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A Survey of Broadcasting protocols in Wireless Network

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Abstract— Broadcasting is a fundamental operation in which a single message is to be sent from a source to all other nodes in the network. This paper presents a brief survey of broadcasting in wireless network and different types of broadcasting techniques. Broadcasting plays an important role in designing communication protocols in various types of networks. For example, in highly parallel systems such as Networks of Workstations (NOW) or Grid computing, it is essential to quickly distribute the input data or computational results quickly to all nodes in the system. The factors affecting the performance of the broadcasting also discussed. Different broadcasting methods have different advantages, hence a suitable method must be chosen for any application. We have discussed the advantages and disadvantages of all the method, and compared these methods on the basis of different criteria.

***Index Terms*— LENWB, Multipoint relay, Contention, Probabilistic, Directional Antenna, RAD.**

I. INTRODUCTION

In this paper we consider the problem of broadcasting in wireless networks. Broadcasting is a fundamental communication primal for wireless networks, and it has therefore been greatly studied both in the systems and in the theory. Though broadcasting itself appears to be an easy problem, it is really quite hard to realize in an efficient and consistent way in a wireless network. The main problem relating to theoretical investigations is that wireless networks have many features that are hard to model in a clean way.

Broadcasting means delivering a packet to all hosts or destinations in a Network. 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 [1] [2] operation in an ad hoc network is therefore more likely than in wired scenario.

II. APPLICATIONS OF BROADCASTING IN MANET

A. *Content Distribution Applications*

A typical application for broadcasting in MANETs is news distribution. Examples are the broadcasting of serve information in a disaster area to coordinate relief actions (e.g. fire fighting [3]), the dissemination of parking availability in a city scenario, propagation of accident information in VANETs and the dissemination of alarms and announcements. Further content distribution applications are publish-subscribe applications, where some nodes are subscribers to content providers. These applications typically run in the background for a few hours or even a few days. Examples are Usenet-on-fly [4], latency insensitive data [5] and file sharing in a peer-to-peer (P2P) manner [6].

B. *Resource Discovery and Advertisement*

Further distinctive broadcast scenarios are resource (or service) discovery and advertisement. MANET nodes may have little or no information at all about the capabilities and services offered by each other. Therefore, mechanisms for resource discovery or advertisement are important for these self-configurable networks. Due to the decentralized and highly dynamic nature of MANETs, service discovery and service advertisement frequently use broadcasting strategies. For highly dynamic topologies the route is constantly changing and the resource is so highly dynamic that maintaining a route to all nodes at every time is very costly. However, most of the time, it is not essential to have an up-to-date route to all other nodes. Hence, a novel class of reactive routing protocols, such as DSR [7] and AODV [8] has been developed. Reactive routing protocols only set up routes to nodes they communicate with and these routes are kept alive as long as they are needed.

III. TAXONOMY OF BROADCASTING

A. *Simple Flooding*

In [9], Ho et al. propose Flooding as a scheme to achieve reliable broadcast and multicast in highly dynamic networks. The algorithm for Simple Flooding starts with a source node broadcasting a packet to all neighbors. Each of those neighbors in turn rebroadcast the packet exactly one time and this continues until all reachable network nodes have received the packet. In a wireless network, drawbacks of simple flooding include:

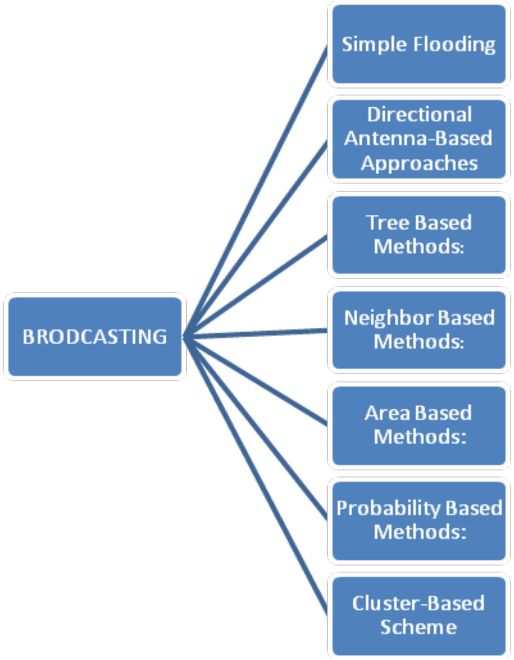

Figure1: Broadcasting in MANET

a. *Redundant rebroadcasts*

Redundant rebroadcasts: When a mobile host decides to rebroadcast a broadcast message to its neighbors, all its neighbors already have the message.

