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Adaptive Threshold Probabilistic Counter Based Broadcast Scheme for Mobile Ad Hoc Networks in Route Discovery

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Abstract: In Mobile Ad hoc Networks (MANETs), the task of routing is distributed among network nodes which act as both end points and routers in a wireless multi-hop network environment. Broadcasting is an essential operation in MANETs routing protocol where each node operationis based on route discovery. The AODV protocol with a route discovery method based on Adaptive Threshold Counting Method. The performance of the AODV routing protocol is analysed fewer than 3 broadcasting schemes AODV with flooding, AODV with counting, AODV with adaptive counting. To discover a route to a specific destination node, existing on-demand routing protocols employ a broadcast scheme referred to as simple flooding whereby a Route Request Packet (RREQ) originating from a source node is blindly disseminated to the rest of the network nodes. This can lead to excessive redundant retransmissions, causing high channel contention and packet collisions in the network, a phenomenon called a broadcast storm. A number of Route Discovery algorithms have been suggested over the past few years based on, for example, location, zoning or clustering. This research argues that such requirements can be largely alleviated without sacrificing performance gains through the use of Probabilistic Broadcast Methods where an intermediate node rebroadcasts RREQ packets based on some suitable forwarding probability rather than in the traditional deterministic manner. Although, several Probabilistic Broadcast algorithms have been suggested for MANETs in the past, in an effort to fill this gap, the first part of this study evaluates the performance of the routing protocols are such as Ad hoc on demand Distance Vector (AODV) and Dynamic Source Routing (DSR) augmented with probabilistic route discovery, taking into the parameters such as network density, end to end delay and packet delivery ratio. In most existing Probabilistic Broadcast algorithms including the one used here for preliminary investigations, each forwarding node is allowed to rebroadcast a received packet the performance of the Ad hoc On-demand Distance Vector (AODV) routing protocol with a route discovery mechanism based on Adaptive threshold counting. The performance of the AODV routing protocol is analyzed under three broadcasting mechanisms are AODV with flooding, AODV with counting and AODV with Adaptive threshold counting. Results establish that a noticeable advantage, in most considered metrics can be achieved using adaptive threshold counting with AODV compared to simple counting or traditional flooding. Researchers evaluate the performance of the simulation results show the approach performs better them both AODV flooding and AODV counting.

Key words: MANETs, flooding, AODV, DSR, probabilistic, counter-based, broadcast storm problem, throughput, reach ability, latency

INTRODUCTION

Broadcasting is a fundamental operation in MANETs where by a source nodes end the same packet to all the nodes in the network. In multi-hop MANETs where all the nodes may not be within the transmission range of the source, intermediate nodes may need to assist in the broadcast operation by retransmitting the packet to other remote nodes in the network. In traditional broadcast settings, the dissemination of packet softens uses up valuable network resources such as node power and bandwidth. Hence, it is important to carefully choose the intermediate nodes so as to avoid redundancy in the dissemination process. Network-wide broadcasting is used extensively in MANETs for the process of route discovery, address resolution and other network layer tasks (Hanashi *et al*., 2009). The broadcasting is frequently used in ad hoc-routing protocols such as Ad hoc on Demand Distance Vector Routing (AODV) Dynamic Source Routing (DSR) for route discovery and route reply (Zhang and Agrawal, 2005). Providing efficient routing protocols is one of the most significant challenges

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in MANETs and is critical for the basic operations of the network (Broch *et al*., 1998; Jiang and Garcia-Luna-Aceves, 2001). In MANETs, a route consists of an ordered set of intermediate nodes that transport a packet across a network from source to destination by forwarding it from one node to the next node. Routing in MANETs is a challenging task. Firstly, the mobility of nodes results in a highly dynamic network with rapid topological changes causing frequent route failures. Secondly, the underlying wireless channel, working as a shared medium, provides a much lower and more variable bandwidth to communicating nodes than in wired networks. As a result, an effective routing protocol for a MANET environment has to dynamically adapt to changing network topology and should be designed to be bandwidth-efficient by reducing the routing control overhead so that as much as possible of the channel bandwidth is available for the actual data communication. The research has been proposed to developing routing protocol for MANETs. These protocols can be classified into three categories such as route discovery and routing information updated that is proactive, reactive and Adaptive Threshold Routing Method.

