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A Novel Approach to Minimize Flooding in MANET Using Symmetric and Asymmetric Paths

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Abstract- **MANET is infrastructure less network and the routing protocol in MANET is not designed specifically with dynamic, self-starting behavior required for wireless networks. Each and every node in MANET acts as a forward and receiver node. Performance of most of the protocols is not encouraging in a highly dynamic interconnection topology. In this paper, a reliable broadcast approach for MANET is proposed, which improves the transmission rate. The MANET is considered with asymmetric characteristics, where the source and forwarding nodes have different properties. In addition, there exists a non-forwarding node, which is a downstream node and never forwards a packet. The status of each node is dynamically changes and thus the topology of the network also dynamic. In this work, the number of redundant transmission is minimized by creating less number of forwarding nodes. The forwarded packet is considered as acknowledgements and the non-forwarding nodes explicitly send the acknowledgements to the source.**

Index Terms— **MANET, Broadcasting, Flooding, Routing protocols, collision rate.**

I. INTRODUCTION

Mobile Ad-hoc Networks (MANETs) have received a great deal of interest from networking researchers, primarily due to their "infrastructure-free" viewpoint. Mobile *ad-hoc* network is to reliably transfer a message between a source and sink(s), in the presence of uncertain network connectivity and link quality. Typical examples of MANETs include mobile users, such as vehicle on highways, communicating without recourse to fixed wireless infrastructure. MANET nodes are mobile and the connectivity pattern of the network is dynamic. The term *topology* is used to refer to node connectivity and link quality throughout the network. Uncertainty in network topology has been examined from the viewpoint of an "unreliable, but fixed" network, where links fail unexpectedly. Recent work considered the overhead associated with a routing protocol which reliably transferred packets despite links disappearing randomly. Several methods have considered entropy type measures associated with topology change.

Wireless networks consist of a number of nodes which communicate with each other over a wireless channel. Some wireless networks have a wired backbone with only the last hop being wireless. Examples are cellular voice and data networks and mobile IP. In others, all links are wireless. One example of such networks is mobile *adhoc* networks. Mobile ad hoc networks (MANETs) are characterized with frequent topology changes and resource constraints (such as battery life and bandwidth). Typical MANET mission-critical applications, including emergency rescue operations, and battlefield communications, exhibit high degrees of connection dynamics due to mobility and complex natural effects (thunderstorms etc). Consequently, a fundamental challenge in ad hoc networks is the design of routing protocols that can respond quickly to network conditions whilst still maintaining low protocol overhead for operation in resource-constrained environments. Routing protocols in MANETs can be either proactive or reactive according to the maintenance strategy of routing tables. Proactive routing protocols attempt to maintain an up-to-date routing table for each of other nodes using time-triggered and event-triggered routing updates and have potential wastage on the maintenance of unnecessary route information. On the contrary, reactive routing protocols discover routes only when needed. In many scenarios, reactive routing is more efficient than proactive routing.

II. BACKGROUND

There have been several adaptive routing approaches for MANETs. It has been presented an approach to adjust refresh frequency based on node mobility and the status of neighbouring nodes. Some proposed a zone-based hybrid routing algorithm which combined proactive and reactive strategies. Some proposed an adaptive Distance Vector routing algorithm by adopting flexible route update strategies according to conditions.

Some traditional proactive routing algorithms are also used which includes Link State algorithm such as OLSR and Distance Vector algorithm such as DSDV. In Link State (LS) protocols like OLSR, each node discovers and maintains a complete and consistent view of the network topology, by which each node computes a shortest path tree with itself as the root (i.e. shortest path first (SPF) algorithm), and applies the results to build its forwarding table. This assures that packets are forwarded along the shortest paths to their destinations. LS protocols rely on periodic refresh messages to reflect topology changes and maintain correct topology information. Each node sends HELLO messages periodically to discover new neighbours and detect link failures.