b. *Contention*

Contention: After a mobile host broadcasts a message, if many of its neighbors decide to rebroadcast the message, these transmissions (which are all from nearby hosts) may severely contend with each other.

c. *Collision*

Because of the deficiency of back off mechanism, the lack of RTS/CTS dialogue, and the absence of CD(collision detection), collisions are more likely to occur and cause more damage.

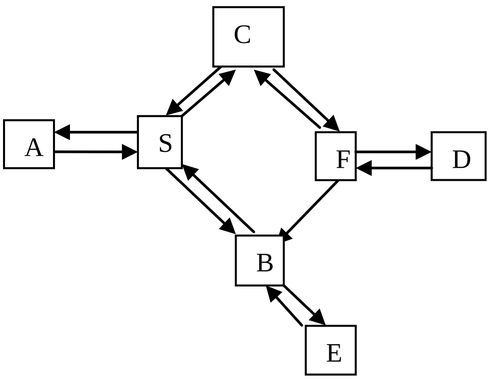

Figure 2: Simple Flooding

Figure 2 illustrates this algorithm. In this figure, node S needs to establish a route to node D. Therefore, node S broadcasts a route apply for to its neighbors. When nodes B. and C receive the route request, they forward it to all their neighbors. When node F receives the route request from B, it forwards the request to its neighbors. However, when node F receives the same route request from C, node F simply discards the route request. As the route request is propagated to a variety of nodes, the path followed by the request is included in the route request packet. References

B. Directional Antenna-Based Approaches

In [10], the theory of using a directional network backbone for efficient broadcasting in combination with directional antennas was proposed. The omni directional transmission range of each node is separated into K sectors and each forwarding node only needs to switch on several sectors for transmission while the entire network receives the broadcast message.

Two techniques are used in smart antenna system that for directional transmission/reception beams: switched beam a model is ideally sector zed as in [11] shown in Fig. 3a,where the effective transmission range of each node is equally divided into Known over lapping sectors, where one or more such sector scan be switched on for transmission or reception. The channel capacity when using directional antennas can be enhanced and the interface can be reduced. Steerable beam systems can adjust the bearing and width of a beam to transmit to, or receive from, certain neighbors. The corresponding antenna mode is an adjustable cone as shown in Fig. 3b.In practical systems, antenna beams have irregular shapes (as shown in Fig. 3c) due to the

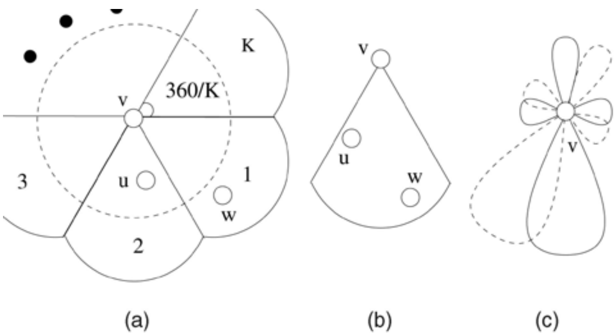

Fig.3. Directional antenna models in (a) ideally satirized, (b) adjustable cone, and (c) irregular beam pattern. Existence of side lobes, which may cause inaccurate estimations.

C. Tree Based Broadcasting

In tree based broadcasting [12] the basic idea is to preserve a spanning tree in the network, and broadcast using this tree by forwarding a broadcast message not to all neighbors but only to those who are neighbors in this tree as well. Since a tree is acyclic, each message is received only once by each node, giving two advantages over the existing methods. Firstly, it is needless to store the previous broadcasts in order to avoid continuous multiplications of the broadcast messages along a cycle of links. Only the originator node of a broadcast message needs to store it and pay attention to whether its broadcast was possibly successful or not if it is of enormous significance. Secondly, it is very cost-effective allowing for how many times a broadcast message should be forwarded. Supposing that the broadcast tree is in constant state, a broadcast message should be forwarded only once per a node in case of one-to-one broadcast forwarding. If local broadcast is available, a broadcast message should be forwarded as many times as many non-leaf nodes there are in the broadcast tree.