Proactive routing protocols: Such as those described by Perkins and Bhagwat (1994) and Clausen and Jacquet (2003) attempt to maintain consistent and up to date routing information (routes) from each node to every other node in the network. Topology updates are propagated throughout the network in order to maintain a consistent view of the network. Keeping routes for all destinations has the advantage that communication with arbitrary destinations experiences minimal initial delay. Furthermore, a route could be immediately selected from the route table. However, these protocols have the disadvantage of generating additional control traffic that is needed to continually updates tale route entries (Broch *et al*., 1998; Jiang and Garcia-Luna-Aceves, 2001). Especially in highly mobile environments, communication overhead incurred to implement a Proactive algorithm can be prohibitively costly (Broch *et al*., 1998). Typical and well-known examples of proactive routing protocols are Destination-Sequence Distance Vector (DSDV) (Perkins and Bhagwat, 1994) and Optimized Links tale Routing (OLSR) (Clausen and Jacquet, 2003).

Reactive routing protocols: Such as those proposed by Perkins *et al*. (2003) and Johnson *et al*. (2007) establish routes only when they are needed. When a source node requires a route to a destination, it initiates a route discovery process by flooding the entire network with a Route Request (RREQ) packet. Once a route has been established by Receiving a Route Reply (RREP) Packet at the source node, some form of route maintenance procedure is used to maintain it, until either the destination becomes inaccessible or the route is no longer desired. These protocols useless bandwidth for maintaining the routing tables at every node compared to proactive routing protocols by avoiding unnecessary periodic updates of routing information. However, route discovery latency can be greatly increased, leading to long packet delays before a communication can start. Ad hoc On-Demand Distance Vector (AODV) (Perkins *et al*., 2003) and Dynamic Source Routing (DSR) (Johnson *et al*., 2007) are well-known examples of reactive routing protocols. There are many schemes proposed for broadcasting in MANETS. The simplest one is flooding (Hanashi *et al*., 2009). In this study, researchers propose an adaptive probabilistic counter based scheme for broadcasting. Researchers use the counter based approach to adjust the probability value. If the value is maximum which means the node is dense area. So, that it can receive a large amount of rebroadcasts from its neighbors, researchers reduce the redundant rebroadcast messages.

LITERATURE REVIEW

This study lean to some of the research work related to probabilistic and counter based broadcasting schemes. In MANET, flooding is one of the earliest broadcasting mechanisms where each node in the network rebroadcasts a message to its neighbours upon receiving it for the first time. Although, flooding is simple and easy to implement, it can affect the performance of a network. The high number of redundant broadcast packets due to flooding in MANETs has been referred to as broadcast storm problem. There are five proposed flooding schemes in MANETs called probabilistic, counter-based, distance-based, location-based and cluster-based broadcasting (Hanashi *et al*., 2009; Williams and Camp, 2002).

In the flooding scheme, each node rebroadcasts to its neighbours in response to every recently received packet. In probability based scheme is a very simple way of controlling message floods. Every node retransmits with a fixed probability, p (Sasson *et al*., 2003).

In the area based scheme, a node determines whether to rebroadcast a packet or not by calculating and using its additional coverage area (Tseng *et al*., 2002). Zhang and Agrawal (2005) and Hanashi *et al*. (2009) have also described a dynamic probabilistic scheme which uses combination of probabilistic and counter based schemes. This scheme dynamically adjusts the rebroadcast probability, p at every mobile host according to the value of the packet counters.

