An Efficient Flooding Based Reliable Broadcasting for Content Delivery in MANETs

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Abstract-A mobile ad-hoc network (MANET) is a kind of wireless network, and it is a self-configuring network of mobile nodes connected by wireless links the union of which form an arbitrary topology. Flooding [2] is one of the most fundamental operation which provides maximum content delivery in mobile ad hoc networks. Normally the flooding causes excessive redundancy of data and increase time complexity. Some efficient flooding based algorithms can solve these problems by using different forwarding node selection processes to deliver the contents. But these flooding schemes used to deliver less amount of data and inefficient in high error rate environments. In this paper we propose reliable broadcasting algorithm with extended connected dominating set method (2-Hop ECDS) for forwarding node selection to deliver the contents effectively. Simulation results show the performance of this proposed method.

Index Terms : MANET, Flooding, Broadcasting, Content Delivery, ECDS

1 INTRODUCTION

1.1 Mobile Ad Hoc Networks

Future information technology will be mainly based on wireless technology. Traditional cellular and mobile networks are still, in some sense, limited by their need for infrastructure (i.e., base stations, routers). For mobile ad hoc networks, this final limitation is eliminated. Ad hoc networks are key to the evolution of wireless networks. Ad hoc networks are typically composed of equal nodes that communicate over wireless links without any central control. Although military tactical communication is still considered the primary application for ad hoc networks, commercial interest in this type of networks continues to grow. Applications such as rescue missions in times of natural disasters, law enforcement operations, commercial and educational use, and sensor networks are just a few possible commercial examples. Ad hoc wireless networks inherit the traditional problems of wireless and mobile communications, such as bandwidth optimization, power control, and transmission quality enhancement.

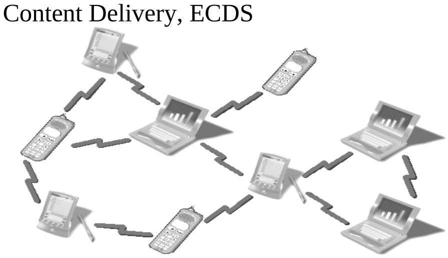

Fig 1: Mobile Ad Hoc Network

In addition, the multi hop nature and the lack of fixed infrastructure generate new research problems such as configuration advertising, discovery, and maintenance, as well as ad hoc addressing and self-routing. In mobile ad hoc networks, topology is highly dynamic and random. The main characteristics can be summarized as follows:

1. The topology is highly dynamic and frequent changes in the topology may be hard to predict.
2. Mobile ad hoc networks are based on wireless links, which will continue to have a significantly lower capacity than their wired counterparts.
3. Physical security is limited due to the wireless transmission.
4. Mobile ad hoc networks are affected by higher loss rates, and can experience higher delay and jitter than fixed networks due to the wireless transmission.

5. Mobile ad hoc network nodes rely on batteries or other exhaustible power supplies for their energy.
The MAC layer specified in the IEEE 802.11 (Wireless LAN) standard or its variations, is typically applied in the existing ad hoc networks.

Protocols for MANETs
Types of protocols used in mobile ad hoc networks are,

Table-driven (Proactive)
These protocols maintain consistent overview of the network. Destination Sequence Distance Vector routing protocol (DSDV) and Wireless Routing Protocol (WRP).Presence of high mobility, large routing tables and low scalability result in consumption of bandwidth and battery life of the nodes. Moreover continuous updates could create unnecessary network overhead.

On-demand (Reactive)
With on-demand protocols, if a source node requires a route to the destination for which it does not have route information, it initiates a route discovery process which goes from one node to the other until it reaches to the destination or an intermediate node has a route to the destination. Some of the better known on-demand protocols are Ad-hoc On-demand Distance Vector routing (AODV), Dynamic Source Routing (DSR) and Temporary Ordered Routing Algorithm. From these the AODV protocol will be used [9].

