Improved Receiver-Based Algorithm for Resourceful Broadcasting in Portable ADHOC Networks

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Abstract - Two efficient broadcasting algorithms based on 1-hop neighbor information is implemented here, i.e. Sender-based broadcasting algorithm and receiver-based broadcasting algorithm. The sender-based broadcasting algorithm selects a subset of nodes to forward the message. An efficient sender-based broadcasting algorithm proposed here is based on 1-hop neighbor information where the number of forwarding nodes selected in the worst case is 11 which reduces the time complexity of computing forwarding nodes to O (n). An elementary and extremely competent receiver-based broadcasting algorithm is also implemented. When nodes are uniformly distributed, the chance of two neighbor nodes broadcasting the same message exponentially diminishes when the distance between them decreases or when the node density increases. Using simulation, the results demonstrates that, the number of broadcasts in our proposed receiver-based broadcasting algorithm can be even less than one of the best known approximations.

Keywords- ***Wireless ad hoc networks, flooding, broadcasting, localized algorithms.***

1. INTRODUCTION

Broadcasting is a fundamental communication operation in which one node sends a message to all other nodes in the network. Broadcasting is widely applied as a primary mechanism in several ad hoc network protocols. Broadcasting is as well applied for topology updates, for network sustainment, or merely for directing a control or cautionary message. The most elementary broadcasting algorithm is flooding, in which all node broadcasts the message once it gets it for the first time. Employing flooding, each node gets the message from all its neighbors in a collision-free network. Therefore, the broadcast redundancy significantly increments because the mean amount of neighbor's increases. High broadcast redundancy can lead to high power and bandwidth consumption in the network and also increments packet collisions, which can lead to extra transmissions. This can cause intense network congestion or substantial performance degradation, a phenomenon known as the broadcast storm problem [3]. Consequently, it is crucial to design effective broadcasting algorithms to bring down the amount of needed transmissions in the network.

A set of nodes is addressed a Dominating Set (DS) if any node in the network either lies to the set or is a 1-hop neighbor of a node in the set. The set of broadcasting nodes forms a Connected DS (CDS). Hence, the least number of required broadcasts isn't less than the size of the smallest CDS. The principal target of efficient broadcasting algorithms is to bring down the amount of broadcasts while holding the bandwidth and computational overhead as low as possible. One approach to classify broadcasting algorithms is established with the neighbor information they use. A few broadcasting algorithms such as flooding and probabilistic broadcasting algorithms [4], [5] don't rely on neighborhood knowledge. These algorithms can't usually assure full delivery and/or effectively bring down the number of broadcasts.

The first proposed algorithm is a sender-based algorithm. In sender-based algorithms, the broadcasting nodes pick out a subset of their neighbors to forward the message. We compare our proposed broadcasting algorithm to one of the best sender-based broadcasting algorithms that apply 1-hop information [5]. In [5], Liu et al. propose a broadcasting algorithm that brings down the number of broadcasts and attains local optimality by picking out the minimal number of forwarding nodes with minimal time complexity O(n log n), where n is the number of neighbors. We show that this optimality only holds for a subclass of sender based broadcasting algorithms applying 1-hop information and demonstrate that our proposed sender based algorithm can achieve full delivery with time complexity O (n).Another proposed algorithm is a receiver-based broadcasting algorithm. In receiver-based algorithms, the receiver determines whether or not to broadcast the message. The proposed receiver-based algorithm is a novel broadcasting algorithm that can significantly bring down the number of broadcasts in the network. We demonstrate that applying our proposed receiver-based algorithm, two close neighbors are not likely to broadcast the same message. In other words, we prove that the probability of broadcast for a node NA exponentially decreases when the distance between NA and its broadcasting neighbor decreases or when the concentration of nodes increases. This algorithm is one of the best known estimations for the minimum number of needed broadcasts.