In Distance Vector (DV) protocols like DSDV, each node maintains a routing table containing the distance from itself to all other nodes in the network. Each node broadcasts periodically its routing table to each of its neighbours and uses similar routing tables from neighbouring nodes to update its table. The route selection is based on Distributed Bellman-Ford (DBF) algorithm. To keep up with network changes, DV protocols use both periodic and triggered updates.

The main problem of traditional proactive routing (especially LS) lies in the use of fixed timer intervals. The refresh intervals are configured by administrators, usually with the default values recommended by protocol designers. High mobility demands small intervals to speed-up topology change detection, while low mobility only needs relatively large intervals. Due to the non-uniform distribution of node mobility, both temporally and spatially, fixed timer intervals fail to be effective when node mobility is high, but may be inefficient when node mobility is low. Thus, the refresh intervals need to be adapted to network conditions.

III. PREVIOUS WORK DONE

The wireless mission-critical systems maybe resource-constrained including limited bandwidth, so minimizing protocol overhead, whilst maintaining performance is important. Proactive MANET routing protocols tend to provide smaller route discovery latency than on-demand protocols because they maintain route information to all the nodes in the network at all time. such protocols may impose excessive soft-state routing control overhead which is generated by disseminating periodic update messages. In order to mitigate the side effects of the soft-state control overheads, there have been proposed two adaptive proactive routing algorithms, namely DT MIAD and DT ODPU [1].

In the Appointed BrOadcast (ABO) method [2], unicast frames that are to be disseminated to neighbors are transmitted in the ways of broadcast. To keep the transmission to the target node reliable, the intended receiver address (IRA) is appended in the frame body. On receiving of an ABO frame, the node whose address matches with the IRA will return an ACK frame to the sending node.

IV. EXISTING METHODOLOGIES

A number of methods have been implemented for reducing routing overheads in MAET for improving the routing overheads, provide maximum possible reliability, and gives best possible response time and throughput, improve efficiency and speed of routing etc. There are different methodologies are implemented for reducing routing overhead , are Adaptive MANET Routing For Low Overhead, Appointed BrOadcast (ABO), MANETs Routing Overhead and reliability.

A. Adaptive MANET Routing For Low Overhead

The proposed methodology has two adaptive proactive routing algorithms, namely DTMIAD and DTODPU. By tuning the value of soft-state refresh interval timers dynamically and automatically.

1) DT MIAD Algorithm DT MIAD (Dynamic Timer Based on Multi-Increase Additive Decrease).

2) DT ODPU Algorithm (Dynamic Timer Based on On-Demand Proactive Update).

Algorithm Used:

1)DT MIAD Algorithm (Dynamic Timer Based on Multi-Increase Additive Decrease) :

The dynamic timer algorithm based on Multi-Increase Additive Decrease (MIAD) is inspired by control-theoretic adaptive mechanisms similar to those ψ˙ _t >0 (2)ψ˙ __t >0 with the increase of node velocity, the expected link change rate increases. Moreover, the increasing speed of the expected link change rate increases with the node velocity. Therefore, the proposed method can examine the dynamics of link change rate in order to detect any changes of node mobility. The pseudo code of the proposed algorithm is as shows as follows.

```
Algorithm  DT MIAD
Input: h0 < 1
β
h ← h0
link chg cnt ← 0
prev chg cnt ← 0
prev2 chg cnt ← 0
rest of init()
loop
Proporgate Refresh Msg()
if link chg cnt > prev chg cnt then
if link chg cnt−prev chg cnt > prev chg cnt−
prev2 chg cnt then
h ← h
α
if h < hmin then
h ← hmin
end if
end if
end if
h ← h
1−h□β
if h > hmax then
h ← hmax
end if
SynchroniseTimerInterval()
prev2 chg cnt ← prev chg cnt
prev chg cnt ← link chg cnt
link chg cnt ← 0
DELAY(h)
end loop
```

2) DT ODPU Algorithm (Dynamic Timer Based on On-Demand Proactive Update):