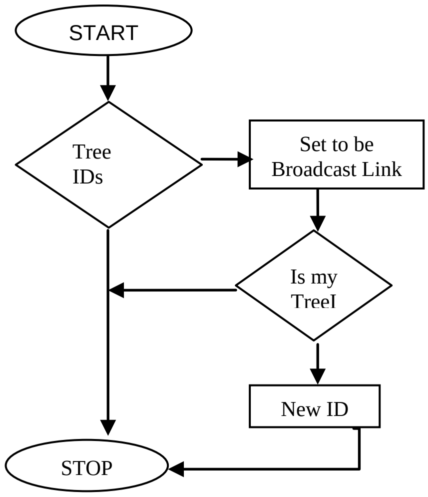

Figure 4: New Link Process

If a Broadcast Link ceases, that is the Broadcast Tree breaks up into two parts, one of the parts will get a new Tree ID. First, the two endpoints of the ceased link make decisions about whose tree will get a new Tree ID. Obviously, this decision must be made without communication. However, it is significance mentioning that if both of them will decide to generate new Tree ID, it causes no problem, only the process will be a bit more resource consuming. For example a simple way to do this is that the end-node having greater Node ID executes this process. Namely, this node A generates a new Tree ID (this process is described later), sets its Tree ID to this value and starts a "New ID" process. The other end-node B of the ceased link waits for getting a new Tree ID for a definite time. If no new Tree ID arrives, then it means that node A has totally disconnected from B. Then node B also generates a new Tree ID in the same way as A did, sets its Tree ID to this value and starts a "New ID" process.

The generation of a new Tree ID is quite simple. If the serial number of the previous Tree ID was, then the new Tree ID will be (s + 1,N), where N is the Node ID of the node that executes this process. If a new node comes into being, its first Tree ID is (0, N), where N is its Node ID. This Tree ID generation ensures that a newly generated Tree ID is certainly unique and it is greater than the previous Tree ID of the node was.

The "New ID" process simply sends an "I have new Tree ID" message including the new Tree ID to each of its neighbors without the node where it received this new Tree ID from. If the Tree ID was generated by this node, it sends this message to all of its neighbors. When a node receives an "I have new Tree ID" message on the link L, it compares the received Tree ID with its own. If the received one is smaller, then it must be past it information, so it does nothing. If it is greater, then the node set L to be a Broadcast Link, updates its Tree ID and starts a "New ID" process. If these Tree ID's are equal, then it means that the node gets this Tree ID for the second time, indicating that the "Broadcast Tree" together with L would contain a cycle. To fix this, it sets L not to be a Broadcast Link.

D. 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 [13].

a. *Multi-point Relaying*

Under Multi-point Relaying [15] 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.

b. *Dominant Pruning*

Dominant pruning [12] uses 2-hop neighbor knowledge for broadcasting. A Source node computes a greedy set cover to select nodes from its 1-hopneighbor-list whose broadcasts will cover all of its 2-hop neighbors. The node transmits this list in the packet header. When a node receives a packet, it checks to see if the packet header node list contains its own address. In that case, it rebroadcasts the packet in the same manner to cover its own 2-hop neighbors apart from the common nodes that are also covered by the source node. In this way, nodes in the greedy set cover are only allowed to rebroadcast the packet.

c. *LENWB*

Lightweight and Efficient Network-Wide Broadcast (LENWB) [16] 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.

