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An Novel Optimized Hybrid Probabilistic Counter Based Broadcasting Scheme in MANET

[1]B.Sundaravadivazhagan and [2]Dr.P.Jaganathan

[1]*Associate Professor, Annauniversity,Department of CSE,,Renganayagi Varatharaj College of Engineering, Thayalpatti (via) ,Salavarpatti, Virudhunagar (d.t)India P.O(626 123)*
[2]*Professor, Annauniversity,Department of MCA,PSNA College of Engineering and Technology, Dindigul, India*

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ABSTRACT

Broadcasting is a fundamental operation in Mobile Ad hoc Networks (MANETs) simple flooding is the most basic broadcasting technique where each node rebroadcasts any received packet exactly once. A number of broadcasting schemes have been proposed in MANETs to improve the drawbacks of flooding. The key risk with novel schemes that aim to reduce redundant broadcasts retransmissions. The proposed, efficient hybrid counter based and coverage based broadcasting scheme is reduced redundant broadcasts are reserved by criteria related to the number of duplicate packets received for this scheme to achieve optimal reach ability, though the counter-based scheme was among the earliest suggestions to reduce the problems associated with broadcasting, there have been few attempts to analyze in depth the performance of such an approach in MANETs. This is done through the implementation and analysis of the Novel hybrid Probabilistic Counter-Based (NHPCB) scheme, developed as part of this work. The study shows a clear benefit of the proposed scheme in terms of average collision rate, saved rebroadcasts and end-to-end delay, we evaluate the performance of NHPCB scheme and simple flooding approach. Simulation result shows our approach better than both simple flooding and fixed probabilistic schemes.

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INTRODUCTION

The MANETs are required to communicate with each other without relying on any fixed infrastructure such as access points. Broadcasting is the process by which a given node sends a packet to all other nodes in the network conventionally broadcast is done through flooding. In Broadcasting is a fundamental communication operation in which one node sends a message to all other nodes in the network. The main objective of efficient broadcasting algorithm is to reduce the number of broadcasts.

A MANET is an independent system consisting of a set of wireless mobile nodes. The MANET is self organizing and self administrating without deploying any infrastructure and the topology is changes randomly and frequently. MANET is widely used in number of applications such as military, Emergency operations; disaster recovery, civil and business operations (Abdalla Hanashi, M. 2009). There are many routing protocols that use the broadcasting the messages. In on demand routing protocols such as ad hoc on demand distance vector (AODV) and Dynamic Source Routing (DSR) use the broadcast information in route request packets to construct routing paths at every mobile node. The Routing protocols to refresh the routing tables regularly. It generates a large number of broadcast packets at various nodes. Redundant rebroadcasts packets, an inefficient broadcast approach may generate many redundant rebroadcasts packets (Aminu Mohammed *et al*., 2008). In probability scheme assign probabilities to each node to rebroadcast depending on the topology of the network. There are two probabilities based scheme have been proposed called counter based approach and location based approach. In this counter based approach the RAD (Random Assessment Delay) is set; at threshold K is determined and a convert K>=1 is formed on the number of times the broadcast message is received. If the counter is less than a threshold value when the RAD expires, the packet is rebroadcast otherwise, it is simply dropped. In Location based approach uses a additional coverage area in the decision to rebroadcast (Bani-Yassein, M., *et al*., 2005). More sophisticated solutions include probabilistic, counter based, location based and

Corresponding Author: B. Sundaravadivazhagan, Annauniversity,Chennai, CSE, Renganayaki Varadharaj College of Engineering.