Dynamic Timer Based on On-Demand Proactive Update (DT ODPU) is based on the concept of the status of a node which is in one of two states: dynamic and static. When internal link changes are detected proposed the Random Trip Mobility Model, "a generic mobility model that generalizes random waypoint and random walk to realistic scenarios" and performs perfect initialization.

```
Algorithm  DT ODPU
Input: 0 < hmin < hmax
h ← hmin
prev refresh time ← now
link chg cnt ← 0
rest of init()
loop
if link chg cnt > 0 then
Proporgate Refresh Msg()
else if now ≥ (prev refresh time+hmax) then
Proporgate Refresh Msg()
prev refresh time ← now
end if
link chg cnt ← 0
DELAY(h)
end loop
```

B.Appointed BrOadcast (ABO): Reducing Routing Overhead in IEEE 802.11 Mobile Ad Hoc Networks

Packet overhearing in the IEEE 802.11

The proposed method the Appointed BrOadcast (ABO) is to achieve packet overhearing for the IEEE 802.11 standard. The proposed Appointed BrOadcast (ABO) method, unicast frames that are to be disseminated to neighbors are transmitted in the ways of broadcast. To keep the transmission to the target node reliable, the intended receiver address (IRA) is appended in the frame body. On receiving of an ABO frame, the node whose address matches with the IRA will return an ACK frame to the sending node. This can be achieved by modifying the IEEE 802.11 data frame.

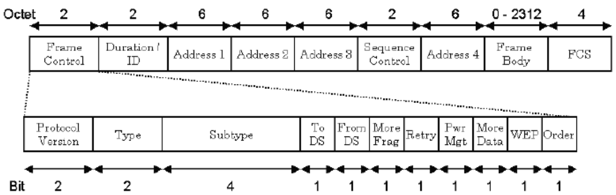

Fig. 1. The IEEE 802.11 frame format in ad hoc mode

The ABO frame, as depicted in Figure 2, has the following modifications:
1)1 The duration value of broadcast frames is 0 in the IEEE 802.11 standard. The IRA is appended at the end of the frame body, 2) address 1 is filled with the local broadcast address
and 3) the duration field is filled with the short interframe space (SIFS) time plus the ACK frame
transmission time. The IRA field is included in the frame check sequence (FCS) calculation. Note that
if encryption is needed, the IRA field is viewed as a part of the plaintext. Address 1 of the local
broadcast address and the value of duration field characterize the ABO frame1.

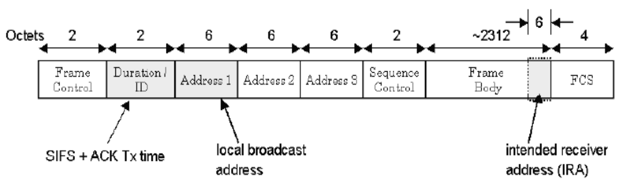

Fig. 2. The ABO frame structure

The ABO method can be triggered whenever a packet is to be disseminated to neighbors. When an
ABO-enhanced node receives a data frame, the node first checks address 1 and the duration fields to see if this is an ABO frame. If true, the following steps will be triggered,
Step 1: check if the IRA field matches its own address, if true, go to step 2, else go to step 3.
Step 2: prepare the ACK frame and transmit it after a SIFS time period.
Step 3: trim the IRA and send the frame body to the upper layer.
Otherwise the received frame is processed as in the IEEE 802.11 standard.
In such way, the ABO method gives routing protocols the flexibility to selectively disseminate packets to neighbors while reliable transmission is ensured.

C. MANETs : Routing Overhead and Reliability

There are three Proposed Model for above scheme:
A .Switched Packet Routing Model.
B. Lower Bound on Overhead.
C. Reliable Routing Decision.

