MANET- Review on Broadcasting Techniques

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ABSTRACT

A mobile ad hoc network (MANET) is a network consisting of a collection of dynamic nodes capable of communicating without any fixed infrastructure. Each and every node can act as sender and router in order to forward the packets between the nodes since the nodes cannot communicate directly among themselves. These communication techniques are termed as broadcasting since it floods messages from one node to all the other nodes in the MANET. This paper depicts the fundamentals of ad hoc network by giving its related research background including the concept, challenges, routing protocols and different broadcasting approaches in MANET.

Keyword: - *MANETS, Simple flooding, Probability based Flooding, Self Pruning, Multi-point Relaying, Random Assessment Delay.,*

1. INTRODUCTION

Mobile Ad Hoc Networks (MANETs) has become one of the most prevalent areas of research in the recent years because of the challenges it pose to the related protocols. The proliferation of cheaper, small and more powerful devices make MANET a fastest growing network. An ad-hoc network is self-organizing and adaptive. Device in mobile ad hoc network should be able to detect the presence of other devices and perform necessary set up to facilitate communication and sharing of data and service. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. The term 'ad hoc' implies that the network is structured for a special, sometimes exclusive service designed for specific applications (e.g., disaster recovery, battlefield). Typically an ad hoc network is established for a finite amount of time [1]. Due to nodal mobility, the network topology may change rapidly and unpredictably over time. The network is decentralized, where network organization and message delivery must be executed by the nodes themselves. Nodes in MANETs act as end points and sometimes as routers to forward packets in a wireless multi-hop environment.

Network wide broadcasting, simply referred to as "broadcasting", is the process in which one node sends a packet to all other nodes in the network. Broadcasting is often necessary in MANET routing protocols. For example, many unicast routing protocols such as Dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV), Zone Routing Protocol (ZRP), and Location Aided Routing (LAR) use broadcasting or a derivation of it to establish routes.

2. CLASSIFICATION OF WIRELESS NETWORK

Wireless networks are classified as mentioned in following ways.

2.1 Infrastructure-less (Ad-hoc) wireless network

In Infrastructure less or Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations. Where each node participates in routing by forwarding data dynamically based on the network connectivity. It improves the Scalability of wireless networks compared to infrastructure based wireless networks

because of its decentralized nature. In critical situations such as natural disasters, military conflicts or any emergency moment, ad-hoc networks are best suitable due to minimal configuration and quick operation.

2.2 Infrastructure-based wireless network

This type wireless network is pre-constructed infrastructure that is made of fixed and network nodes and delivered network services via these infrastructures. The mobile node can move while communicating, the base stations are fixed and as the node goes out of the range of a base station, it gets into the range of another base station.

3. CHALLENGES IN MANET

The following are the factors that are applicable only to MANET, but are not limited to,

3.1 Dynamic Topology

The nodes are free to move and it does not require any fixed infrastructure. Due to this dynamic nature the path between the nodes are not static.

3.2 Limited Bandwidth

Between communicating nodes only limited bandwidth is available than infrastructure networks. The communication is less reliable since it makes use of electromagnetic waves through air.

3.3 Energy Constraints

The nodes within the network are battery operated which exhaust over time thus reducing the active duration of node. It requires techniques for energy management.

3.4 Path Failures

Due to the dynamic nature of nodes, there is no static link between the nodes thus resulting in frequent link breakages leading to frequent path failures and route discoveries.

3.5 Hidden Terminal Problem

It refers to collision of packets at a receiving node due to the movement of nodes; hence ongoing session suffers frequent path breaks. This situation leads to often path breaks.

4. ROUTING PROTOCOLS

A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes. There are numerous of routing protocols have been proposed for such kind of ad hoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. Routing protocols can be commonly classified into three types as Table Driven Protocols or Proactive Protocols, On-Demand Protocols or Reactive Protocols and Hybrid protocols

4.1 Table Driven or Proactive Protocols

These routing protocols require every node to maintain up-to-date information of each and every node in the network. Some of the existing table driven or proactive protocols are: DSDV, DBF, GSR, WRP and ZRP.

4.2 On-Demand Protocols or Reactive Protocols

These routing protocols require a route from source to destination on demand rather maintaining frequent update. Some of the existing on demand routing protocols are: DSR, AODV and TORA.

4.3 Hybrid Routing Protocols

These routing protocols combine the features of proactive and reactive routing protocols and hence use the both.

5. BROADCASTING TECHNIQUES

In general, the broadcasting strategies can be grouped into four families: Simple flooding, Probability-based methods, Area-based methods and Neighbor knowledge based methods.

5.1 Simple flooding

In this method, a sender node initiates a message to all its neighbors, each of these neighbors will check if they have seen this message before , if yes the message will be dropped, if not the message will rebroadcasted at once to all their neighbors. The process goes on until all nodes have the message. This method is suitable for MANET with low density nodes and high mobility. It ensures no packet losses. But it may cause network congestion and quickly drain the battery power. Blind flooding ensures the coverage; the broadcast packet is guaranteed to be received by every node in the network. Redundant transmissions in blind flooding may cause the broadcast storm problem [10], in which redundant packets cause contention and collision.

