Different Enhancements for Flooding Scheme in Mobile Ad hoc Networks

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ABSTRACT
Mobile Ad hoc Network (MANET) is a self-organizing, infrastructure less, multi hop network. The flooding scheme, used to discover routes in MANET is shown to cause high retransmissions, packet collisions and media congestion that can significantly degrades the network performance. Flooding must be handled efficiently in order to improve the performance of the protocol. The existing techniques for flooding are not so efficient. So to improve the efficiency of flooding the combination of blind flooding and node caching can be used. In that method cache the nodes which are recently involved in data packet forwarding, and use only them to forward route requests. Dropping route request forwarding from the other nodes considerably reduces routing overhead.

Keywords
component: Mobile Ad-hoc Networks, Flooding, AODV, Route Request packet (RREQ).

1. INTRODUCTION
A Mobile Adhoc Network (MANET) is a self-organizing, infrastructure less, multi hop network. There has been a growing research activity on wireless Mobile Adhoc Networks (MANETs) over the past years due to their potential effectiveness in civilian and military applications. MANETs are formed dynamically by an autonomous system of mobile nodes that are connected via wireless links without using an existing fixed network infrastructure or centralized administration. The wireless and distributed nature of MANETs poses a great challenge to system security designers. With the increasing number of applications to harness the advantages of Adhoc Networks, more concerns arise for security issues in MANETs. Node mobility enforces frequent networking reconfiguration which creates more chances for attacks.

In MANET the nodes can communicate via a multi hop route. To find such a multi-hop route, MANETs commonly employ on demand routing algorithms that use flooding or broadcast messages. In flooding, a node transmits a message to all of its neighbors. The neighbors in turn relay the information to their neighbors and so on until the message has been propagated to the entire network. Such flooding is referred as blind flooding.

As one can easily see, the performance of blind flooding is closely related to the average number of neighbors (neighbor degree). As the neighbor degree gets higher, blind flooding suffers from the increase of redundant packets, probability of collision, and congestion of wireless medium. When topology or neighborhood information is available, only subsets of neighbors are required to participate in flooding to guarantee the complete flooding. Such flooding is called as efficient flooding. The characteristics of MANETs (e.g. node mobility, the limited bandwidth and resource), however, make the periodic collection of topology information difficult and costly (in terms of overhead). For that reason many on demand adhoc routing schemes and service discovery protocols simply use blind flooding. In Adhoc On-demand Distance Vector routing (AODV) [1] which is a reactive routing algorithm, every intermediate node decides where the routed packet should be forwarded next. AODV uses periodic neighbor detection packets in its routing mechanism.

The rest of the paper is organized as follows. Next part presents different methods existing for efficient flooding schemes and Conclusion

2. EFFICIENT FLOODING SCHEMES
Selective rebroadcasting of flooded messages is a way to limit the number of redundant transmissions. Instead of simply rebroadcasting the message a node evaluates a local function F and then uses the outcome of this computation to decide whether to forward the message. In its simplest form, this function returns its result based on some static probability. More complex functions take into account additional topological or statistical information.

However, it generates excessive amount of redundant network traffic, because all nodes in the network transmit the flooding message. This will consume a lot of energy resources of mobile nodes and cause the congestion of the network. Due to the broadcast nature of radio transmissions, there is a very high probability of signal collisions when all nodes flood the message in the network at the same time, which would cause more re-transmissions or some nodes failing to receive the message. It is so called the broadcast storm problem.

Several schemes have been proposed to decrease the effect of broadcast storm caused by simple flooding. They are classified into three categories: probability based methods, area based methods and neighbor knowledge methods. The probability-based is simple, but their performance depends on the variation of network density. This is due to the values of the probability and the counter threshold that are defined regardless of the variation on the network environment. The area-based methods consist of the distance-based scheme and the location- based scheme. Within the node transmission range, the longer distance from the previous broadcasting node, the more additional coverage can be acquired resulting in more opportunity to reach more nodes. In particular, if a node has only few neighbors, none of these neighbors may rebroadcast the message. Selective flooding thus balances message overhead against reliability.

Mistral [5] finds some middle ground by introducing a new mechanism that allows tone-tune the balance between message overhead and reliability. The key idea is to extend selective flooding approaches by compensating for messages that are not rebroadcast. This compensation is based on a technique borrowed from forward error correction (FEC). Every incoming data packet (dp) is either rebroadcast or added to a compensation packet (cp). The compensation packet is broadcast at regular intervals and allows the receivers to recover one missing data packet.