distance based approaches. In probabilistic approaches, a mobile host rebroadcasts packets according to certain probability. In counter based approaches, a packet will be rebroadcast only when the number of copies received at a host is less than a threshold. Distance and Location based approaches reduce redundant rebroadcast by exploiting geographical information (Bani-Yassein, M., *et al*., 2006; Bani-Yassein, M., *et al*., 2005; Cartigny, J and D. Simplot, 2003). In Broadcast schemes are commonly divided into 2 categories deterministic schemes and probabilistic schemes. In deterministic schemes use network topological information to build a virtual backbone that covers all the nodes in the network. The nodes exchange information about their immediate or 2 hop neighbors. Probability schemes in difference nodes make a instantaneous local decisions about whether to broadcast a message or not. In hybrid schemes were proposed which combines the advantages of counter based and coverage based schemes to yield a significant performance improvement (Chin-Kai Hsu, *et al*., 2005; Haas, Z.J., *et al*., 2002; Hao Zhang, Zhong -Ping jiang, 2006; Lou, W and J. Wu, 2002). In probability scheme and counter based scheme requires no topological information. In the probability scheme, every receiving node transmits the packet with a predetermined probability *p.* This scheme has been further explored in, where some optimization techniques are proposed for searching a proper *p.* In the counter-based scheme, a node makes its decision on the basis of the number of redundant packets it receives during a RAD. If this number exceeds some threshold; the packet will not be transmitted. In the distance and location based schemes are assume that the distance and physical location information of one-hop nodes are available from some extra device. In distance based scheme, only the receivers that are far from the sender are required to transmit the packet. The location based scheme only allows a receiver to transmit a packet if the new area it covers is larger than a threshold (Mohammed, A., *et al*., 2007). In a dense network more transmission redundancy would be introduced that is likely to generate significant transmission contention and collision such as phenomenon referred as Broadcast storm problem and can lead to a total collapse in the operation of the entire network. (Muneer Bani Yassein, *et al*., 2011). There has been considerable research efforts on mitigating the transmission redundancy associated with flooding (Bani-Yassein, M., *et al*., 2006; Haas, Z.J., *et al*., 2002; Muneer Bani Yassein, *et al*., 2011; Ni, S.Y., *et al*., 1999; Peng, W and X.Lu, 1999; Qi Zhang, Dharma P.Agrawal, 2005). However, most of the proposed probabilistic schemes are inadequate in reducing the number of redundant broadcast while still guarantee that most nodes receive the packet. In some cases, the schemes require near-global network topological information (Qayyum, L.V.A and A. Laouit, 2002; Sasson, Y., *et al*., 2003; Stojmenovic, I., *et al*., 2002; Tseng, Y-.C., *et al*., 2003) or used additional hardware devices for distance measurement or location identification (Muneer Bani Yassein, *et al*., 2011) in order to reduce the redundant transmissions. Therefore, a broadcast scheme that can reduce the *broadcast storm problem* while still guaranteeing that all nodes receive the packet would be highly desirable. Among the earliest proposed solutions to *broadcast storm problem* are the fixed probabilistic (Muneer Bani Yassein, *et al*., 2011) and counter-based scheme (Muneer Bani Yassein, *et al*., 2011). In fixed probabilistic scheme, a mobile node rebroadcasts a packet according to a certain fixed forwarding probability value while in counter-based scheme packets are rebroadcast only when the number of copies of the packets received at a node is less than a threshold value. Although fixed probabilistic and counter-based schemes were the earliest suggested solutions to broadcast storm problem, neither of the two schemes separately is adequate in reducing redundant retransmissions and still guarantees most of the nodes receive the broadcast packet. Similarly, there has been so far hardly any attempt to analyse the effect of different forwarding probability values and threshold values on the performance of the two schemes taking into account important operating conditions in MANETs, such as node mobility, traffic load and network density.The aim of this research is to suggest efficient probabilistic schemes for MANETs that combine the features of fixed probability and counter-based scheme in order to mitigate the broadcast storm problem deleterious effects without sacrificing reachability (i.e. the ratio of nodes that can receive a broadcast packet).

But none of method can achieve overall performance of saved rebroadcast, reachability (RE) and Packet Delivery Ratio (PDR). In this study we propose a method NHPCB that aims to reduce broadcast storm problem. The rest of the paper is configured as follows: section II introduces the background and related work of broadcasting in MANET. In section III and IV We present the proposed Novel Hybrid Probabilistic Counter Based approach. Our simulation result that the proposed scheme can achieve better performance in terms of saved rebroadcast, end to end delay and PDR and analyses of the algorithm are presented in section V and section VI concludes the paper and suggestions for the future work.

Related Work And Background:

There are a number of schemes that have been developed to improve the effects of the BSP in MANETs. In this proposed scheme, we concentrate with Probabilistic counter based scheme and Coverage based scheme. In this section, we present a review some of the most recent and related work on probabilistic algorithm in MANET. The flooding technique is considered as a simple and direct approach to a broadcast message from one node to another node in the network. Since the reachability approaches are solved, however the main drawbacks of using flooding that leads to broadcast storm problem.