The model develops mathematical operations for switched packet routing that incorporates uncertainty in network topology. Second model is to define bounds on the minimum average routing overhead.
1) Switched Packet Routing Model.
Assume that the routing protocol is deterministic, the number of nodes within the network is fixed, and the random process describing the network topology model is ergodic with respect to the routing protocol. These assumptions allow us to address fundamental aspects of routing decisions .Consider a collection of N nodes N = {v1, v2, . . . ,vN},connected via communication links to form a network G. Then network defines a graph G = {E, V }, for which nodes are the vertices. The network may be equivalently represented by the graph G or an adjacency matrix, Adj, where element c(i, j) is the cost of the link from the ith to the jth node. Each edge is directed, allowing for non-symmetric physical channels .Each link exists (ie. G is completely connected) although edge weights may be infinite to model physical disconnectedness. Each link in the network takes a cost value from the finite1set:
C =_c1, c2, c3, . . . ,c|C|_(1)
MANET literature often restricts consideration to C = {1,∞},ie. a link is available or not and
|C| = 2. At a particular time, each link selects a link cost randomly from the set C.

2) Lower Bound on Overhead
Suppose a source node vs is provided a priori with the routing decision ai that was chosen randomly from the alphabet A, and suppose that each relay node vr does not have access to any related information about the routing decision. What is the minimum average information vs must provide vr?A deterministic routing protocol is a random variable, that maps network topologies to routing decisions:
f : Ω→A, f(ω) = a

The probability of a particular routing decision ai € A for routing protocol f, is given by the probability of the corresponding partition Qfi. That is, it is the probability that a network topology appears that has ai its label .A protocol only observes route changes when the network topology changes from some partition Qi to another partition Qj, for i_= j. So individual topology changes are not necessarily distinguishable at the “route level” and need not differentiate topologies that fall within the same partition. Since it has assumed the topologies appear independent and identically distributed (i.i.d.) with probability P in time, the routing decisions must also appear i.i.d. with probability
Pf (ai) = P(Qi), ai€ A
in time. a lower-bound on any method of compressing route control information. In many situations it is possible to achieve the lower bound, however, one must code over successive routing decisions.

3) Reliable Routing Decision.
Suppose the source node vs is given a noisy topology estimate T. This situation may occur if routers use a (noisy)location based routing scheme , or the network is highly dynamic. Since the router decision is based on T, the decision y will be a noisy version of the true decision x, with some joint probability

PX,Y(y, x). This situation is depicted in Figure From this joint distribution, there is need to define a new “conditional” routing protocol g that operates on the same topology space Ω and same route alphabet A, see. A simple scheme to reduce the probability of error without altering the routing strategy, is to repeat packets. Now demonstrate the repeat packet scheme and show that it improves the reliability of the packet selecting the correct route. In each plot the MANET has 20 nodes. It is consider a network using a least cost routing strategy. No other side information is provided.

V. ANALYSIS AND DISCUSSION

1)Adaptive MANET Routing For Low Overhead:
The proposed method integrate algorithms with the OLSR implementation which runs in version 2.9 of NS2 and uses the ad-hoc networking extensions provided by CMU .The evaluation of the proposed algorithms that compare the routing performance of the proposed adaptive routing algorithms with that of a standard proactive routing protocol, and present the observations under the variation of various parameters, such as node velocity and node density.
2)Appointed BrOadcast (ABO): Reducing Routing Overhead in IEEE 802.11 Mobile Ad Hoc Networks:
The results for m=30% and m=50% in Figure. Larger m results in more transmissions at the link layer except that when all nodes are either IEEE 802.11, i.e., k=0, or ABO-enhanced nodes,
i.e., k=1. The number of transmissions can be reduced for certain m when using the criteria that frames targeted to an ABO-enhanced node are selected first to use the ABO method the IEEE 802.11 and ABO-enhanced nodes handle their respective frames are depicted in Figures 3, where the dotted lines between the NSDU and NPDU implies that they are present only at the source node and the destination node. The IEEE 802.11 nodes transmit standard IEEE 802.11 frames only, thus the higher the proportion of ABO-enhanced nodes in a network, the better the dissemination efficiency