In its simplest form, Forward Error Correction (FEC) creates l repair packets for every m data packets such that any m out of the resulting (m+l) packets is enough to recover the original m data packets. Traditional applications of FEC generate l repair packets for every m data packets and inject them into a data stream, which insulates the receiver from at most l packet losses. One of the fundamental advantages of FEC is that it imposes a constant overhead on the system and has easily understandable behavior under arbitrary network conditions. However, this simple form of FEC was developed for streaming settings, where a single sender is transmitting data at a high, steady rate such as in bulk _le transfers or in a video or audio feeds. Part of our challenge is to develop a FEC solution matched to the characteristics of MANET.

In the current implementation of the system, purely probabilistic flooding is used, mostly because this approach is extremely simple and is intuitively easy to visualize. Recall that in PPF, a node rebroadcasts a flooded message with static probability p. Although PPF might not be an ideal choice of algorithm in a practical deployment, the algorithm has no hidden effects that might make it hard to interpret our experimental findings.

To recover data packets from compensation packets use a two-level recovery mechanism. The first level recovers data packets based on the data packets that have already been received. If (c < 1) data packets contained in a compensation packet are known, the missing one can be reconstructed. Actually, it do not store complete compensation packets, but only compensation packets that contain the IDs, TTL(s), and payload of the missing packets. After some time compensation packets are garbage collected, as it has become highly unlikely that the missing data packet(s) will be received in the future.

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In his simple scheme, Hai Liu et al [4] guarantee that a flooding message can reach all nodes if there is no collision and the network is connected. To overcome broadcast storm problem, 2hop neighbor information can be used. But maintaining 2-hop neighbor information for each node incurs extra overhead for the system and the information can be hardly accurate when the mobility of the system is high.

The method s described as three parts. a) Forwarding node selection, where a node selects a subset of its 1-hop neighbors to forward the flooding message; b) forwarding node optimization, which further reduces the size of forwarding nodes by removing the nodes that are already covered; c) mobility handling, where each node incrementally updates its forwarding set in response to topology changes.

All nodes that are 2-hop away from the source s are sure to be covered by F(s). Notice that s's 3-hop neighbors are neighbors of s's 2-hop neighbors. There must exist some transmission nodes in F(s), such that s's 3-hop neighbors are 2-hop neighbors of these transmission nodes. Thus, s's 3-hop neighbors are sure to be covered by forwarding sets of these transmission nodes. Therefore, the flooding message will be forwarded hop by hop throughout the whole network. The authors considered a kind of networks where all nodes are within coverage disk of a central node, denoted by s. Any network in this category consists of a central node and its neighbors, shown in Figure 2.1[4].

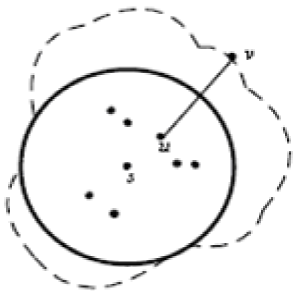

Figure 2.1: Example of neighbors area of node s

Suppose s is a node that receives a flooding message for the first time and s appears in the forwarding list attached to the message. S is designated as a forwarding node and it computes the next hop forwarding nodes from its neighbors. Since s only has 1-hop neighbor's information, it does not know who the 2-hop neighbors are. To achieve 100 percentage deliverability, F(s) must cover the entire neighbor's area of s.

Taking the example given in the Figure 2.2[4], s has three neighbors: u, v and w. Since union of d(u), d(v) and d(s) makes up the neighbor's area of s, it is enough to cover all s's 2-hop neighbor's if only u and v forward the message. In the other word,

$$d(w) \subseteq d(u) \cup d(v) \cup d(s) \quad (1)$$

There is no need for w to forward the message. Computing the minimal F(s) is to find a subset of N(s) such that every node in the subset contributes to the neighbor's boundary of s. Before considering the procedure for merging boundaries, introduce data structures to represent arcs and boundaries.

The F(s) computed is only locally optimal based on the 1-hop information of s. When a node u receives the flooding message from s an if u is a forwarding node nominated by s, the computing of F(u) can be further optimized based on the information of F(s), which is attached to the flooding message from s. This is because some nodes in F(u) may be already covered by node s or node-set F(s), and thus F(u) could be further reduced by removing out those nodes. The significance of this optimization is that it prevents the flooding message from going backwards. The message is always propagated forward towards the uncovered area, which reduces the redundant transmissions greatly.

