STUDY ON BROADCASTING TECHNIQUES IN MOBILE AD HOC NETWORK

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Abstract: Broadcasting is the process in which a source node sends a message to all other nodes in MANET. Network wide broadcasting in Mobile Ad Hoc Network provides important control and route establishment functionality for a number of unicast and multicast protocols. The broadcast scheme is widely used within routing protocols by a wide range of wireless ad hoc networks such as mobile ad hoc networks, vehicular ad hoc networks, and wireless sensor networks, and used to spread emergency messages in critical scenarios after a disaster scenario and/or an accident. This paper provides such analysis by classifying existing broadcasting schemes.

Keywords: Broadcasting, Mobile Ad hoc network, Routing, Multicating

I .INTRODUCTION

The word ad hoc is from Latin and means "for this (only)". In the case of computer networks, the ad hoc networks mean wireless network without infrastructure, they can be called spontaneous network. One Way to understand ad hoc networks is by comparing them with infrastructure based wireless networks, such as cellular network and WLAN. In the infrastructure based wireless networks a node can only send a packet to a destination node only via access point (in cellular network like GSM, it is called base station). The access point establishes an network area and only the nodes in this area can use access point's services. There are some unknown events, which cause access point's malfunction. The nodes lose their network and they are quasi not working. It is the biggest infrastructure's disadvantage. There are also some reasons to sacrifice or not to use access point's services. These can be cost factor, impossibility to install access point in short time, etc. In this case the nodes have to build its own network. This network is called wireless ad hoc network.

The wireless ad hoc networks only consist of nodes equipped with transceiver. The network is created to be independent from an infrastructure. Therefore, the nodes must be able to arrange their own networks. Keep in mind that a node can now communicate only with other nodes in its transmission range. In the infrastructure based wireless network, the nodes can communicate with a node, which is located in another network area, by transmitting data to destination access point and this access point relay the data to the desired node. It seems like, that the ad hoc networks are not powerful enough. Each node has its own transmission range, if these small transmission areas are combined, they will form a much bigger transmission area. The nodes transmit their data with single or multiple hopping techniques. Now a suitable routing algorithm must be implemented, so the process of transmitting data will be more effective. The figure 1 shows, how the nodes form a transmission cloud.

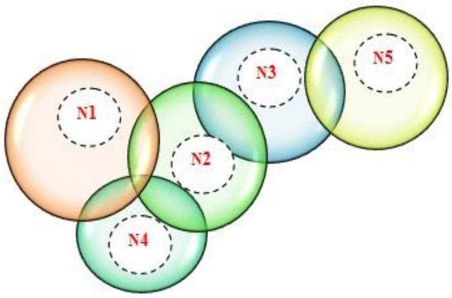
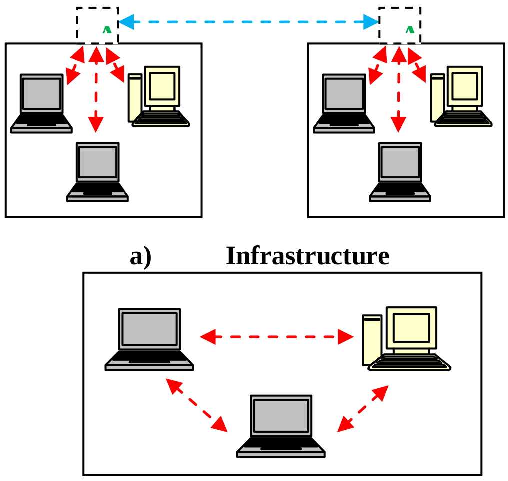


Figure 1: Transmission area in ad hoc

IEEE 802.11 used for Ad Hoc Networks: The IEEE Standard 802.11 (IEEE, 1999) describes common family of wireless LANs [1]. The standard specifies physical layer (PHY) and medium access control (MAC) of wireless transmission. The main purpose of this standard was the specification of simple and robust wireless LANs. The standard is expected to support the energy conservation of the mobile terminal, consideration of hidden terminal, and possibility of a global license-free service.