Australian Journal of Basic and Applied Sciences, 8(18) December 2014, Pages: 311-320

Probabilistic broadcast schemes for MANETs, the packets are broadcast with a probability *p* that can be fixed or counter value or coverage value to the sender.Typical probabilistic schemes are classified into five categories: fixed probabilistic, counter-based, location-based, and distance-based and hybrid- based schemes. (Bani-Yassein, M., *et al*., 2004; Ni, S.Y., *et al*., 1999; Qi Zhang, Dharma P.Agrawal, 2005 ; Tseng Y.-C., *et al*., 2002; Williams, B., T. F.G. Camp, 2002; Wu, J and W. Lou, 2003).

In fixed Probabilistic Scheme (Muneer Bani Yassein, *et al*., 2011) every mobile node is allowed to rebroadcast a packet based on a predetermined forwarding probability *p* on receiving a broadcast packet *pkt* at a node N. If *pkt* is received first time and the *pkt* with a probability *p*.The studies in (Muneer Bani Yassein, *et al*., 2011; Tseng Y.-C., *et al*., 2002) have shown that probabilistic broadcast schemes can significantly reduce the BSP.

Cartigny and Simplot (Williams, B., T. F.G. Camp, 2002) have proposed some probabilistic schemes where the forwarding probability *p* is computed from the local density *n.* The authors have introduced a fixed value parameter *k* to achieve high reachability for a given network topology.

In the counter-based scheme (Bani-Yassein, M., *et al*., 2005; Muneer Bani Yassein, *et al*., 2011), a node upon the reception of a broadcast packet initiates a random assessment delay (RAD) timer and a counter which counts the number of received duplicate packets. When the timer expires, if the counter exceeds the threshold value, the node assumes all its neighbours might have received the same packet, and will not rebroadcast the packet. Otherwise the node will broadcast the packet.

In location-based scheme (Bani-Yassein, M., *et al*., 2005; Muneer Bani Yassein, *et al*., 2011), each node is expected to know its own position relative to the sender's position using geo-location technique such as GPS. Upon the reception of a previously unknown packet, the node initiates a waiting timer and accumulates the coverage area that has been covered by the arrived packet. When the waiting timer expires, if the accumulated coverage area is larger than a threshold value, the node will not rebroadcast the packet. Otherwise, the node broadcast the packet.

In hybrid Schemes under this category combine the features of the fixed probabilistic scheme with any of the other probabilistic broadcast schemes. It can be fixed probabilistic and counter-based or distance-based or location-based. Most recent works (Bani-Yassein, M., *et al*., 2006; Ni, S.Y., *et al*., 1999; Wu, J and W. Lou, 2003) on probabilistic broadcasting falls under hybrid schemes and the contributions of this research study also fall under the same category. This section reviews some of the probabilistic broadcast schemes which are more related to this research study. Some of the related schemes are presented below.

Bani-Yassein *et al* (Wu, J and W. Lou, 2003) have proposed an adjusted probabilistic flooding scheme which is a combination of fixed probability and knowledge-based approaches. It uses two rebroadcast probability values which ar dynamically adjusted according to the local number of neighbours at each mobile host. The probability value changes when the host moves to a different neighbourhood. In sparse network region, the rebroadcast probability is set high while a low probability value is set in dense region of the network. Compared with the fixed probability scheme, the scheme achieves better saved rebroadcast. However, its performance degrades under high traffic load. Similarly, the use of 'hello' packet to acquire neighbourhood information and the distribution of global information (i.e. average neighbours, maximum neighbours) to all nodes induces more overhead.

In the same authors propose a highly adjusted probabilistic flooding scheme as an extension of their previous work. In this scheme, three different rebroadcast probability values are used for three regions of the network (i.e. dense, moderate and sparse) with node located in sparse region assigned a high probability value while the lowest probability value is set for nodes in dense region. This scheme also suffers from the same drawback as its predecessor in terms of overhead associated with gathering neighborhood information and the distribution of extra global information (i.e. average, minimum and maximum neighbours). Similarly, the determination of optimal values for these parameters is quite difficult.

Zhang and Dharma (Bani-Yassein, M., *et al*., 2006) proposed a dynamic probabilistic scheme which focuses on optimizing route discovery process in AODV routing protocol. The scheme combines the features of probabilistic and counter-based schemes which dynamically adjust the rebroadcast probability *P* at each mobile node based on the value of local packet counters. Therefore, as nodes move to different neighbourhood the value *P* changes, i.e. a packet is rebroadcast with a current probability *P* if the packet is received for the first *N* times (i.e. *N* is the threshold value to indicate whether enough copies of the broadcast packet was received or not). The probability *P* is decrease by a small constant *d* when an additional copy beyond *N* of an existing packet is received, or increased by another small constant *e* if a node did not received anything within the time interval.