1.2 Content Delivery
The content delivery network operation in adhoc network has significant difference from wired networks. In wired situation the contents are delivered server to clients or p2p with fixed infrastructure. But in adhoc networks the operation is different one. In Mobile ad hoc networks the contents (data, audio, video, etc) are shared in the form of packets in peer to peer fashion. In mobile ad hoc networks one of the main factors which we need to achieve is reliability. More important we have to achieve maximum reliability for data delivery in high error rate situation. In the communication world the mobile terminals such as mobile phones, PDAs, laptops are unavoidable terminals. Between these mobile nodes the contents (multimedia files, text files) are shared in peer to peer fashion. Most of these devices are equipped with some technology that can be used to distribute entertainment contents such as music, movie clips, and commercial films. However, content sharing faces several challenges such as short communication range, limited bandwidth, user mobility, performance variations in different environmental situation. So these contents are delivered in the form of packets with each mobile peer. Without infrastructural support from base stations, mobile nodes in an ad hoc network communicate with each other in a peer-to-peer fashion. This poses a challenge in data (content) dissemination among the mobile peers, each having limited transmission range and unpredictable mobility. A mobile node is able to share coded file segments from different peers at different times and in different locations. When it receives sufficient segments, it will be able to reconstruct the original data [7],[6].

To design efficient mobile adhoc network environment for content delivery we need to analyze following mechanisms.

1.3 Flooding Operation
Flooding is one of the most fundamental operations in mobile ad hoc networks. This mechanism provides maximum content deliverability ratio. But flooding suffers from the problems of excessive redundancy of messages, resource contention, and signal collision. This causes high protocol overhead and interference with the existing traffic in the networks[2].

1.4 Broadcasting Operation
The broadcasting operation is different from the flooding mechanisms .The broadcast mechanism is used for transmission of a large amount data or stream media data, which requires a broadcast routing to find an efficient route before the actual transmission of data so that data can be transmitted efficiently along the prefound route. Broadcasting is a fundamental operation in all kinds of network; it may be used for discovering neighbors, collecting global information, naming, addressing. While most existing works on MANET taking flooding as a

straightforward and direct solution, these may lead to lower reach ability and longer latency. We thus refer to this scenario the broadcast storm problem**.** To alleviate the broadcast storm, one should inhibit redundant rebroadcasts of the broadcast packets. [1]

1.5 Dominating Set

A dominating set (DS) is a subset of nodes such that every node in the graph is either in the set or is adjacent to a node in the set. If the sub graph induced from a DS of the network is connected, the DS is a CDS. These sets are needed when the mobile network becomes larger. These connected dominating sets are formed based on neighbor node's locations (hops) [8],[11].

2 Existing Methods

Most researches used different algorithms to broadcast the packets to the destination. They are classified as follows

2.1Cluster based broadcastings

2.2Ad hoc broadcast algorithms

2.3Partial dominant Pruning algorithms

2.1 Cluster based broadcasting

In this algorithm the mobile nodes have cluster heads to forward the data. The Cluster heads are selected by using Lowest ID clustering algorithm .Based on this algorithm which node has lowest ID value that would be selected as cluster head. Each time the network need to select cluster heads depends on mobility [5].

2.2 Ad Hoc Broadcast Process

Broadcast Relay Gateway (BRG) is used to select the number of forwarding nodes to relay the packets. This algorithm is also prominently suppressing the number of 2-hop neighbors to relay the packet. In which BRG acting intelligently if any of the nodes is not present in the covered node set, It will automatically select another node to relay the packet immediately without any delay. Its performance is better than the previous one [3]

2.3 Partial dominant Pruning algorithm

It is further reducing the coverage of 2-hop neighbors to be covered by 1-hop neighbor in which a common neighbor is selected to relay the messages. But the algorithm does not perform the reliable communication. It does not get any acknowledgement from the receiver node. In the above mentioned algorithms the forwarded node is waiting for some amount of time. This means that the node should wait for the timer's predefined time for acknowledgement. Unless otherwise it did not get any reply from the forwarding node and resend the packets for the maximum number of retries. So that latency will be increased [4].