a) Infrastructure

b) Ad hoc

Figure 2: IEEE 802.11

The wireless networks can be categorized based on their system architecture into two basically versions [1]. The one is Infrastructure (Figure 2a) and second is ad-hoc network (Figure 2b). The biggest different of them is infrastructure networks consist of access point and nodes, meanwhile the ad hoc networks are independent from access point. In the infrastructure version, a terminal can't communicate directly with other terminals in the same cell and other cell. A access point here perform control messages. Messages are sent to the access point and then the access point distributes the messages to the desired terminal. If a terminal want to communicate with a terminal, which is located in other cell, the access point will relay the message to other access point, which has control over desired cell. The access points are normally wired connected. The problem in infrastructure, if the access point defects, all terminal in this cell can't perform any communication. Unlike the infrastructure, the ad hoc networks have a different method to distribute messages. Given a network like figure 1. N1 want to communicate with N5. N5 is located outside N1 transmission range, so N1 must hop the message to N4-N2-N3-N5 or N2-N3-N5. Routing algorithm will decide, which route performs the best. There will be no problem if N4 leaves the network, because N1 still has a route to N5. Therefore ad hoc networks are robuster than infrastructure.

Routing is the process of selecting paths in a network along which to send data packets. An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad-hoc network. A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. To find a route for packet delivery and deliver the packet to the correct destination these protocols are used. The studies on many functionality of routing protocols have been an active area of research for many years. Basically, routing protocols can be classified into three types as (a) Table Driven Protocols or Proactive Protocols (b) On-Demand Protocols or Reactive Protocols and (c) Hybrid protocols.

- **Proactive Routing**

Proactive protocols rely upon maintaining routing tables of known destinations, this reduces the amount of control traffic overhead that proactive routing generates because packets are forwarded immediately using known routes, however routing tables must be kept up-to-date; this uses memory and nodes periodically send update messages to neighbors, even when no traffic is present, wasting bandwidth [4]. Proactive routing is unsuitable for highly dynamic networks because routing tables must be updated with each topology change, this leads to increased control message overheads which can degrade network performance at high loads [5].

- **Reactive Routing**

Reactive Protocols use a route discovery process to flood the network with route query requests when a packet needs to be routed using source routing or distance vector routing . Source routing uses data packet headers containing routing information meaning nodes don't need routing tables; however this has high network overhead. Distance vector routing uses next hop and destination addresses to route packets, this requires nodes to store active routes information until no longer required or an active route timeout occurs, this prevents stale routes [4]. Flooding is a reliable method of disseminating information over the network, however it uses bandwidth and creates network overhead, reactive routing broadcasts routing requests whenever a packet needs routing, this can cause delays in packet transmission as routes are calculated, but features very little control traffic overhead and has typically lower memory usage than proactive alternatives, this increases the scalability of the protocol [1].

- **Hybrid Routing**

Hybrid protocols combine features from both reactive and proactive routing protocols, typically attempting to exploit the reduced control traffic overhead from proactive systems whilst reducing the route discovery delays of reactive systems by maintaining some form of routing table [4]. The two survey papers [2], [3] successfully collect information from a wide range of literature and provide detailed and extensive reference material for attempting to deploy a MANET, both papers reach the conclusion that no single MANET routing protocol is best for every situation meaning analysis of the network and environmental requirements is essential for selecting an effective protocol. Whilst these papers contain functionality details for many of the protocols available, performance information for the different protocols is very limited and no details of any testing methodologies is provided, because of this the validity of some claims made cannot be verified.

II.BROADCASTING

"Broadcasting" is the transmission of datagram (packets) to all other nodes in the network. Broadcasting is necessary in MANET routing protocols. In telecommunication and information theory, broadcasting refers to a method of transferring a message to all recipients simultaneously. Broadcasting can be performed as a high level operation in a program.