The value of the packet counter does not necessarily correspond to the exact number of neighbours from the current host, since some of its neighbours may have suppressed their rebroadcast according to their local rebroadcast probability. On the other hand, the decision to rebroadcast is made after a random delay which increases latency (Mohammed *et al*., 2008a). The Efficient Counter-based Scheme (ECS) that aims to mitigate the broadcast storm problem associated with flooding. The use of ECS for broadcasting mobile nodes to makes localized rebroadcast decisions on whether or not to rebroadcast a message based on both counter threshold and forwarding probability values. Essentially, this adaptation provides a more efficient broadcast solution in sparse and dense networks. Several previous studies (Tseng *et al*., 2003; Mohammed *et al*., 2008b), researchers have proposed an adaptive counter based scheme in which each node can dynamically adjust its threshold value C based on its number of neighbours. Specifically, they extend the fixed threshold C to a function C(n) where ni number of neighbors of the node. This approach requires a neighbor discovery mechanism to estimate the current value of n which can be achieved through periodic exchange of packets among mobile nodes. The counter based scheme can be expressed as follow: a node initiates a counter with a value of one and sets RAD (random chosen between 0 and T_{max} seconds) during the RAD, the counter is incremented by one every time it receives a redundant packet. The delay is necessary for two reasons. First, it allows nodes adequate time to receive redundant packets and assess whether to rebroadcast. Second the randomized scheduling prevents collision (Mohammed *et al*., 2008b). If the counter is less than the threshold upon the expiration of the RAD timer, the node simply retransmit the packet. Otherwise drop it and decline to retransmit it. In this study, researchers propose a new probabilistic approach that Adaptive Threshold Probabilistic Counter based Route discovery scheme (ATPCR) the rebroadcast probability for routing discovery according to the number ofits neighbor nodes to higher throughput, higher saved-rebroadcast, better reachability and lower route request.

ADAPTIVE THRESHOLD PROBABILITY COUNTER BASED ROUTE DISCOVERY (ATPCR)

In ATPCR a route discovery is initiated whenever a source node wishes to send data to another node. The source node broadcasts a packet to all its 1-hop neighbors. However, this research introduces a new counter-based broadcast scheme to achieve efficient broadcasting by adaptive threshold with predetermined forwarding probability pwhich can be the fixed probabilistic route discovery, each neighboring node that receives the packet initiates a counter c identifies nodes with duplicate data packet using threshold values and node removes the redundant message. Probabilitistic schemes do not require global topological information of the network to make a rebroadcast decision. As such, every node is allowed to rebroadcast message. The proposed work also adapts the Random Assessment Delay (RAD) timer which is to resolve dilemma between reach ability and saving rebroadcast, researchers propose ATPCR in which each individual host can dynamically adaptive threshold C based on its neighborhood status. After waiting for a Random Assessment Delay (RAD) which is randomly chosen between 0 and T_{max} seconds, if c reaches a predefined counter threshold C (C is the same as in ATPCR), the node does not rebroadcast the received packet. Otherwise, if c is less than the predefined threshold C, the packet is rebroadcast with a probability P (based on local density information) as against automatically rebroadcasting the message in a adaptive counter based scheme. The algorithm for the proposed probabilistic based adaptive threshold route discovery.

Procedure for ATPCR

Input parameters:

Receiving an pk packet to relay by at node x
p(x): Rebroadcast probability of packet (pk)
rd: Generate a random number rd between [0, 1]
n: neighbor n at x
thr: Set the threshold value

Output parameters:

Dp(x): Discard the packet
Rb(x): Rebroadcast packet
Drp(x): Drop the packet

Calculation of broadcasting probability upon receiving a broadcast packet(pk); Algorithms for the proposed probabilistic Adaptive Threshold Routing discovery Algorithm (ATPCR):

```
If receiving an packet m at node x
Obtain the number of neighbours n at x
Set the threshold value;
set RAD
Generate a random number rd between[0, 1]
 While(RAD) do
{
If (rebroadcast packet) increment C value
}
End while
n1 minimum number of neighbor, n2 maximum number of neighbours;
Get the number of neighbours at node Nj at node j.
```

```
Get the upper and lower averages of number of neighbours max and min
 if nj<min
          Set broadcast probability p = p1
else if min <nj<max
          Set broadcast probability p = p2
else if nj>max
          Set broadcast probability p = p3
End if
   If rd>p
{
Rebroadcast packet
}
Else if (c>C)
{
        Drop packet
}
 End if
 Increment the counter-Adaptivethreshold
If (counter_threshold< threshold) Go to rd>p;
 Else exit algorithm
```

PERFORMANCE EVALUATION

In this study, researchers evaluate the performance of the proposed Adaptive Threshold Probabilistic Broadcast algorithms. Researchers compare and contrast the algorithm against the Flooding algorithms, 3 counters AODV algorithms. Researchers implement the entire three algorithms in AODV protocol. The metrics for comparison include the average number of routing rebroadcasts, reachability, the average number of collisions, end to end delay and the throughput.