With the broadcasting method described above, the simplest one is flooding, which also produces the highest number of redundant rebroadcasts. The probabilistic approach reduces the number of rebroadcast at the expense of reachability. Counter based algorithms have better reachability and throughput but suffer relatively longer delay; In this research, proposed a Novel optimized hybrid probabilistic counter based approach that

Australian Journal of Basic and Applied Sciences, 8(18) December 2014, Pages: 311-320

dynamically adaptive threshold according to the number of its neighbor nodes to higher end to end delay, higher PDR and higher saved rebroadcast.

The Proposed Scheme:

In this section, we present a Novel Hybrid Probabilistic Counter-Based (NHPCB) which is used to reduce the contention and collision problems associated with conventional counter based approaches. It achieves efficient broadcasting by adaptive threshold with a predetermined forwarding probability 'p' which can be fixed based on the local density information. The counter identifies nodes with duplicate data packet using threshold values and node removes the redundant message. This probabilistic approach does not need global topological information of the network to make a rebroadcast decision. Here every node is allowed to rebroadcast a message .The use of this scheme is to facilitate the mobile nodes to rebroadcast a message if the number of received duplicate packets is less than a threshold by taking in to account the status of the node density. In a network of random distribution of mobile nodes as in MANETs, there are regions of varying degrees of node density. Therefore, the forwarding probability p should be set dynamically to reflect local topological characteristics of a given node; e.g. whether the node is located in a sparse or dense region. Consequently, it is critical to identify and categorize mobile nodes in the various regions of the network and appropriately adjust their forwarding probabilities. To achieve this, the node densities at various regions in the network are first determined using the neighbourhood information collected at nodes located in those regions. The neighbourhood information is collected using periodic exchange of ''hello" packets to construct a 1-hop neighbour list at each node in the network. Using the node densities at various regions in the network, two new adjusted probabilistic route discovery approaches are suggested in this paper.

For a given topology scenario, Two inputs are give to calculate probability value. If N is the number of nodes in the network and Ni is the number of neighbours at a node xi at a particular time instant, the average number of neighbours at a node in the network at that time instant is defined by the relation

$$n=\sum^{N}{}_{i=1(Ni)} / N \qquad (1)$$

Secondly, the maximum number of neighbours, n_{max} and minimum number of neighbours, n_{min} are determined using the average number of neighbours. Let $N_1,N_2, \ldots ,N_k$ be the number of neighbours at nodes $x_1,x_2, \ldots ,x_k$ respectively, such that $N_i>$, where i is a positive integer such that $i \leq k$, then the expected maximum number of neighbours is defined as

$$n_{max}=\sum^{N}{}_{i=1(Ni)} / N \qquad (2)$$

Also, if $N_1,N_2, \ldots ,N_r$ are the number of neighbours at nodes $y_1,y_2, \ldots ,y_r$, respectively, such that $N_i <$, where i is a positive integer such that $i\leq r$, then the expected minimum number of neighbours is defined as

$$n_{min}=\sum^{r}{}_{i=1(Ni)} / r \qquad (3)$$

Therefore, the expected minimum, average and maximum number of neighbours for a give topology scenario is related as

$n_{min}<n<n_{max}$

- When the node neighbor number (N_i) is less then n_{min} the node lies in low sparse network,
- If node neighbor number N_i lies between n_{min} and n then the node belongs to medium sparse network
- If node neighbor number N_x lies between n and n_{max} node belongs to dense network

When it is more than n_{max} most important factor in the evaluation of the new scheme is the selection of the threshold probability value p_i for a giving Group-i. A large p_i for a group of nodes in a dense region of the network incurs more redundant rebroadcasts and a low pi in a sparse region of the networks leads to a poor network connectivity. Assume that the initial probability threshold is p_c, and then the forwarding probability at a node in Group-i can be obtained by

$$p_i = \frac{1}{i} p_c \qquad (4)$$

Each node independently chooses which group it belongs to by using its local node density and sets its forwarding probability accordingly

$$N_b = \sum_{i=1}^{2} p_i N_i \qquad (5)$$

Where N_i is the number of nodes in Group-i and p_i is the forwarding probability at nodes in Group-i

$$\sum_{i=1}^{3} p_i N_i < \sum_{i=1}^{2} p_i N_i < p\,(N-2) < (N-2) \qquad (6)$$

Proposed Calculations:

Australian Journal of Basic and Applied Sciences, 8(18) December 2014, Pages: 311-320

Probabilistic accepts two input parameters

Network Density

Let α is the average number of neighbors,
n_{min} Minimum number of neighbors,
n_{max} Maximum number of neighbors,
Then density α of the network is defined as (1).
α = {Low sparse if N_i <}
α = {Medium sparse if < $N_i \leq$}
α = {Dense if < $N_i \leq$}

Calculate Hop Count:

Hop count of the network up to node N_i is denoted as ϕ_i
$\phi_i = 1 - h_i/H$
h_i and H indicate number of hops from broadcast sender up to current node N_i and maximum allowed hop count in the network. As a result, rebroadcast probability of N_i also decreases.