Multicasting to all nodes in an ad hoc network is corresponding to broadcast. That is, broadcast can be termed as a special case of multicast. But as there is the special requirement "deliver to all", efficient protocols independent of multicast methods can be intended for broadcast operations. Broadcasting can be useful in several applications such as audio video conferencing, distributing weather reports, stock market updates or live radio programs. Broadcast is also essential for several uncast and multicast routing protocols for a collection of controls and routing concern functionality. These applications emerge as wireless or mobile devices become more and more everywhere with increased processing and multi-media capability. Network wide broadcast [6] [7] operation in an ad hoc network is therefore more likely than in wired scenario.

Efficient broadcasting in a mobile ad hoc network focuses on selecting a small forward node set while ensuring broadcast coverage. The objective is to determine a small set of forward nodes to ensure full coverage. A formal framework is used to model inaccurate local views in MANETs, where full coverage is guaranteed if three sufficient conditions connectivity, link availability, and consistency are met. A MANET consists of a set of mobile hosts that may communicate with one another from time to time. No base stations are supported. Each host is equipped with a CSMA/CA (carrier sense multiple access with collision avoidance) transceiver. In such environment, a host may communicate with another directly or indirectly. In the latter case, a multi hop scenario occurs, where the packets originated from the source host are relayed by several intermediate hosts before reaching the destination. The broadcast problem refers to the sending of a message to other hosts in the network. The problem considered here has the following characteristics. In a broadcast process, each node decides its forwarding status based on given neighborhood information and the corresponding broadcast protocol. Most existing broadcast schemes assume either the underlying network topology is static during the broadcast process such that the neighborhood information can be updated in a timely manner. The results in show that existing static network broadcast schemes perform poorly in terms of delivery ratio when nodes are mobile.

The broadcasting technique forms the fundamental communication technique in MANET. The route discovery process involves transmission of route request (RREQ) packets from source to destination through every outgoing links which is also known as blind flooding. The transmitted RREQ packets are received by all the surrounding nodes which try to find out whether these packets are already contained (or) not. If the packets are not contained already they are to be retransmitted and this is performed till all the nodes have received and transmitted the broadcast packets at least once. The figure 3 pictures the broadcasting technique in MANET where during path failure the source node finds path to the destination. So, the route request packet is send through all the possible nodes and establishes a route to the destination.

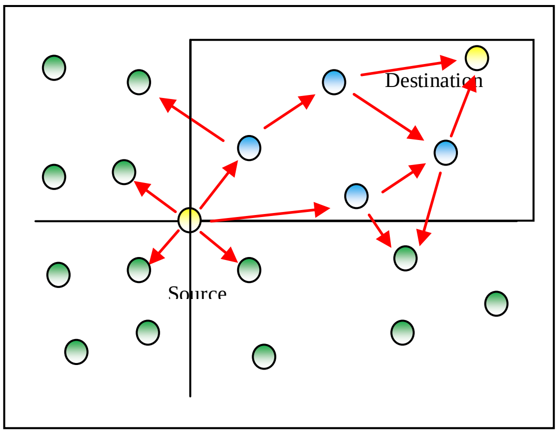


Figure 3: Broadcasting in MANET

The *broadcast problem* refers to the sending of a message to other hosts in the network. The problem considered here is assumed to have the following characteristics.

- ***The broadcast is spontaneous:*** Any mobile host can issue a broadcast message at any time. For reasons such as host mobility and lack of synchronization, preparing any kind of global topology knowledge is prohibitive (in fact this is at least as hard as the broadcast problem). Little or even no local connectivity information may be collected in advance.
- ***The broadcast is unreliable:*** No acknowledgement mechanism will be used. However, an attempt should be made to distribute a broadcast message to as many hosts as possible without paying too much effort. The motivations to make such an assumption are
  - (i) A host may miss a broadcast message because it is off-line, it is temporarily isolated from the network, or it experiences repetitive collisions.
  - (ii) Acknowledgements may cause serious medium contention (and thus, another "storm") surrounding the sender, and receiver.
  - (iii) In many applications (e.g., route discovery), a 100% reliable broadcast is unnecessary. In addition, we assume that a host can detect duplicate broadcast messages. This is essential to prevent endless flooding of a message. One way to do so is to associate with each broadcast message a tuple (source ID, sequence number) as that in [8,9].