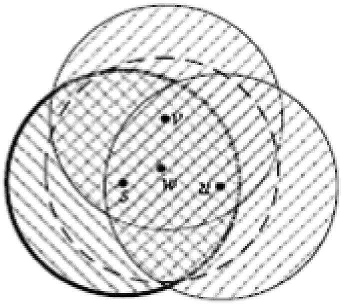

Figure 2.2: Neighbors area of node s

To analyze the performance of the flooding scheme, compare it with three deliverability guaranteed schemes: Pure flooding, Edge Forwarding, and Connected Dominated Set (CDS) based flooding .In CDS-based scheme, a node marks itself belonging to the CDS if there exist two unconnected neighbors. A marked node can quit the CDS later if its neighbor's are covered by two CDS neighbors and they have greater IDs. It was proved that the marked nodes form a CDS. Notice that all forwarding nodes in a flooding operation form a CDS in the network. It means that the number of forwarding nodes is no less than the number of MCDS (Minimum CDS) in the network.

The study of the performance of flooding schemes can be done against two parameters: number of nodes and transmission range. The ratio of forwarding nodes is defined to be the ratio of total number of nodes involved in the packet forwarding in a flooding operation over the total number of nodes in the network. Reducing the forwarding nodes in flooding would effectively reduce the signal collision in the network. If the number of collisions is high, it would result in more packet loss or more retransmissions. Also using the metric, number of collisions, evaluation of the efficiency of flooding schemes can be carried out.

The paper [4] addressed the efficient flooding problem in MANETs. They presented an efficient flooding scheme that uses only 1-hop neighbor information. It has been proved that this scheme achieves the local optimality in terms of: 1) the number of forwarding nodes is the minimal; 2) the time complexity, O (nlogn) is the lowest.

In blind flooding every mobile node rebroadcasts one copy of received RREQ, so the maximum number of rebroadcasts is equal to N-2, where N is the number of nodes in the network. This can potentially lead to excessive redundant retransmissions therefore high channel contention and causing excessive packet collisions in dense networks. Such a phenomenon is referred to as broadcast storm problem.

Many approaches are proposed to improve flooding redundant messages. However, reducing the number of redundant messages leads to a low degree of coverage and connectivity. Sofian Hamad et al [3] developed a method which is based on the area based methods where the accurate position of node is determined using Global Position System(GPS).The neighbor knowledge methods usually utilize the one-hop or two-hop neighborhood information to reduce redundant transmissions. The neighborhood information is obtained by periodically exchanging "HELLO" messages among neighbor nodes. The aim of this work [3] is to design an efficient flooding algorithm for mobile ad-hoc network to improve the network performance by eliminating the redundant retransmission, therefore reducing the chances of contention and collision among the neighboring nodes.

The main concept of this algorithm is to partition the radio transmission range of the mobile node into four zones. Then, one node per zone is selected to forward the RREQ. The selection process is performed by determining the closest node to the edge of the zone as shown in Figure 1 to provide more coverage area. The sender attaches the address of the Candidate Neighbor to Rebroadcast the RREQ (CNRR) into the RREQ field. Any neighbors when received the RREQ will check if the sender select it as forwarder node or not, if so, it will partition its transmission range and select a new set forwarder nodes and attach them into the RREQ and rebroadcast the RREQ, otherwise it will drop the RREQ. After locating each neighbor in the right zone, and then form the Figure2.3 [3] and the distance from the sender node to each neighbor is calculated using the equation:

$$\mathrm{Distance}(S;N) = \sqrt{(S_X - N_X) + (S_Y - N_Y)} \qquad (2)$$

According to the above equation, node S will be able to know the distance from each neighbor. So now node S locates each neighbor in the right zone from its perspective in addition to the distance from each neighbor. To choose the candidate neighbor in each zone, node S will choose the farther node in each zone. The final step is to insert the four candidate neighbors into CNRR (Candidate Neighbor to Rebroadcast RREQ) inside the RREQ field. On the reception of RREQ, each node checks CNRR field inside RREQ and the decision of rebroadcast is taken based on the inclusion of its network address in the list. If the node finds its address inside this field that means rebroadcast the RREQ and otherwise discard it.