2. RELATED WORK

2.1. Mobile Ad Hoc Network

A Mobile Ad hoc Network is a collection of mobile wireless nodes that combine to form a network without any infrastructure. Each device in a MANET is free to move independently in any direction, and will therefore interchange its links to other devices often. Each must forward traffic unrelated to its own use, and therefore be a router. The main challenge in constructing a MANET is equipping each device to endlessly preserve the information

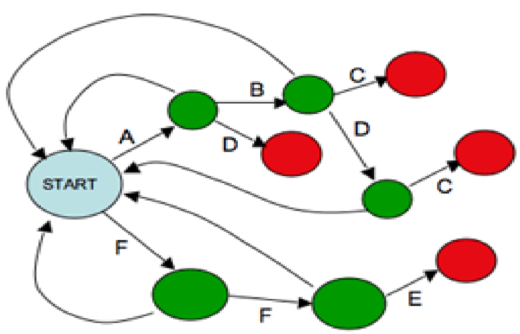
needed to properly route traffic. Such networks may function by themselves or may be connected to the larger Internet.
The main challenges in MANET are reliability, bandwidth and battery power. Broadcasting is important in MANET for routing information discovery. Broadcasting is the process in which a source node sends a message to all other nodes in MANET.

2.2. Wireless Ad Hoc Network

A wireless ad hoc network is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. Each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. In addition to the classic routing, ad hoc networks can use flooding for forwarding the data.

2.3. Flooding

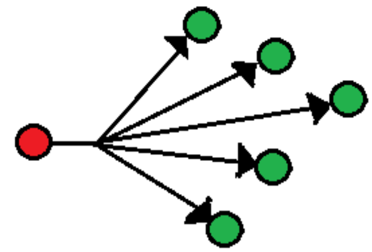
A procedure in which a router or similar devices forwards a packet of information to all of the devices to which it is attached.
A flooding algorithm is an algorithm for distributing material to every part of a network. Flooding algorithms [2] are used in system such as Usenet and peer-to-peer file sharing systems.
There are several constraints of flooding algorithm:
1. Each node acts as both a transmitter and a receiver.
2. Each node tries to forward every message to every one of its neighbors except the source node.



Flooding

2.4. Broadcasting

Broadcasting refers to a method of transferring a message to all recipients simultaneously. Broadcasting refers to transmitting a packet that will be received by every device on the network. In practice, the scope of the broadcast is limited to a broadcasting domain. In a broadcast process, each node decides its forwarding status based on given neighborhood information and the corresponding broadcast protocol.
Broadcasting: Transmitting to all the nodes
The broadcast operation as a fundamental service in mobile ad hoc networks is prone to the broadcast storm problem if forwarding nodes are not carefully designated. Efficient broadcasting in a mobile ad hoc network focuses on selecting a small forward node set while ensuring broadcast coverage.



Broadcasting

3. Sender-Based Broadcasting Algorithm

Our first proposed broadcasting algorithm is a sender based algorithm, i.e., each sender chooses a subset of nodes to forward the message. Each message can be identified by its source ID and a sequence number incremented for each message at the source node. This algorithm is a general sender-based broadcasting algorithm and shows the structure of our proposed sender-based broadcasting algorithm. Upon exhalation of the timer, the algorithm calls for the MAC layer to schedule a broadcast. The message scheduled in the MAC layer is buffered and then broadcast with a probability p.
The sender-based broadcasting algorithms can be split up into two subclasses. In the first subclass, each node determines whether or not to broadcast exclusively based on the first received message and neglects the rest of the identical messages that it receives subsequently. In the second subclass of sender-based broadcasting algorithms, each node can determine whether or not to broadcast after each message reception. However, if a node broadcasts a message, it will omit the rest of the same messages that it receives in the future. Therefore, each message is broadcast once at most by a node employing the broadcasting algorithms in both subclasses.
The demonstrations show that the proposed algorithm can bring down both the computational complexity of choosing the forwarding nodes and the maximum number of selected nodes in the worst case.

Algorithm: A General Sender-Based Algorithm

1: Extract information from the received message M
2: if M has been scheduled for broadcast or does not contain node's ID then
3: drop the message
4: else
5: set a defer timer
6: end if
7: When defer timer expires
8: Select a subset of neighbors to forward the message
9: Attach the list of forwarding node to the message
10: Schedule a broadcast.