Calculate Node Location:

Let L_x be the current location and D_{th} is the distance threshold. Node location and D_{th} is the distance threshold. Node location is denoted by β
β={if $L_x < D_{th}$ }
β={if $L_x > D_{th}$ }
The steps involved in the novel based probabilistic counter based are as follows:

- Reachability – measures the proportion of nodes which can receive a broadcast packet. A mobile host will miss a packet if all of its neighbours decide to suppress rebroadcasts.
- Saved Rebroadcast (SRB) – This is defined as (r – t)/r, where r and t are the number of nodes. That received the broadcast message and the number of nodes that transmitted the message respectively. A mobile host rebroadcasts every routing request packet if received for the first time. Consequently, there are N-1 possible rebroadcasts, where N is the total number of mobile nodes.
- End-to-end delay - is the average time difference between the time a data packets sent by the source node and the time it is successfully received by the last node in the network.

Routing overhead -the total number of route request packets transmitted during the simulation Time. For packets sent over multiple hops, each transmission over one hop is counted as one Transmission.

Novel Hybrid Probabilistic Counter-Based (NHPCB) Procedure:

1. Uses MAC layer
2. Init: Pre: a broadcast packet P @ X node
3. Coverage based scheme

Add every incoming message on receive list
Calculate the distance of each sending node
Estimate the location of each sending node
Identifying the Coverage area for each node in the network
Estimate EAC of the node
Compute the probability based on EAC of the node

4. Counter Based scheme

Initiate a delay on message reception
reset counter
Inc counter on each additional reception
check the counter on expiry of delay

5. Hybrid algorithm

Calculate probability on EAC
Calculate probability on counter
Combine the probability

6. Rebroadcast based on probability

Coverage Based Scheme:

In the coverage based scheme a node retransmit the message if and only if the EAC (Expected Additional Coverage) value held by the node is larger than the predefined threshold

Analysis of the Counter Based Scheme:

Australian Journal of Basic and Applied Sciences, 8(18) December 2014, Pages: 311-320

1. Uses MAC layer
2. Init:

Pre: a broadcast packet P @ X node
Post: Rebroadcast P @ FN according to algorithm
B id Get Broadcast ID
Ø Node X higher order degree

3. FNselection

Hop count : 1 hop neighbor -> Multihop neighbors
Execute Broadcast Message
Mh.Counter=0
MAC-Broadcast (m)
Handled msgs ← ø selection Msg U m
FN.Selector{ }
do FN.Selector{ }
Message Handler delay
delay←mh(max delay)
loop

4. Counter Based scheme

Threshold ← (threshold fixed by delay factor)
Maxdelay ←delay (max fixed delay)
Degree ←ø(degree of FN selection)
Bcounter ←Cø(list of counter)
To execute CBS-Broadcast (m)
FN←handled Message
CBS-deliver (m) occurs as follows upon Mac-deliver (m) do
If FN(m) ∈ handled msgs then
BCounter[m]←Bcounter[m]+1
Else
FNhandeled msgs←handled msgs←handeled msg Um
Bcounter[m]←1
    CBS.deliver(m)
    delay←FN[mh(delay)]
    wait (delay)
    IF Bcounter[m]<=threshold then
MAC-Broadcast(m)
    FN:Rebroadcast(m)
    GOTO:Section 3

5. Probability

n-number of 1 hop neighbor
Get degree ø of a node X
If packet m received 1'st time
If n<N then
    Node X has Low degree
    Rebroadcast probability p=p1;
Else n>=N
    Node Y has high degree:
    Rebroadcast Probability P=P2;
End if
End if
If probability low
Rebroadcast [m]
Otherwise
Drop it.