3 Proposed Method

Our proposed method has two steps

1. Reliable broadcasting algorithm to design resilient Mobile Ad Hoc Network (F/W node set selection and Broadcasting algorithm)

2. Broadcast the contents (data, text, audio or video) through the mobile nodes

3.1 Forwarding Node Set Selection Process (FNSSP-ECDS)

1. Each node v sets X=H(v)-N(u) and $U=N_2(v)-N(u)-N(F(u)-\{v\})$

2. Node v uses the FNSSP to find F(v) in X to cover U.

Theorem: Forwarding Node Set Selection algorithm provide a set of forwarding nodes that cover all the nodes within a 2-hop neighbor set and doubly cover the nonforwarding nodes within a 1-hop neighbor set.

Proof. The correctness of the FNSSP-ECDS is proven as follows: Based on the description of the algorithm, N_2 (v)-{v}is partitioned into three sets: 1) the set N(u) that is covered by u, 2) the set N(F(u)-{v}), which is covered by those forwarding nodes of u, and 3) the set $U=N_2(v)-N(u)-N(F(u)-\{v\})$ that is covered by v's forwarding node set F(v).Thus,$N_2(v)$ is fully covered. Moreover, H(v) is also covered by v itself and, therefore For the example network shown in Fig.3a N(2)={1,2,3,5,6}and$N_2(2)$={1,2,3,4,5,6,7} .When using the FNSSP, sender node 2 selects nodes 1, 3, and 5 as its forwarding nodes. Node 1 is selected because there is no node in N(1) to cover it. In Fig.3b, suppose the source of a broadcast is node 5 and node 2 has received the broadcast packet from node 5. Node 5's forwarding node set is F(5)={2,4,6}. Therefore, node 2's uncovered 2-hop neighbor set is $N_2(2)$-N(5)-N({4,6})={3}.Using the FNSSP, node 2 selects node 3 as its forwarding node.

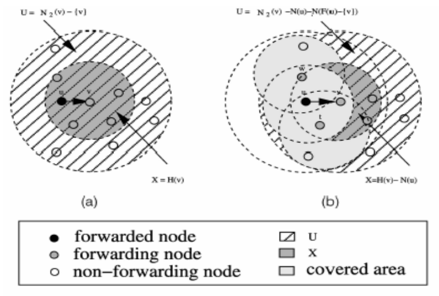

Fig 2: Forwarding Node Selection

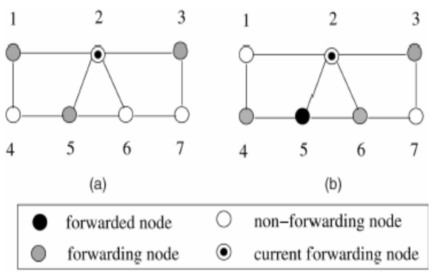

Fig 3: FNSSP-ECDS

3.2 The Reliable Broadcasting Algorithm

The reliable broadcasting algorithm uses the following symbols:

F(v): the forwarding node set of node v

U(v): the uncovered 2-hop neighbor set of node v

X(v): the selectable 1-hop neighbor set of node v

P(v,F(v)): a unique broadcast packet P forwarded by node v that attaches v's forwarding node set F(v)

Twait: the predefined duration of a timer for a node to overhear the retransmission of its forwarding nodes

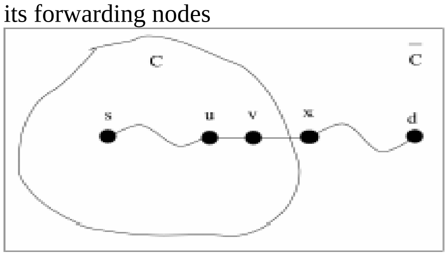

Fig 4:Broadcasting Algorithm

The works as follows

1. When a node s starts a broadcast process, s uses the algorithm to select its forwarding node set F(s) and broadcasts the packet P together with F(s).