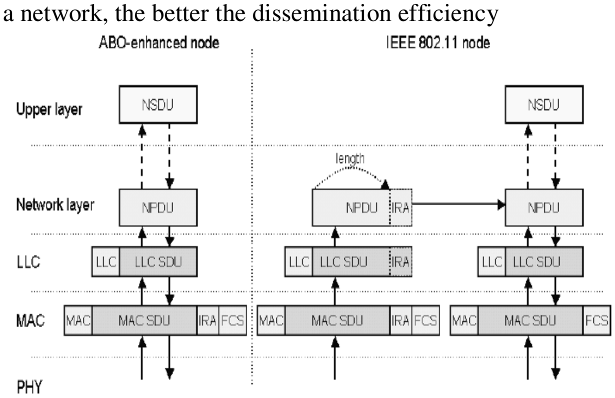

Fig. 5. Handling of the IEEE 802.11 and ABO frames

3)MANETs : Routing Overhead and Reliability
The evaluation of the proposed method develops mathematical operations for switched packet routing that incorporates uncertainty in network topology. It also minimizes average routing overhead. Then simulate these bounds for a 20node MANET using a least cost routing strategy. It also presents and simulates a simple error reduction scheme.

VI. PROPOSED METHODOLOGY

Study of the existing methods, have shown the following drawbacks.
Adaptive approaches have the following potential drawback
Dependency on network measurement.
Increased complexity.
Unknown performance bounds.
The ABO frame must not be fragmented at the link layer, besides, the ABO frame is not coupled with the RTS/CTS transactions as broadcast frames
The method gives good result only when packets are of small size.
The above drawbacks are related to topology and a sudden change in topology of network.
Each node in a MANET acts as a router to receive and forward packets for seamless communications between people and devices. Suitable routing protocol mechanism is used for routing the packet. In a MANET, nodes moves randomly, leave the network, or the power is switched off and new nodes may join the network unexpectedly. Due to this fact and characteristics, MANET is considered as an unstable network, where links between nodes may break frequently. Therefore, all the nodes in a MANET generates control message periodically and distribute it to update their connection states.
The simplest way of broadcasting a packet to all nodes in the network is basic flooding or blind flooding [7] which allows each node to retransmit a packet to its neighbours, in case it has not received broadcast packet during earlier transmission. The rebroadcasting process continues until all nodes in the network have received a copy of the packet. Since, topology packets pass through every possible path in parallel, it is assured that the flooding can always find the shortest path between various source and destination combinations.
However, the basic nature and characteristics flooding mechanism causes a large number of packets propagation in MANETs. This will eventually overload the network and traffic is congested, which is depicted in Figure 1.

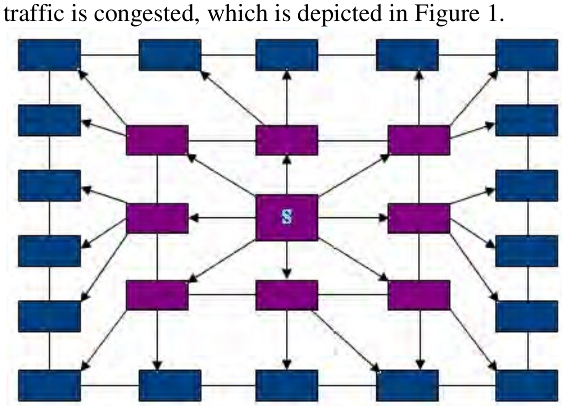

Figure 6. Sample Flooding Scenario

This will be the same case when topology changes. Each node periodically updates the routing information, so while exchanging this information flooding will be there.
In general, all the routing protocol in MANETs relies on a broadcast scheme to disseminate routing information.
So it can be proposed that a reliable broadcast approach for MANET, for improving the retransmission rate. We have

considered MANET with asymmetric structure, where 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 view is considered as a specific snapshot of network topology and the broadcast process with respect to a particular broadcast process. This method tries to minimize the number of redundant transmission in the MANET by minimizing the number of forwarding nodes. A forward node list is generated such that all the nodes in the list transmit the packet in the downstream and this is being treated as ACKs. Further, non-forward 1-hop neighbours explicitly send the ACK and sender acknowledges the same.