In MANETs all the nodes move randomly with high mobility, the farthest neighbors may move out the communication range with a high probability. Also, due to the collisions, interference and decrease of the channel capacity with high distance between the sender and receiver; some farthest neighbors in the candidates list may fail to receive the broadcast RREQ successfully. The authors deal with these problems by mechanisms in which the candidate nodes are selected based on their distance from the source node. A source node can select only a candidate node among the neighbors if the distance between them is less than 80 percentage of the source transmission range.

This new algorithm that candidates four nodes to rebroadcast the This new algorithm that candidates four nodes to rebroadcast the RREQ while prevent some other nodes from rebroadcasting RREQs, which results in better bandwidth usage and reduced channel contention. EF- AODV achieves improvements comparatively based on Network overhead, Throughput, End-To-End delay and Packet Delivery Ratio. In all those metric, it achieves better performance and the main advantage was the huge saving of preventing the unnecessary RREQs from dissemination in the network.

Shobha et al [8] developed a protocol which adapts itself automatically to different mobility conditions. This paper suggests approach to constrain route request broadcast based on mobility of nodes. This technique is best suited for networks where the movement of the nodes is with different random velocities in different random directions. This protocol adapts itself automatically to two mobility conditions i.e. moderate and high speed. Intuition behind this technique is that the nodes moving with higher mobility rates will have better recent routes compared to slow moving nodes which may not be aware of the drastic changes happening in the network.

In this paper the authors proposed a method for efficient flooding when the nodes are moving in random direction with random velocity by selecting a few of the neighboring nodes for forwarding the route requests based on their mobility and recent usage of the nodes for forwarding the data.

This technique does not group the nodes in the network into clusters. They used the mobility of the nodes as the criteria for selecting the nodes to forward the Route requests so that unnecessary flooding can be avoided. Node caching AODV (AODV-NC) technique caches the nodes which have recently forwarded the data packets and uses only these selected nodes for forwarding the Route request packets. Route request uses a fixed threshold parameter H. The first route request is sent with the small threshold H. The node cache cannot guarantee existence of paths between all source-destination pairs; therefore, if the route request with the small threshold H fails to find a route to destination, then a standard route request is generated at the source.

EAODV1 shows good performance for moderate speed of node movement in random direction with random speed and deteriorates in its performance for high speed of node movement. EAODV2 shows good performance for high speed of node movement in random direction with random speed and deteriorates in its performance for moderate speed of node movement. So they have implemented the AODV protocol such that it selects EAODV1 or EAODV2 automatically based on the speed of movement of the nodes in the network; we have named this AODV as Adaptive AODV. This enables us to use AODV efficiently under different mobility conditions in the network.

In this approach it select the neighborhood nodes for broadcasting route requests based on their mobility rate and recent involvement in routing so that blind flooding of the route request in the network can be avoided. Results of AAODV has shown that, it is suitable for highly scalable and dynamic networks as it has drastically reduced the amount of overhead, improved PDR(Packet Delivery Ratio) and reduced end to end delay in the popular reactive routing protocol AODV in different mobility scenarios.

3. CONCLUSION

After considering the various methods for improving the efficiency of flooding techniques, it is clear that none of them gives an improved solution. Several broadcasting techniques are compared and concluding that neighbour-knowledge based broadcasting is better than probabilistic and area based methods in reducing packet redundancy. By considering the method specified in about the adaptive AODV [8], it gives a better method for flooding. The method is the combination of blind flooding and node caching. In that cache nodes which are recently involved in data packet forwarding, and use only them to forward route requests. So that blind flooding of the route request in the network can be avoided, this in turn reduces the routing overhead.

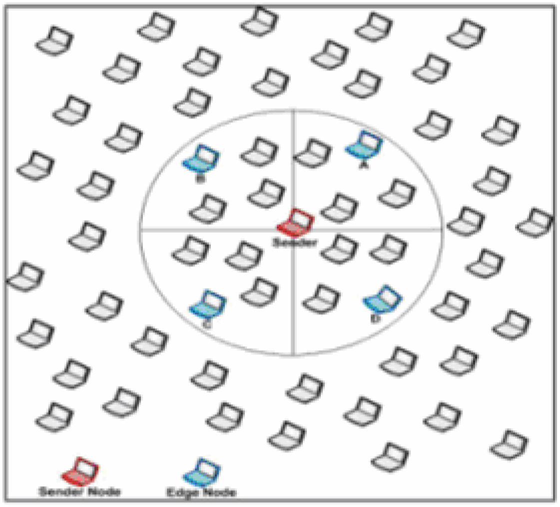

Figure 2.3: Divide the transmission range and locate each neighbor in the right zone.

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