Algorithm 1 flood (m)

1. upon receiving of message m at node n:
2. If message m received for the first time then
3. broadcast (m) {this is the basic local broadcast primitive
   To nodes within range only}
4. end if [3].

5.2 Probability-based methods

5.2.1 Probability based Flooding

When a node receives a broadcast message for the first time, the node rebroadcasts the message with a probability *P*. If the message received is already seen, then the node drops the message irrespective of whether or not the node retransmitted the message when received for the first time. Thus, randomly having some nodes not rebroadcast saves node and network resources without harming delivery effectiveness. Probabilistic broadcasting is one of the simplest and most efficient broadcast techniques [10]. In this approach, each intermediate node rebroadcasts received packets only with a predetermined forwarding probability. To determine an appropriate forwarding probability, Season et al. [10] have suggested the use of random graphs and percolation theory in MANETs. The authors have claimed that there exists a probability value Pc < 1, such that by using Pc as a forwarding probability, almost all nodes can receive a broadcast packet, while there is not much improvement on reachability for p > Pc. Since Pc is different in various MANET topologies, and there is no existing mathematical method for estimating Pc, many probabilistic approaches use a predefined value for Pc. The advantage of probabilistic broadcasting over the other proposed broadcast methods is its simplicity.

Algorithm 2: Fixed Probabilistic Route Discovery

1. Upon receiving a RREQ packet rrq a node
2. If RREQ is received for first time
3. Set rebroadcast probabilistic to p=Pc
4. Endif
5. Generate a random number Rnd over the range [0, 1]
6. If Rnd <= p
7. Broadcast the RREQ packet
8. Else
9. Drop the packet[5]

5.2.2 Counter based Method

Ni et al [5] show an inverse relationship between the number of times a packet is received at a node and the probability of that node being able to reach additional area on a rebroadcast. This result is the origin of their Counter-Based scheme. Upon reception of a broadcast packet, the node initiates a counter with a value of one, sets a RAD (which is randomly chosen between 0 and Tmax seconds), counts the number of redundant packets received. When the RAD expires, if the counter does not exceed the threshold then the packet is rebroadcasted. Otherwise packet is dropped.

5.3 Area-based methods

5.3.1 Distance based approach

In Distance based approach, a node compares the distance between itself and each neighboring node that has previously forwarded a given packet. Upon reception of a previously unseen packet, a Random Assessment Delay (RAD) is initiated and redundant packets are cached. When the RAD expires, all source node locations are examined to see if any node is closer than a threshold distance value. If true, the node doesn't rebroadcast. So, a node using the distance-based approach needs the information of the geographic locations of its neighbors' in order to make a rebroadcast decision. Measuring the distance of the source of the received packet may accomplish by physical layer parameter i.e. signal strength at the node. Otherwise, if a GPS receiver is available, the location information can be included in each packet of the nodes that are transmitted.

5.3.2 Location based Method

In this method each node have to identify its own location relative to the location of sender using the geo location technique e.g., Global Positioning System. Each node in a MANET will add its own location to the header of each message it sends or rebroadcasts. When a neighboring node receives the packet, it notes the location of the sender and computes the additional coverage area obtainable if it were to rebroadcast. If the additional coverage area to rebroadcast is less than the given threshold, the node will not rebroadcast and the same packets are ignored .Otherwise, the node assigns a RDT before delivery. During RAD, a redundant packet is received by a node then it is recomputed the additional coverage area and compares that value to the threshold. The comparison of the area calculation and threshold occurs for all redundant broadcasts received until the packet reaches either the scheduled send time or is dropped. [9]

5.4 Neighbor knowledge based methods

5.4.1 Self Pruning

Self Pruning [8] is the simplest method in reducing broadcast redundancy. In this method, each node requires knowledge of its 1-hop neighbors, which is acquired by sending periodic "Hello" packets. A node contains list of known neighbors in the header of each broadcast packet. Broadcast packet received by neighbor nodes checks whether their list matches Additional nodes, it rebroadcasts else it avoid doing rebroadcasting.

In Fig-1, after receiving a message from node 6 node 2 will rebroadcast the message to node 3 and node 1 as its only additional nodes. Note that node 1 also will rebroadcast the same message to node 3 as its only additional node. In this situation still the message redundancy takes place.