d. *CDS Based Algorithm*

CDS-based algorithm described by W. Peng and Lu in [17] computes the MPRs in a more limiting way. In AHBP a node after receiving a broadcast packet computes the initial cover set by considering source node only. However, in CDS-based algorithm the initial cover set is computed by considering all nodes that are MPRs of the source node as well as the source node. After calculating the initial cover set, a node selects nodes from its first hop neighbor set to cover all the 2-hop neighbors. This approach leads to slighter number of MPRs compared to AHBP,

e. *Ad Hoc Broadcast Protocol (AHBP)*

In AHBP [17], nodes that are selected as Broadcast Relay Gateway (BRGs) within a broadcast packet header are allowed to rebroadcast a packet. The way how BRGs are chosen is similar to multipoint relaying. However the two differs in following cases:

1. AHBP informs 1-hop neighbors of the BRG nodes through the broadcast data packets rather than “hello packets” as in multipoint relaying algorithm.
2. In AHBP when a node receives a broadcast packet, it determines at the same using its 2-hop neighbor knowledge the nodes that are already covered with the same transmission of the source node. While computing its own BRGs it does not consider these nodes since they are already covered. In contrast MPRs are not chosen in multipoint relaying considering the source route of the broadcast packet.

f. Scalable Broadcast Algorithm (SBA)

The Scalable Broadcast Algorithm (SBA) [17] requires that all nodes have knowledge of their neighbors within a two hop radius. This neighbor knowledge coupled with the identity of the node from which a packet is received allows a receiving node to determine if it would reach additional nodes by rebroadcasting. 2-hop neighbor knowledge is achievable via periodic “Hello” packets; each “Hello “packet contains the node’s identfier (IP address) and the list of known neighbors. After a node receives a “Hello “packet from all its neighbors, it has two hop topology information centered at itself. Suppose Node B receives a broadcast data packet from Node A. Since Node A is a neighbor, Node B knows all of its neighbors, common to Node A, that have also received Node A’s transmission of the broadcast packet. If Node B has additional neighbors not reached by Node A’s broadcast; Node B schedules the packet for delivery with RAD (Random Assessment Impact timer). If Node B receives a redundant broadcast packet from another neighbor, Node B again determines if it can reach any new nodes by rebroadcasting. This process continues until either the RAD expires and the packet is sent, or the packet is dropped. The authors of [17] propose a method to dynamically adjust the RAD to network conditions; they weight the time delay based on a node’s relative neighbor degree. Specifically, each node searches its neighbor tables for the maximum neighbor degree of any neighbor node, d Nmax. It then calculates a RAD nodes with the most neighbors usually broadcast before the others.

E. Area Based Methods

Suppose a node receives a packet from a sender that is located only one meter away. If the receiving node rebroadcasts, the additional area covered by the retransmission is quite low. On the other intense, if a node is placed at the boundary of the sender node’s transmission distance, then a rebroadcast would reach significant additional area, 61% to be exact [18]. A node using an Area Based Method can estimate additional coverage area based on all received redundant transmissions. We note that are abased methods only considering the coverage area of a transmission; they don’t consider whether nodes exist within that area.

a. Distance-Based Scheme

A node using the Distance-Based Scheme compares the distance between itself and each neighbor node that has previously rebroadcast a given packet1. Upon reception of a previously unseen packet, a 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.

b. Location-Based Scheme

The Location-Based scheme [18] uses a more precise estimation of expected additional coverage area in the decision to rebroadcast. In this method, each node must have the means to determine its own location, e.g., a Global Positioning System (GPS).Whenever a node originates or rebroadcasts a packet it adds its own location to the header of the packet. When anode initially receives a packet, it notes the location of the sender and calculates the additional coverage area obtainable were it to rebroadcast. If the additional area is less than a threshold value, the node will not rebroadcast, and all future receptions of the same packet will be ignored. Otherwise, the node assigns a RAD before delivery. If the node receives a redundant packet during the RAD, it recalculates the additional coverage area and compares that value to the threshold. The area calculation and threshold comparison occur with all redundant broadcasts received until the packet reaches either it’s scheduled send time or is dropped.

F. Probability Based Methods

a. Probabilistic Scheme

It is similar to simple flooding except that each node will broadcast the packet with a probability [18]. If this probability is high then the node is more likely to rebroadcast the packet. When the network is dense, then there are many nodes with shared network coverage, so setting this probability low achieves nearly 100% reach ability while saving network resources. However, if network is sparse, then this probability should be set high to achieve good reach ability. When the probability is 100%, it is similar to simple flooding.

b. Counter-based Scheme

Ni et al [18] 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 [18], 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, 3some nodes won’t rebroadcast; in sparse areas of the network, all nodes rebroadcast.