2.1 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.

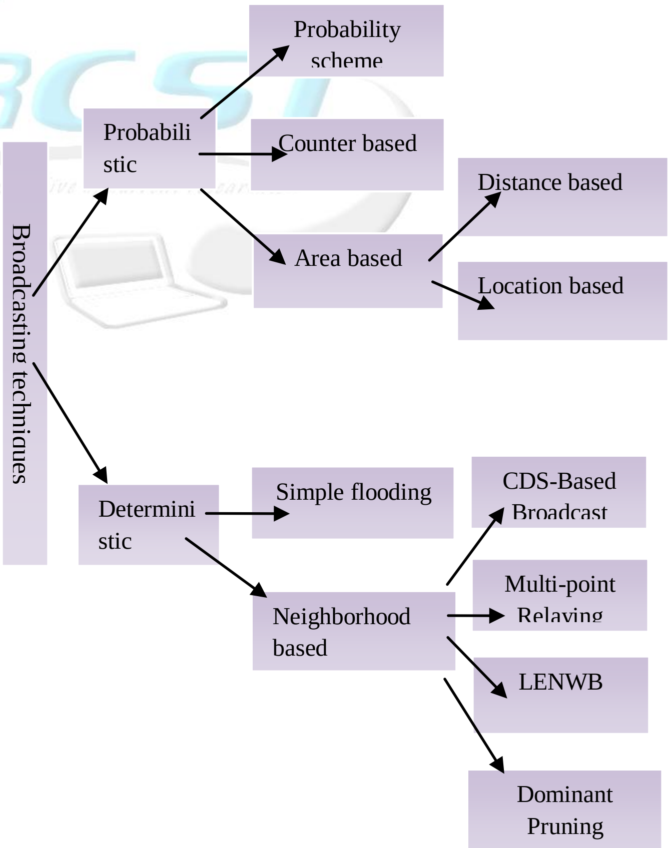


Figure 4: Broadcasting methods

- **Simple flooding** [10,11], requires each node in a MANET to rebroadcast all packets

- **Probability based** [12], assigns probabilities to each node to rebroadcast depending on the topology of the network
- **Area based** [12], common transmission distance is assumed and a node will rebroadcast if there is sufficient coverage area and
- **Neighborhood based** [13,14], State on the neighborhood is maintained by neighborhood method, the information obtained from the neighboring nodes is used for rebroadcast

2.1.1 Simple flooding method

In this method, a source node of a MANET disseminates 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 re-disseminated at once to all their neighbors. The process goes on until all nodes have the message. Although this method is very reliable for a MANET with low density nodes and high mobility but it is very harmful and unproductive as it causes severe network congestion and quickly exhaust the battery power. Blind flooding ensures the coverage; the broadcast packet is guaranteed to be received by every node in the network, providing there is no packet loss caused by collision in the MAC layer and there is no high-speed movement of nodes during the broadcast process. However, due to the broadcast nature of wireless communication media, redundant transmissions in blind flooding may cause the broadcast storm problem [15], in which redundant packets cause contention and collision.

2.1.2 Probability Based Methods

- **Probabilistic Scheme:** The Probabilistic scheme from [16] is similar to Flooding, except that nodes only rebroadcast with a predetermined probability. In dense networks multiple nodes share similar transmission coverage's. Thus, randomly having some nodes not rebroadcast saves node and network resources without harming delivery effectiveness. In sparse networks, there is much less shared coverage; thus, nodes won't receive all the broadcast packets with the Probabilistic scheme unless the probability parameter is high. When the probability is 100%, this scheme is identical to Flooding.
- **Counter-Based Scheme:** Ni et al [16] 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 basis of their Counter-Based scheme. Upon reception of a previously unseen packet, the node initiates a counter with a value of one and sets a RAD (which is randomly chosen between 0 and Tmax seconds). During the RAD, the counter is incremented by one for each redundant packet received. If the counter is less than a threshold value when the RAD expires, the packet is rebroadcast. Otherwise, it is simply dropped. From [16], threshold values above six relate to little additional coverage area being reached. The overriding compelling features of the Counter-Based scheme are its simplicity and its inherent adaptability to local topologies. That is, in a dense area of the network, some nodes won't rebroadcast; in sparse areas of the network, all nodes rebroadcast.