Below, a simple asymmetric model of MANET is presented in Figure 4 for better understanding of the proposed work.

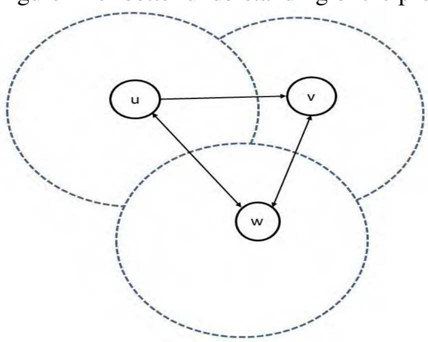

Figure 4. The nodes with symmetric and asymmetric paths

In above Figure, u,v and w are set of nodes in a MANET with corresponding directions and the transmission ranges of u,v and w are different. While the link (u,v) is asymmetric, and (u,w) as well as (w,v) are considered as symmetric. The node v understand the asymmetric link (u,v) while it receives the HELLO message from u with the first hop neighbour list of u. It is observed that the node itself is not in the first hop neighbour list and v initiate a local broadcast Route Request (REQ) to identify u. The intermediate node, which is w attaches the ID and forwards the REQ. While the REQ packet reaches u, the asymmetric link (u,v) is recognised and the feedback path is built as (v,w,u) and this path is informed. As a result, any node can build the feedback path with one intermediate node, which is consists of one hop neighbour with only one intermediate node. While a source node is intended to broadcast a message, a subset of its neighbours are identified and all of them are considered as forwarding nodes. The broadcast message is attached to all these forwarding nodes. Each node in the network receives the broadcast message and delivered to the application layer. The receiver node verifies the stamping for its entry as forwarding node. The forward node computes the next hop forwarding nodes from the current node and the message is broadcasted. These selected nodes covers all the nodes of the 2-hop neighbours with respect to the sender and finally the message is despatched all the nodes effectively. In the proposed approach, a virtual backbone is formed with a set of forwarding nodes. The forwarding nodes are selected in such a way that the delivery of broadcast packets throughout the network is balanced effectively for avoiding broadcast storm and ACK implosion problem. This is due to the fact that the proposed approach allows the only the forwarding nodes to transmit the packet. The retransmission of the forwarding nodes are considered as ACK and no additional ACK is sent in the network. In case of failure due to overhearing forwarding nodes, the sender retransmits the packet so that the packet loss is recovered in a local region. In addition, the proposed approach handles the issue of receiver-initiated approach, which consumes more time to detect the missed packets.

VII. POSSIBLE OUTCOMES AND RESULT

Study depicts that the proposed protocol handles the scalability and applicability issues even the number of nodes are increased. This is due to the fact that the number transmitting nodes are drastically reduced by having one-hop neighbour participating in transmission. As a result a number of large duplicated and dropped packets are reduced.

VIII. CONCLUSION

In this paper, a new framework is proposed, a broadcast approach for minimizing flooding and can be used for routing. The number of broadcast packet is minimized and reduces memory requirements by avoiding needless duplications. The proposed approach is scalable to large populations of nodes. The route to a destination may be returned by any intermediate node. In addition, the link breakages are reported immediately and routes are quickly reestablished. The flooding overhead is reduced and the retransmission rate is improved. The distributed dynamic routing is simplified.

IX. FUTURE SCOPE

An effective route maintenance scheme can be proposed based single to multi hop forwarding scheme. This is performed to enhance the data packet delivery ratio while decreasing the number of routing overhead messages through single hop neighbor beaconing of the primary route nodes.

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