In the sender-based broadcasting algorithms, each broadcasting node binds a list of its designated forwarding nodes to the message before broadcasting it. This forwarding node selection process is carried out by the Forward Node Selection Algorithm. As pictured in Algorithm, each node schedules a broadcast for a received message whenever the node is picked out by the sender and if it has not scheduled the same message earlier. Clearly, each message is broadcast once at most by a node and broadcast schedule can be set at any time. For example, a message could be cut down after the first reception but scheduled for broadcast the second time. Understandably, the principal design issue in this algorithm is how to choose the forwarding nodes.

3.1. Forwarding-Node Selection Algorithm

A forward node selection algorithm is one in which the receiving node (i.e.) a node which receives the broadcast message is applied to choose a subset of nodes to which the broadcast message has to be forwarded. This subset selection is made up based on the concept of bulged slice [1] in which a bulged slice of any node is the intersection of broadcasting range of three neighbor nodes. Based on this bulged slice the subset nodes are decided. This subset is called as B-Coverage set. A node can have many B-Coverage sets. This slice based algorithm is one that selects 11 nodes in the worst case, where n is the number of neighbors.

4. Receiver-Based Broadcasting Algorithm

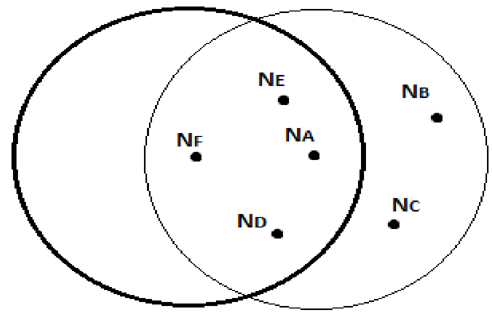
A receiver-based broadcasting algorithm can significantly bring down redundant broadcasts in the network. As referred in the beginning, in receiver-based broadcasting algorithms, the receiver of the message determines whether or not to broadcast the message. Therefore, a potential advantage of receiver-based broadcasting algorithms over sender-based ones is that they do not increase the size of the message by appending a list of forwarding nodes. As referred before, in receiver-based broadcasting algorithms, the receiver of the message determines whether or not to broadcast the message.

Algorithm: A General Receiver-Based Algorithm

1: Extract information from the received message M
2: if M has been received before then
3: drop the message
4: else
5: set a defer timer
6: end if
7: When defer timer expires
8: decide whether or not to schedule a broadcast

4.1. Responsibility-Based Scheme

The principal idea of this algorithm is that a node avoids broadcasting if it is not responsible for any of its neighbors. A node N_A is not responsible for a neighbor N_B if N_B has received the message or if there's a different neighbor N_C such that N_C has received the message and N_B is more nearer to N_C than it is to N_A. Suppose N_A stores IDs of all its neighbors that have broadcast the message during defer period. When executed by a node N_A, Algorithm first uses this information to decide which neighbors have not received the message (Lines 1-9 of Algorithm). It then returns false if and only if it ascertains a neighbor N_B that has not received the message and AB <= BC for any N_A's neighbor N_C that has received the message. The output of Responsibility Based Scheme determines whether or not the broadcast is redundant.



An Example of an RBS decision

5. Conclusion And Future Work

Therefore two efficient broadcasting algorithms based on 1-hop neighbor information is implemented here, i.e., sender based algorithm and receiver based algorithm are implemented. Initially a forwarding node selection algorithm is proposed, that chooses at the most 11 nodes in O (n), where n is the number of neighbors. This limited number of nodes is an improvement and has time complexity O (n log n). Forwarding-node selection algorithm results in fewer broadcasts in the network. An efficient receiver-based algorithm is also implemented and it demonstrates why it significantly brings down the number of forwarding nodes in the network and also the number of broadcasts in the network which significantly reduces the network traffic. The 2-hop based version of receiver-based algorithm can guarantee invariant approximation to the optimal solution (minimum CDS). This broadcasting algorithm constructs a CDS and can ensure both full delivery and a constant approximation ratio to the optimal solution. As a future work an investigation of the necessary conditions to ensure both full delivery and constant approximation ratio to the minimum CDS.

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