G. Cluster Based Method

Clustering [19] is the process of grouping nodes together into clusters (groups) as shown in Fig.5. A representative of each cluster is called the cluster head (nodes B and D). A cluster encompasses all nodes within a cluster head transmission range. Nodes that belong to a cluster, but are not the cluster head, are called ordinary nodes. Often nodes may belong to more than one cluster. These nodes are called gateway nodes (node C). Only cluster head nodes and gateway nodes are responsible for propagating messages. The process of forming clusters may be either active or passive. In Fig. 5, ordinary node A broadcasts a message. The message is received by node B and is relayed to all nodes within node B's broadcast range. Node C is a gateway node that receives the message from node B and rebroadcasts the message. Cluster head node D receives the message and rebroadcasts it to its neighboring nodes. The directed solid lines show the propagation of the message among those nodes that are allowed to rebroadcast. Dashed directed lines show the propagation of the message from the cluster heads and the gateway nodes to ordinary nodes. In active clustering, nodes must cooperate in order to elect cluster heads. This is achieved through periodic exchange of control information. The formation of clusters in active clustering is independent of the background data traffic.

The selection of a cluster head may be based upon Lowest ID algorithm or Highest ID algorithm [20]. In [21] and [22], clustering is used as an optimized flooding mechanism, whereby only cluster heads and gateways rebroadcast messages. Additionally, the cluster heads in the mechanism ensure reliable delivery of the message to those nodes belonging to their cluster. In [23], a mechanism that builds a cluster-based backbone for the dissemination of information is proposed. They propose the creation of a static and a dynamic backbone. The static backbone is created using a source-independent connected dominating set. The dynamic backbone is created using a source-dependent connected dominating set. In passive clustering [24, 25], cluster formation is dependent on background data traffic.

Therefore, passive clustering will not form clusters until there is background traffic. This is because, in passive clustering, the flow of data traffic is used to propagate cluster control information and collect neighbor information through promiscuous packet reception. Promiscuous packet reception is achieved by allowing the MAC layer to pass all received packets up the TCP/IP stack irrespective of MAC address. Passive clustering is beneficial in that it utilizes the existing data traffic to form clusters. However, without existing data traffic, it is unable to form clusters and provide the benefits of an optimized flood. Active clustering requires that cluster control information be exchanged between nodes and cluster heads. Thus, it requires more overhead than passive AB C D Cluster head node Gateway node Ordinary node Fig. 5 Example of a cluster-based flood initiated from node A with only cluster head and gateway nodes rebroadcasting 130 J. Lipmanetal. Clustering or non-clustered flooding mechanisms for the formation of clusters. However, unlike passive clustering, there is no delay concerned as it does not need background traffic.

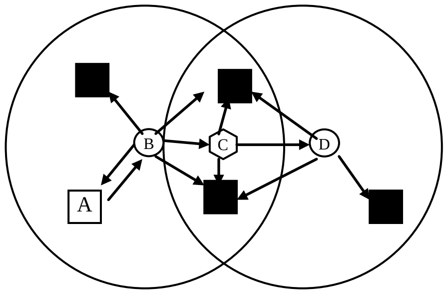

Figure 5 Example of a cluster-based flood initiated from node A with only cluster head and gateway nodes rebroadcasting.

IV. CONCLUSION

As a forthcoming technology, wireless network have gained increased research interest in recent years. Efficient broadcast is one of the important research issues that plays a significant role in the performance of wireless network. Many techniques have been presented to minimize redundant rebroadcasting and save the limit energy.

In this paper we have reviewed various broadcasting techniques for wireless network, like Simple Flooding, Directional Antenna Based, Tree Based, Neighbors Based, Area Based, Probability Based, and Cluster Based Broadcasting.

Although schemes in different groups may have different objectives, these issues always need to be measured because they are important for evaluating the performance and scalability of a given scheme regardless of its objective.

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