For a given topology scenario, if N is the number of nodes in the network and Ni is the number of negihbours at node xi at a particular time instant, the average number of neighbours_n at a node in the network at that time instant is defined by the relation.

Simulation setup: Researchers use network simulator to evaluate the algorithms. Researchers study the performance of the broadcasting approaches in AODV routing protocol. The AODV protocol uses a flooding routing protocol. Researchers have implemented two AODV approaches: one using 3 counters AODV and other Adaptive Threshold Probabilistic Routing algorithm.

The simulation scenarios consist of three different settings, each specifically designed to assess the impact of a particular network operating condition on the performance of the protocols. First, the impact of network density or size is assessed by deploying 25, 50 and 100 mobile nodes. The second simulation scenario investigates the effects of offered load on the performance of the routing protocols by varying the number of source destination pairs (flows for short) over the range 1, 5, 10, 15 flows for each simulation scenario. The last set of simulations evaluates the performance impact of node mobility by varying the maximum node speed of 45 mobile nodes over the range 1, 5, 10, 15, 20 and 25 m sec^{-1} in a fixed area (Table 1).

Table 1: Simulation environment

Simulation parameters	Values
Simulator	NS-2 version 2.34
Traffic type	600×600 m^2
Transmission range	100 m
Band width	2 mbp
IFQ length	45
Simulation time	900 sec
Packet size	10 packets sec^{-1}
Topology size	30
MAC layer protocol	IEEE802.11b
Traffic type	CBR (Constant Bit Rate)
Channel bandwidth	11 Mb sec^{-1}
Interval	95%
Number of trails	20 m sec^{-1}
Maximum speed	4
Adaptive threshold	0.01 sec

Analysis: The objective of this research is proposed to the performance of a Adaptive Threshold Probabilistic Broadcast algorithms using AODV probabilistic references.

This study main idea is to reduce the rebroadcasting node in route discovery phase, therefore reduce the network density and decrease the collision. As a result end to end delay can also be reduced and the throughput can be improved. Based on this analysis, the algorithm should perform better than AODV in dense networks.

Impact of network density: In this study, the network density has been varied by changing the number of nodes deployed over a 600×600 m area for each simulation scenario. Each node moves according to Random Trip Mobility Model with a speed chosen between 1 and 20 m sec^{-1}. For each simulation trial, 10 randomly selected source-destination connections (i.e., traffic flows) are used.

Normalized routing load: Figure 1 shows that the routing overhead generated by each of the routing protocols increases almost linearly as the network density increases. The results also reveal that for a given network density, the routing overhead generated by AD-THRESHOLD-AODV is lower compared with that by 3 COUNTERS-AODV, AODV-FLOODING and AODV. The good performance behavior of AD-THRESHOLD-AODV is due to the fact that the forwarding probability at a node is set according to its local counter value and the threshold value. Thus, the number of redundant retransmissions of RREQ packets is significantly reduced and as a consequence the overall routing overhead is reduced.

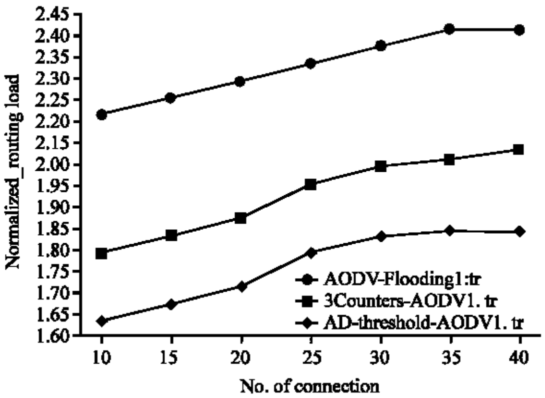

Fig. 1: Normalized network routing load versus network number of nodes placed over a 600×600 m area using a maximum node speed of 10 m sec^{-1}

