding and broadcasting is found to not optimized and require an optimized broadcasting approach for finding the routing path. It is observed that some of the two hop neighbors have been considered by the same node again and again as forwarding node. As a result, the messages are sent to the nodes are more and redundant. This situation can be handled for achieving reliable and effective broadcasting mechanism.

B. Reliable Broadcasting Mechanism

It is known that while broadcasting message is received from the source node (*s*), the *s* nominates *u* as the forwarding node. Using the information present in the broadcast message from *s*, identifying the intermediate forwarding node can be optimized effectively. This is due to the fact that some of the two hop neighbors of the intermediate forwarding node may be already considered by the source node. The forwarding node *f* of node *u* select its forwarding node to cover $UCL(u,f)=N_2(f)-N_1(f)-N_1(u)-N_1(NL(x,u))$ with *u* is the forwarding node of *x*. This can be construct optimal forward node list and the entire procedure is shown in the form of a flowchart in Fig. 6.

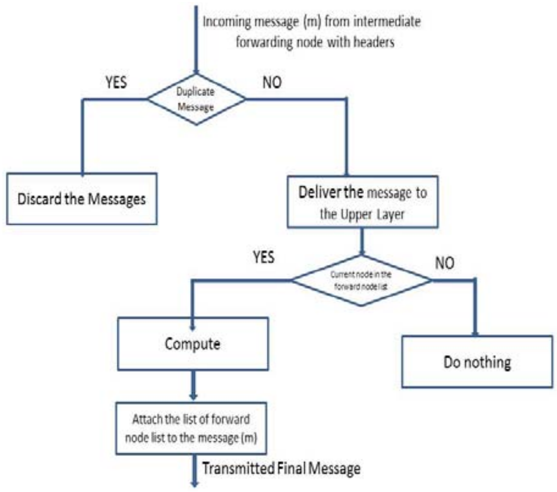

Fig. 6 Flow chart for generating the optimized forward node list

From Fig. 6, it is noticed that the decision is taken based on the message received from the intermediate forwarding nodes. While a message is received by a node, presence of the same message is verified for duplicate and discarded. If the message is received for the first time, it is delivered to the upper layer and it is ensured that the current node is in the forward list. A new forward list is computed and the same is forwarded as well as final message is transmitted. While broadcasting, packets are transmitted in the network from the source node to the neighboring nodes; there is a case that some of the neighboring nodes may not receive the packets. This scenario is considered differently with forwarding and non-forwarding nodes and is depicted in Fig. 6.

Here, *s* is the source node, *f* and *nf* is forwarding and non-forwarding node respectively. The packet from *s* to *nf* is missed and has not created any problem in the network. This is due to the fact that *nf* is the non-forwarding node. In Fig. 6 the other scenario is presented. The broadcasted packet from the source node *s* has not reached the forwarding node *f*. Since, the forwarding nodes are very important here, this transmission error has caused subsequent problem and will reflect in the network. In general, the proposed approach realizes two reasons for packet loss, which are transmission error and mobility of nodes. In this approach, the transmission error is handled by maintaining timer for transmission. As shown in Fig. 6, due to transmission error by *f*, other nodes, which are in the forward node lists, may not receive the broadcast packet. We use simple resend algorithms, which adaptive for handling this issue. The node *s* waits for a predefined period after transmitting broadcast packet. If *s* is not receiving transmission signal from *f* within the predetermined time, the node *s* resends the packet maximum retry is reached. Similarly, the problem due to the mobility of the nodes is handled effectively in the proposed approach. The transmission error occurs due to mobility of a forwarding node. In Fig. 6, we depict the scenario. The forwarding node *f* has moved out of transmission range of *s* and thus caused transmission error. The resend approach has found that there is no response from the node *f*. Alternatively, the other nodes in the forward node list is identified to cover the area, which is being covered by *f*. Suppose, with the forward node list $\{f_1, f_2, f_3 \dots f_n\}$ of *s*, the node *s* transmits the packet and has not obtained any response from say *f1* and *f2*. As a result, the content of uncovered node list *UCL (s)* is $N_2(s)-s-N(NL(s)-f_1-f_2)$. Now, select any node f_k from *NL* such that f_k covers most of the nodes and add it to $N_1(s)$ in *NL*. Also, f_k should cover most of the nodes in *UCL(s)*.

In the above two cases, the source node has no knowledge on *f*, .i.e. whether *f* is in its range or not. While *s* refreshes its forward and non-forward node lists periodically, *s* can resend the duplicate packets to the new forward node list identified by Fig. 2. Also, this helps to handle the scenario while new nodes are entering into the transmission range of *s* and thus the packets are retransmitted locally.

C. The Effective Broadcast Algorithm

Below, we present a broadcast algorithm and uses effective idea to cover entire network

Step 1. Broadcast packet from the source node *(s)*
(a) Select 1-hop neighboring list as forwarding node list
(b) Obtain 2-hop neighboring list using Fig. 2.