2.1.3 **Area-based methods**

- **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.
- **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. [17]

2.1.4 Neighbor Based Methods

A fine way of assessment of the requirement of transmitting a new copy of the message is to check if it can be transmitted to at least one node that has not received it before. The following step should be to define a minimal set of mediator nodes, allowing -transmitting the message to each station of a given network [18].

- **Multi-point Relaying:** Under Multi-point Relaying [19] scheme, each node is assumed to have a list of its 1 -hop and 2-hop neighbors, obtained via periodic "Hello" beacons. The "Hello" messages consist of the identifier of the sending node, the list of the node's known neighbors and the Multi-Point Relays (MPRs). After receiving "Hello" messages from all its neighbors, a node has the 2-hop topology information centered at itself. Using this list of 1-hop and 2-hop neighbors, a node selects the MPRs – the 1-hop neighbors that most efficiently reach all nodes within its 2-hop neighborhood. Each node selects the set of MPRs using a greedy approach of iteratively including the 1-hop neighbors that would cover the largest number of uncovered 2-hop neighbors.
- **LENWB:** Lightweight and Efficient Network-Wide Broadcast (LENWB) [20] also makes use of 2-hop neighbor knowledge. But a node does not obviously

build a forward list when transmitting a packet. Rather, each node makes the choice whether to rebroadcast based on information of which neighbors have received a packet from the common source node and which neighbors have a advanced main concern for rebroadcasting. The main concern of a node is proportional to the nodes degree. When received a broadcast packet, a node proactively computes if all of its lower priority neighbors will receive those rebroadcasts; if not, the node rebroadcasts.

- **Dominant Pruning:** Dominant Pruning also uses 2-hop neighbor knowledge, obtained via "Hello" packets, for routing decisions [21]. Unlike SBA, however, Dominant Pruning requires rebroadcasting nodes to proactively choose some or all of its 1-hop neighbors as rebroadcasting nodes. Only those chosen nodes are allowed to rebroadcast. Nodes inform neighbors to rebroadcast by including their address as part of a list in each broadcast packet header. When a node receives a broadcast packet it checks the header to see if its address is part of the list. If so, it uses a Greedy Set Cover algorithm to determine which subset of neighbors should rebroadcast the packet, given knowledge of which neighbors have already been covered by the sender's broadcast. The Greedy Set Cover algorithm, as adapted in [21] from [22], recursively chooses 1-hop neighbors which cover the most 2-hop neighbors and recalculates the cover set until all 2-hop neighbors are covered.
- **CDS-Based Broadcast Algorithm:** Peng and Lu describe the Connected Dominating Set (CDS)-Based Broadcast Algorithm, a more calculation intensive algorithm for selecting BRGs, in [23]. Where AHBP only considers the source of the broadcast packet to determine a receiving node's initial cover set, CDS-Based Broadcast Algorithm *also* considers the set of higher priority BRGs selected by the previous sender [23]. For example, suppose Node A has selected Nodes B, C and D (in this order) to be BRGs. When Node C receives a broadcast packet from Node A, AHBP requires Node C to add neighbors common to Node A to the initial cover set. CDS-Based Broadcast Algorithm *also* requires that Node C adds neighbors common to Node B, because Node B is a higher priority BRG. Likewise, Node D is required to consider common neighbors with nodes A, B and C. Once the initial cover set is determined, a node then chooses which neighbors should function as BRGs. The algorithm for determining this is the same as that for AHBP and Multipoint Relaying (see steps 1-4 for choosing Multipoint Relays).

III.CONCLUSION

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 presented an overview on the state of the art of broadcasting methods in MANETs. This paper provides different broadcast schemes available in order to overcome the broadcasting problems.

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