2. When a node v receives P from an upstream sender u, it records P. v also updates its X(v)=X(v)-N(u) and U(v)=U(v)-N(u)-N(F(u)-{v}).Note that X(v) and U(v) are initialized to H(v) and H_2(v). Then, v checks whether it is a designated forwarding node of u. If not, v drops the packet and stops the process; otherwise, v further checks whether P is ever received. If P is a new packet for v, v uses the FNSSP-ECDS algorithm to compute its forwarding nodes F(v) and sends P with F(v). If v has already received P from another node, v will not forward P, but send an ACK to u to confirm the reception so that u will not retransmit the same packet at a later time.

3. When the sender u broadcasts P, it waits for a predefined duration T_{wait} to overhear the retransmission of its forwarding nodes. If u overhears a retransmission packet from its forwarding node v, u regards this as an ACK from v. u may receive explicit ACKs from some of its forwarding nodes to confirm the reception. If u does not overhear all of its forwarding nodes when the timer expires, it assumes that the transmission failure has occurred for this packet. u then determines a new F(u) to cover the rest of the uncovered U(u) and resends the packet . In Fig. 4, the set C inside the circle represents the covered node set and $\bar{C}$ represents the uncovered node set. Therefore, s $\in$ C and d$\in \bar{C}$. Since the network is connected, there exists a path from s to d. Suppose node x is the uncovered node that is closest to s on the path and v is the predecessor of x on the path. Based on the assumption, v has received the broadcast packet, say v has received the packet from node u for the first time. Because x $\in$ N_2 (u), guarantees that u covers x. Therefore, this reliable broadcasting algorithm guarantees that the network is fully covered.

After the mobile ad hoc network was developed by using reliable broadcasting algorithm we can deliver the contents like text, audio, video or other data packets. In the simulation (NS-2xx) we can deliver the data between mobile nodes in the form of trace files (.tr).This trace files are executable files. That means we convert the contents into trace file formats and then deliver that files through mobile nodes.

4 Performance Evaluations

In the above section we analyze the existing methods and proposed method. Here we study the performance of proposed algorithm based on following performance metrics: throughput, delay, broadcast forward ratio. These performance metrics are analyzed from received data packets in some mobile nodes. Here we can see the performance of this method related to received packets and deliverability level for different receiver nodes. And the comparison between the different methods is shown below.

Time (sec)	***At Node 0***	***At Node 5***	***At Node 11***	***At Node 12***	***At Node 14***
5.66	89	110	106	120	99
9.50	180	203	216	220	204
32.50	743	758	870	809	826
156.5	3764	3071	4403	3980	4169

Table1: Received Packets at five receiver nodes

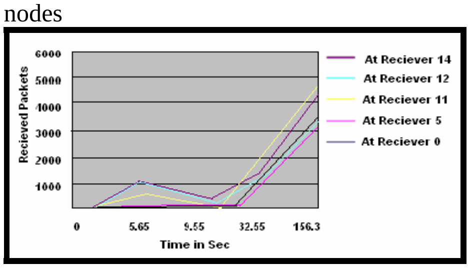

Fig 5: Received Packets at five receiver nodes

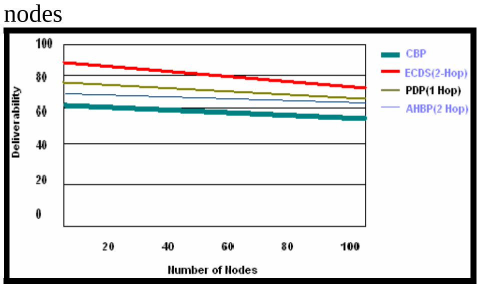

Fig 6:Comparision between methods

5 Conclusions

In this paper we introduced reliable broadcasting algorithm to deliver the contents like text, audio, video or data packets. In this method first we develop efficient mobile adhoc network by using proposed broadcast algorithm. For that we design forwarding node set by using extended connected dominating set-2 hop and broadcast the data through the nodes. This method provides full reliability for all forwarding nodes but not for nonforwarding nodes. In order to provide full reliability for all nonforwarding nodes, negative acknowledgement(NACK) mechanism is used such that a nonforwarding node will send a NACK message when the node notices a packet loss. So by using this algorithm we can deliver the contents through mobile nodes with maximum reliability, less delay, maximum content delivery ratio and better coverage than other methods.

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