Step 2. While any node say *u*, receives broadcast packet
(a) Check the broadcast message, whether already received or not
(b) In case, step 2(a) is false, deliver the packet to the upper layer of the protocol of node *u*
(c) The broadcast message table is updated suitably

Step 3. All the nodes in the forwarding list receives the new broadcasting packet
(a) Each node in the forwarding node list records the packet
(b) The forwarding node list for each node in the above is calculated
(c) The packet is rebroadcasted

Step 4. Only no-forwarding 1-hop neighbours of *(s)* acknowledges the broadcast Messages.

Step 5. The source node s waits to receive acknowledgement from non-forwarding node and retransmission of broadcast packet from forwarding nodes.
(a) Timer is initiated
(b) Retransmission of broadcast is not received by *s* and is considered as failure
(c) Acknowledgment is not received by the source node s and is considered a transmission failure
(d) Resend the packet for a maximum number of time (predetermined)

Step 6. From Steps 5(b) and (c), the forwarding and non-forwarding nodes are identified and declared as nodes are out of transmission range.

Step 7. Determine the effect on the network
(a) If a non-forwarding node misses a broadcasting packet and subsequently missing the propagations are not caused in the network
(b) If a forwarding node misses a broadcasting packet, all its neighbor misses this packet and effects the network
(c) After maximum number of retries, the retransmission from a forwarding node is failed and then another forwarding node from the forward list is selected to cover the earlier scenario.

While a broadcast packet present in a network, all the intermediate nodes other than source node decides whether to retransmit the packet or drop it. This decision is done by each node independently based on a given termination criterion. Here, in the proposed approach it is assumed that each node has freedom to move freely. However, it is ensured that broadcast and forward node as well as non-forward node selection processes is carried out quickly. This is due to the fact that the content of $N_1(f)$ and $N_1(N_1(f))$ is not changing and makes all the procedure inoperable. Further, to handle the issue effectively, a TAG is attached each node as marked/unmarked. A node says, *v* is denoted as marked if it has received the broadcast packet otherwise it is unmarked. While *v* decides its forwarding node list, the TAG status of all the nodes are used and all the nodes in $N_1(v)$ is TAG as marked, *v* stops its retransmission and the packet is discarded. The above discussion is presented in the form of a procedure and it is sufficient to ensure that all the nodes in $N_1(N_1(v))$ receives the broadcast packet. The termination condition is handled by considering the following conditions

(a) In $N(N(s))$, *v* is forwarding node for *s* and *w* is marked by *v and*
(b) In $N(N(s))$, *v* is not forwarding node for *s*. Assume v as forwarding node that covers a node *w* such that *w* is in $N(v))$

IV. Experimental Results

The performance of the proposed approach is evaluated in NS-2 environment. This tool is designed by researchers at Berkeley University and it provides simulation support for various well known protocols such as TCP, routing, and multicast protocols over wired and wireless networks. The proposed approach reduces the flooding effectively and the network topology is understandable from the less number of flooding packets. The performance of the proposed approach is compared with a well-known AODV variant. For evaluation, two different conditions and settings are used for various important ad hoc networks parameters. We have considered with mobile nodes over topology 1000m x 1000m for studying the impact of network density and offered load on the performance of the broadcast schemes are investigated for various flows for each simulation experiment. The density of nodes and traffic load are changed for various values from low to high. This is due to the fact that the proposed approach is applicable for network having different network densities and traffic loads. The methods such as Fixed Probability (FP-AODV), Blind Flooding (BF-AODV), and Smart Probabilistic Broadcasting (SPB-AODV) are studied and their performance is compared with the proposed approach. We have collected average of 30 different randomly generated mobility models for the simulation and the confidence interval is 95%. This is due to the fact that considering more number of random network topology provides more precise simulation result compared to lower valued topologies. The main parameters used in the simulations are summarized in Table I.

TABLE I
Various Parameters Used in the Simulation Experiments

S. No	Parameter	Value
1	Transmitter range	Transmitter range
2	Bandwidth	2Mbit
3	Interface queue	length 50 messages
4	Simulation time	900 sec
5	Pause time	0 sec
6	Packet size	512 bytes
7	Topology size	1000×1000 $m2$
8	Nodes speed	4 m/sec
9	Number of node	25,50,75,100 nodes
10	Traffic load	5,10,20,30
11	Data traffic	CBR
12	Mobility model	Random Way-Point
13	Number of trials	30 trials

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The comparison parameter we consider is the number of retransmissions of a single packet via each broadcast technique. The model [49] under which we investigate the performance of these flooding mechanisms is the unit disk model, i.e. nodes are randomly dispatched uniformly on a map and the network graph is then the network obtained by connecting nodes. Which are at a distance smaller than or equal to the unit. The well-known evaluation parameters such as routing overhead, collisions rate and end-to-end delay are considered for performance evaluation. The routing overhead is the total number of RREQ packets generated and transmitted during the total simulation time. The collisions rate is the total number of RREQ packets dropped by the MAC layer due to collisions between RREQ packets during route discovery operation. The end-to-end delay is the average delay of a data packet to reach from source to destination and includes all possible delays. Duration evaluation, the network density is changed with the number of nodes placed in a 1000m x 1000m area of each simulation scenario. The nodes move based on random way point mobility model with a speed between 1 and 4m/sec. For each simulation, the number of random source and destination connections is chosen as 10 and generates 4 data packets/second. The overhead by the competitive protocols increases with the number of nodes and is shown in Fig. 7. The scalability and applicability issues are considered even the number of nodes are increased and this is because the number transmitting nodes are drastically reduced by having one-hop neighbor participating in transmission. As a result a number of large duplicated and dropped packets are reduced.