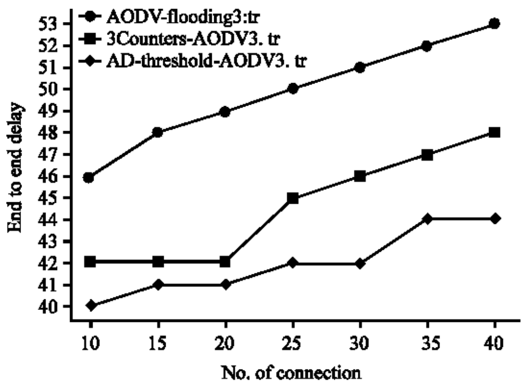

Fig. 2: End to end delay versus network number of nodes placed over a 600×600 m area using a maximum node speed of 10 m sec^{-1}

End to end delay: Figure 2 shows that the end to end delay for each of the routing protocols is relatively high for both sparse and dense networks. In a sparse network, the RREQ packets fail to reach the irrespective destinations because of poor network connectivity. On the other hand, in a relatively dense network, most of the originated RREQ packets fail to reach their destinations due to the increased chance of channel contention and packet collisions caused by excessive redundant retransmissions of the RREQ packets. This potentially increases the time required for data packets to cross from the source to destination. In a sparse network, AD-THRESHOLD-AODV achieves a comparable performance to AODV while AODV-FLOODING out performs 3 COUNTERS-AODV. However, in a dense network, AD-THRESHOLD-AODV performs better than all the other three protocols. This is due to the significant reduction in both the routing overhead and the collision rate as shown in Fig. 1 and 2, respectively.

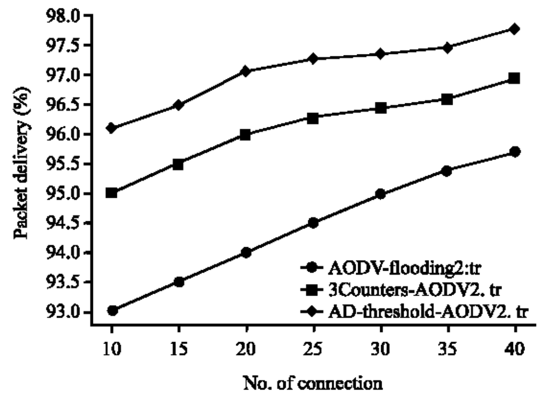

Fig. 3: Packet delivery ratio versus network number of nodes placed over a 600×600 m area using a maximum node speed of 10 m sec^{-1}

Packet Delivery Ratio (PDR): Figure 3 shows that the normalized throughput for each of the routing protocols is low when the network density is set low (i.e., 20 nodes). This is due to the poor network connectivity associated with sparse networks. On the other hand, in a dense network where excessive redundant retransmissions of control packets (e.g., RREQ packets) is predominant, channel contention and packet collisions increase there by lowering the bandwidth available for data transmission. As shown in Fig. 3, AD-THRESHOLD-AODV outperforms 3 COUNTERS-AODV, AODV-FLOODING and AODV when the network is relatively dense. The improved performance of AD-THRESHOLD-AODV in a dense network is due to the significant reduction in the number of retransmissions of RREQ packets by dynamically computing the appropriate forwarding probability for each node using its local counter value.

CONCLUSION

This study proposes a new adaptive threshold probabilistic counter based broadcast schemes for MANET in route discovery. This scheme to achieve efficient broadcasting by adaptive threshold with a probability p. Which can be fixed based on the local density information. This study has proposed the operation of these broadcasting schemes implemented as a route discovery term with an AODV routing protocol. The variations of AODV implemented are referred to as ATPCR route discovery. The performance of the resulting AODV routing protocol (referred to as ATPCR-AODV) has been compared against the traditional flooding AODV, adaptive threshold AODV and fixed probabilistic. The proposed approach dynamically sets the value of the rebroadcast probability for every host node according to its neighbor's information. The proposed research also adapts the RAD value to network congestion level and uses packet origination rate as an indicator of network congestion by keeping track of the number of packets received per second at each node. Simulation results reveal that this simple adaptation minimizes end to end delay and maximizes delivery ratio and thus achieves superior performance in terms of saved rebroadcast, end to end delay and reachability over the other schemes.

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