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A new dynamic counter-based broadcasting scheme for Mobile Ad hoc Networks

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ABSTRACT

Broadcasting is an essential operation in Mobile Ad hoc Networks (MANETs) to transmit a message (data packet) from the sender to the rest of the network nodes. Although flooding is the simplest mechanism for broadcasting, where each node retransmits every uniquely received message exactly once, it is usually costly and results in serious redundancy, contention and collisions in the network. These problems are widely referred to as the broadcast storm problem. In the light of this, this study introduces a new counter-based broadcasting scheme to achieve efficient broadcasting in MANETs. This is achieved by using a counter-based scheme with a dynamic threshold to increase the successful delivery rate of packets and enhance the throughput of the network. Extensive simulation experiments have been conducted. Our results show that the new scheme outperforms the well known exiting schemes, namely the two counter-based broadcasting scheme and blind flooding.

1. Introduction

A Mobile Ad hoc Network (MANET) is an independent system consisting of a set of wireless mobile nodes, which communicate with each other without the existence of infrastructure. MANETs has several characteristics. First, the node in the MANETs is self-organizing and self-administrating without deploying any infrastructure. Second, MANET mobile nodes communicate with each other using multi-hop wireless links. Third, MANET topology changes could occur randomly, rapidly and frequently, so the topology is dynamic [1]. There are number of characteristics in MANET such as mobility services, no infrastructure and battery-powered properties make it used in a number of applications for MANET. MANET is widely used in military, emergency operations, battle-fields, disaster recovery, group communication, civil and business operations. MANETs can be very useful in setting up an infrastructure-less network used to make a reliable and fast communication among soldiers in the battle-fields to recover any failure in the network.

In MANETs, broadcasting plays a fundamental role as a means of broadcasting a message from a source node to all other nodes in the network [2]. Broadcasting is a fundamental operation in several applications such as discovering neighbors, paging, addressing, communication in battlefield, home networking, temporary local area networks, disaster recovery operations and group communication [3–5]. Moreover, there are many routing protocols that use broadcasting for route discovery [4] such as Ad hoc On-Demand Distance Vector Routing (AODV) [6], Dynamic Source Routing (DSR) [6], Zone Routing Protocol (ZRP) [7], and Location Aided Routing (LAR) [8]. In this paper, we will add a new approach to the AODV protocol with counter-based scheme to transmit the packets to all the nodes with optimal packets delivery ratio.

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AODV is an on-demand protocol used to provide the route discovery and maintenance in a wide variety of network topologies and environments and to achieve improved performance, robustness and better scalability. Route Discovery works like this: When a source node needs to communicate with a particular destination, it checks its routing table for the existence of a path towards this destination in. In case a route is found, then it transmits the data to this destination, otherwise, a route discovery procedure is evolved. The source node creates and broadcasts a *Route Request* (RREQ) packet to reach to the destination itself or an intermediate node with a 'fresh enough' route to the destination as a valid route entry for the destination whose sequence number is similar to that contained in the RREQ. Each node receiving the request sends a *reverse route* by unicasting a *Route Reply* (RREP) back to the source. Route Maintenance is a mechanism used to repair routes when they are invalidated or have broken links, so this error propagated to neighbors that have used this node as their next hop. It then creates a Route Error (RERR) message and propagated to all nodes until it reach to the source node. Once the source receives the RERR, it can re-initiate a route discovery if it still requires the route.

The main feature of AODV is its ability to use a destination sequence number for each route entry created by the destination for any route information sending to requesting nodes with loop freedom and this requesting node always selects the node with the greatest sequence number. This protocol works on wired and wireless media. In AODV, the neighboring nodes can detect each other's broadcasts by using symmetric links between neighboring nodes. It does not attempt to follow paths between nodes when one of these nodes cannot hear the other one [9].

These protocols are based on simplistic form of broadcasting called *flooding*; where every node in the network retransmits every unique received packet exactly once but may lead to a serious problem, often known as the broadcast storm problem [5,10]. So to solve this problem, the researchers present two categories. The first category is known as probabilistic broadcast schemes and includes probability-based, counter-based, location-based, distance-based and hybrid-based schemes.

In probability-based scheme, the node rebroadcasts a message according to fixed and predetermined probability around 0.65. In counter-based schemes, messages are rebroadcasted only when the number of copies of the message received at a node is less than a threshold value. In the location-based scheme, messages are rebroadcasted only when the additional coverage concept [11] determines the location of the mobile nodes to broadcast. In distance-based scheme messages are rebroadcasted according to the decision made between the relative distance of mobile node and the previous sender.

In cluster-based scheme, the network is divided into number of clusters; each cluster has a single cluster head and several gateways. Each cluster head, in turn, acts as a source for rebroadcast within its own cluster and the gateways can communicate with external clusters and are responsible for transmitting the broadcast message externally. Hybrid schemes [12,13] combine between the advantages of probabilistic and counter-based schemes to achieve the performance improvement. The second category is known as a deterministic broadcast scheme and includes multipoint relaying [14], node-forwarding [15], neighbor elimination [16], and clustering [17]. Deterministic schemes use network topological information to build a network including all the nodes in the network, so every node needs to exchange its information. Probabilistic schemes do not use any information from network but, rather, start of building a network with each broadcast domain. Consequently, these schemes have smaller overhead than deterministic ones.

The rest of this paper is organized as follows. Section 2 introduces the related work of the counter-based rebroadcast. Section 3 presents the new algorithm proposed of counter-based scheme. Section 4 evaluates the potential characteristics of our scheme. Finally, Section 5 concludes this study.

2. Related work

Flooding has been one of the earliest broadcast mechanisms, where every node in the network retransmits a message to its neighbors when receiving it for the first time, but this mechanism cause a very important problem known in the MANETs environment as the broadcast storm problem [3,5,10,18]. The probabilistic approach has been proposed in [5,11,18,19] as a mechanism to reduce redundant rebroadcast messages [20]. Probabilistic approach works as follows: when receiving a packet, each node forwards the packet with probability p. Ni et al. [10] have proposed a probability-based scheme to reduced the redundant rebroadcast packets like flooding and counter-based schemes. Every node in flooding is rebroadcast with a fixed probability P. On the other hand, counter-based scheme is proposed with additional coverage of each rebroadcast when receiving n redundant messages of the same packet.

Zhang and Agrawal in [21] proposed a Dynamic probabilistic broadcast scheme as a combination of the probabilistic and counter-based approaches. The scheme is implemented using AODV protocol. Cartigny and Simplot in [11] proposed the Probabilistic scheme as a combination of the advantages of probability-based and distance-based schemes.

Another approach has been developed in order to deal with broadcast message called Counter-based scheme which works as follows: when receiving a packet, the node initiates a counter and a timer. The counter is increased by one for each received redundant packet. When the timer terminates, if the counter is larger than a threshold value, the node will not rebroadcast the packet; otherwise, the node will broadcast it. On the other hand, when receiving a packet in the distance-based scheme using the timer to know the locations of the senders of each received packet. Before the timer terminates, the node checks the location of these senders. If any sender is closer than a threshold distance value, the node will not rebroadcast the packet. Otherwise, the node rebroadcasts it. After that, another type of schemes was proposed to reduce the redundant rebroadcast as Location-based scheme and it works as follows: when receiving a packet, the node initiates a timer and a