TABLE II
THE EFFECT OF THE NETWORK DENSITY ON THE OVERHEAD VALUES

Number of Nodes	25	50	75	100
Proposed	10000	18000	20000	25000
ABS-AODV	13000	22000	25000	31000
SPB-AODV	17000	29000	30000	40000
FP-AODV	18000	35000	38000	51000
BF-AODV	19000	33000	44000	60000

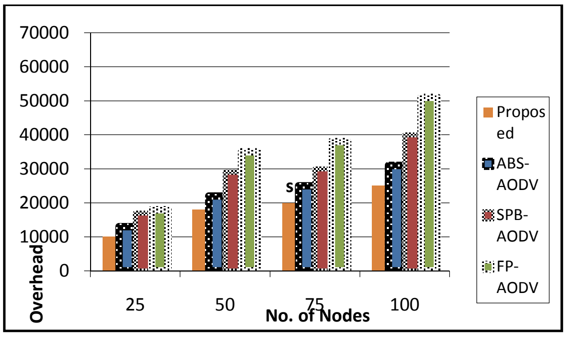

Fig. 7 The effect of the network density on the overhead

The collision rate of the proposed approach is compared with some of the similar approaches and is shown in Fig. 8. The collision rate is reduced considerable compared all other approaches.

TABLE III
THE EFFECT OF THE NETWORK DENSITY ON THE COLLISION RATE VALUES

Number of Nodes	25	50	75	100
Proposed	800	1800	3000	3300
ABS-AODV	1100	2200	4000	4000
SPB-AODV	1100	2800	4600	5000
FP-AODV	1900	3100	5100	6200
BF-AODV	2000	3200	6000	7000

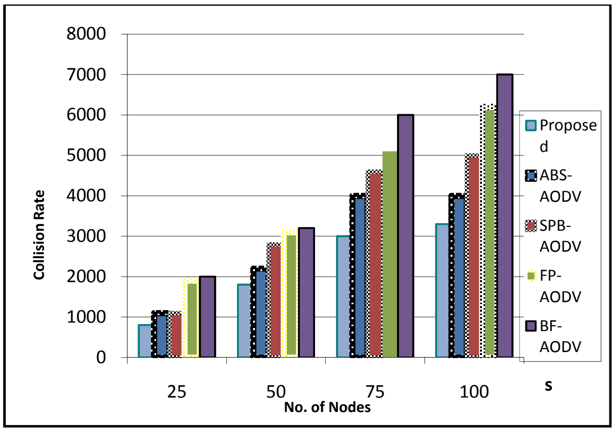

Fig. 8 The effect of the network density on the Collision rate

The effect of traffic load is investigated for 5, 10, 20, 30 and 40 packets per second and measure the collision rate and shown in Fig. 9. It is observed that the number of collisions is increased with offered load and this is due to the fact that the number of RREQ generated increase with the load and disseminated packets also increases. Due to self-contention between the same shared transmission channels, most of the RREQ packets collide with each in the network. It is observed from the result that for an injection rate point, the proposed approach outperforms all the contemporary methods.

TABLE IV
THE EFFECT OF TRAFFIC LOAD ON THE COLLISION RATE VALUES

Traffic Load	5	10	20	30	40
Proposed	2100	2200	2400	3500	3800
ABS-AODV	1900	2100	2600	4100	4500
SPB-AODV	1900	2250	3000	4800	5300
FP-AODV	2100	2600	3400	5400	6200
BF-AODV	2400	2900	3800	6000	7400

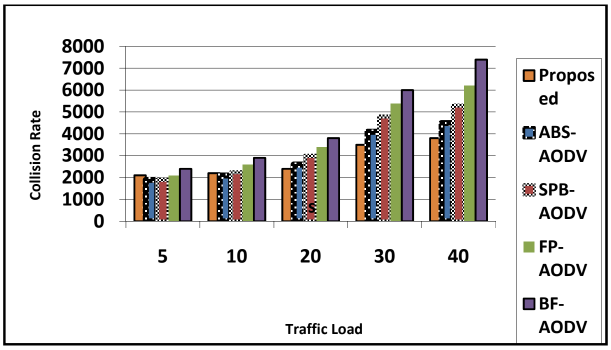

Fig. 9 The effect of traffic load on the collision rate

V. CONCLUSION

In this paper, a broadcast approach is proposed for minimizing flooding for routing in MANET. A forwarding and non-forwarding node list is created optimally for minimizing the number of forwarding packets. A TAG is attached to the nodes and based on the value of the TAG, the retransmission processes is handled. As a result, the overhead on broadcasting and flooding is reduced and the retransmission rate is improved. The performance of the proposed approach is measured in terms of collision rate and overhead and it performs well compared to the recently proposed counterpart approaches.

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