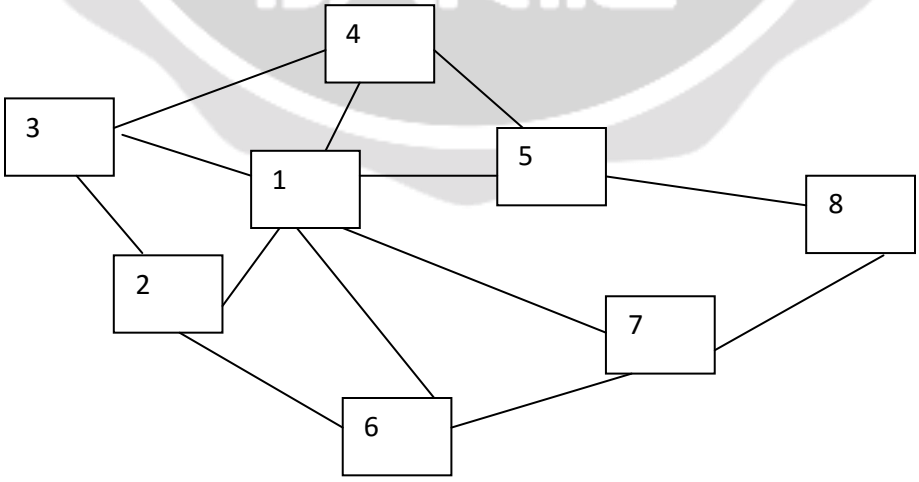

Fig -1: Self Pruning approach

5.4.2 Multi-point Relaying

Multipoint Relaying [7] is similar to Dominant Pruning; upstream senders will choose the rebroadcasting nodes. For example, say Node A is instigating a broadcast packet. It will select some or all one hop neighbor nodes to rebroadcast packet that they receive from Node A. The chosen nodes are called Multipoint relays (MPRs). Each MPR is necessary to decide a subset of its one hop neighbors to act as MPRs. Since a node knows the network topology within a 2-hop radius, it can select 1-hop neighbors as MPRs that most efficiently reach all nodes within the two hop neighborhood. The following algorithm was proposed by the author [7] for a node to choose it MPRs:

1. 1-hop neighbor has to discover all 2-hop neighbors that can be reached by them.1-hop neighbors must be allotted as MPRs.
2. Decide the resultant cover set (i.e., the collection of 2-hop neighbors that will receive the packet from the current MPR set).
3. From the left over 1-hop neighbors not yet in the MPR set, determine the one that would cover the majority 2-hop neighbors not in the cover set.
4. till all 2-hop neighbors are covered repeat step 2.

5.4.3 SBA Algorithm

The Scalable Broadcast Algorithm (SBA) requires all the nodes must have knowledge about neighbors with two hop radius. With the neighbor knowledge, nodes determine whether it could reach additional nodes by rebroadcasting. By sending periodically 'hello' packets, 2-hop neighbor knowledge is attainable; each "hello" packets have identifier of node and the list of known neighbors. Two hop radius node information are known by nodes after receiving "Hello" packets from neighbor nodes. Suppose Node A send a broadcast packet to Node B. Node B knows all neighbors of Node A since it is a neighbor. Other than Node A's broadcast if Node B has additional neighbors, it prepares the packet for delivery with a RAD. suppose redundant broadcast packet from another neighbor are received by Node B , it find out whether can reach by rebroadcasting.

5.4.4 Ad Hoc Broadcasting approach

In this approach, only nodes selected as gateway nodes and a broadcast message header are allowed to rebroadcast the message. The approach is described as follows:
1. Locate all two hop neighbors that can only be reached by a one hop neighbor. Select these one hop neighbors as gateways.
2. Calculate the cover set that will receive the message from the current gateway set for the neighbors not yet in the gateway set, find the one that would cover the most two hop neighbors not in the cover set. Set this one hop neighbor as a gateway.
3. Repeat process 2 and 3 until all two hop neighbors are covered.
When a node receives a message and is a gateway, this node determines which of its neighbors already received the message in the same transmission

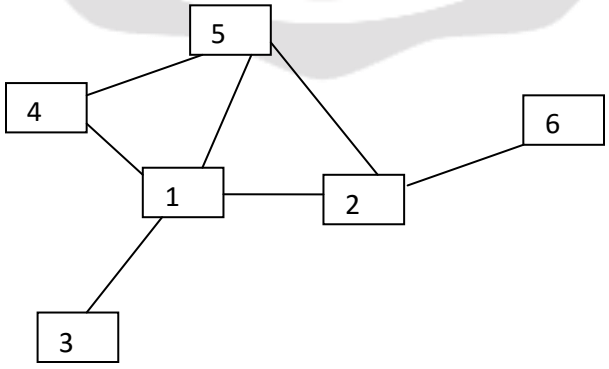

Fig -2: Ad hoc broadcasting approach

In Fig-2 Ad hoc broadcasting approach, node 2 has 1, 5 and 6 nodes as one hop neighbors, 3 and 4 nodes has two hop neighbors. Node 3 can be reached through node 1 as a one hop neighbor of node 2. Node 4 can be reached through node 1 or node 5 as one hop neighbors of node 2. Node 3 selects node 1 as a gateway to rebroadcast the message to nodes 3 and 4. Upon receiving the message node 5 will not rebroadcast the message as it is not a gateway.

6. CONCLUSION

Broadcasting is one of the fundamental issues in the entire wireless network and transmission of data through proper channel without any loss of data is a very difficult task. In this paper a review of broadcasting protocol was made and its effect on the network through different protocols and approaches are discussed. From all the broadcasting techniques discussed in the earlier chapter the area based methods are chosen for an elaborate study since it performs well when compared with all the techniques. It is chosen as the best choice for avoiding redundant rebroadcasts.

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