Performance Analysis:

The NS2 simulator used in the simulation of Mobile Ad hoc Networks. To evaluate the performance of the proposed scheme for the novel based probabilistic counter based adaptive thresholds scheme. For given topology scenario, if N is the number of nodes in the network and Ni is the number of neighbours at a node xi at a particular time instant, the average number of neighbours _n at a node in the network at that time instant is

Australian Journal of Basic and Applied Sciences, 8(18) December 2014, Pages: 311-320

defined by the relation. 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/s in a fixed area. The simulation is allowed to run for 900 seconds for each simulation scenario. Other simulation parameters that have been used in our experiment are shown in Table 1.

Table 1: Simulation Parameters

Simulation Parameter	Parameter Value
Simulator	NS-2 (v.2.29)
Transmission range	100 meters
Bandwidth	2 Mbps
Interface queue length	45
Packet size	512 byte
Traffic type	CBR
Packet rate	10 packets/sec
Topology size	600 x 600 m2
Number of nodes	20,30…45
Number of trials	30
Simulation time	900 sec
Maximum speed	20 m/s
Counter threshold (C)	4
RAD Tmax	0.01 seconds

Effects of offered traffic load simulation:

Like the previous studies, the offered traffic load simulation is done by changing the number of Constant Bit Rate (CBR) connections. This CBR connection ensures that all cells in a transmission are maintained from end to end. This service type is used for voice and video transmission that requires a little or no cell loss and rigorous timing controls during transmission. The numbers of CBR connections that are considered in the experiments are 10, 20, 30 and 45 for the number of nodes.

The maximum speed 20 m/s is chosen to study the effects of traffic load in the network with high speed. When the speed is high, the traffic load is concentrated on some nodes so the congestion is occurred.

The simulation parameters of this experiment are set as follows:

- Number of nodes: 45
- Maximum speed: 20 m/s.
- Packet rate: 4 packets /second.

Normalized Routing Load (NRL):

Fig. 1 shows the results of the normalized routing load vs. the network sizes (number of connections) for all the three schemes. Apparently, this figure shows that increases in connections tend not to lead to noticeable increase in the NRL using our proposed scheme. When the traffic load increases, there exist many connections between any nodes used to reach to the destination, so we choose one of these connections. Most of the generated data packets and connections are dropped resulting from collisions and contention. Nevertheless, our proposed scheme will decrease the NRL over the traffic load percentage against other schemes and show better performance up to 30%. This is because the AODV flooding sends the packets to all nodes continuously without checking if these nodes receive this packet in previous time; thus, this causes a collision and contention in the network leading to additional load on the network.

Australian Journal of Basic and Applied Sciences, 8(18) December 2014, Pages: 311-320

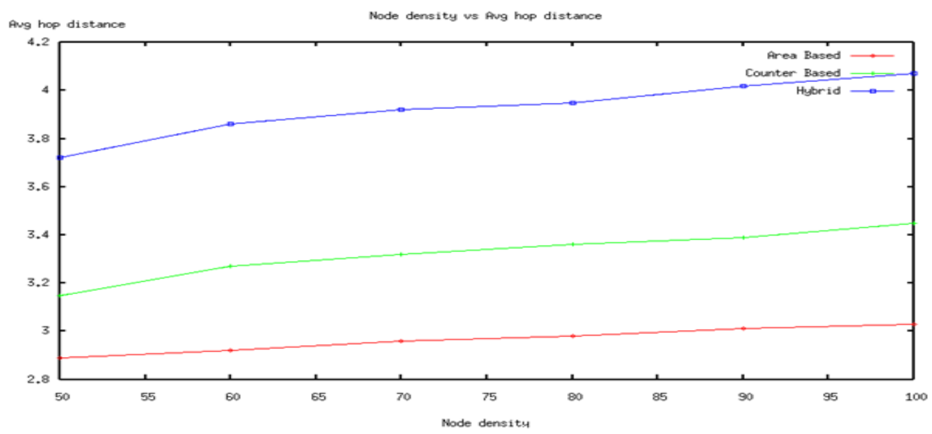

Fig. 1: Normalized routing load vs. the network sizes.

Average End to End Delay:

Fig.2 represents the delays of all schemes for different traffic loads. The delay is increased as the traffic load grows. The number of packets transmitted on the network has a considerable impact on delay. When the number of CBR connections increases the number of collisions, contentions and redundant rebroadcast packets grows. Thus, this leads to more retransmissions of packets towards the destination and, hence, resulting in growing delay. Fig. 3 shows that AODV flooding incurs higher end-to-end delay. This is owing to the higher number of redundant rebroadcasts of RREQ packets with collisions and contention caused by many RREQ packets that fail to reach the destination.

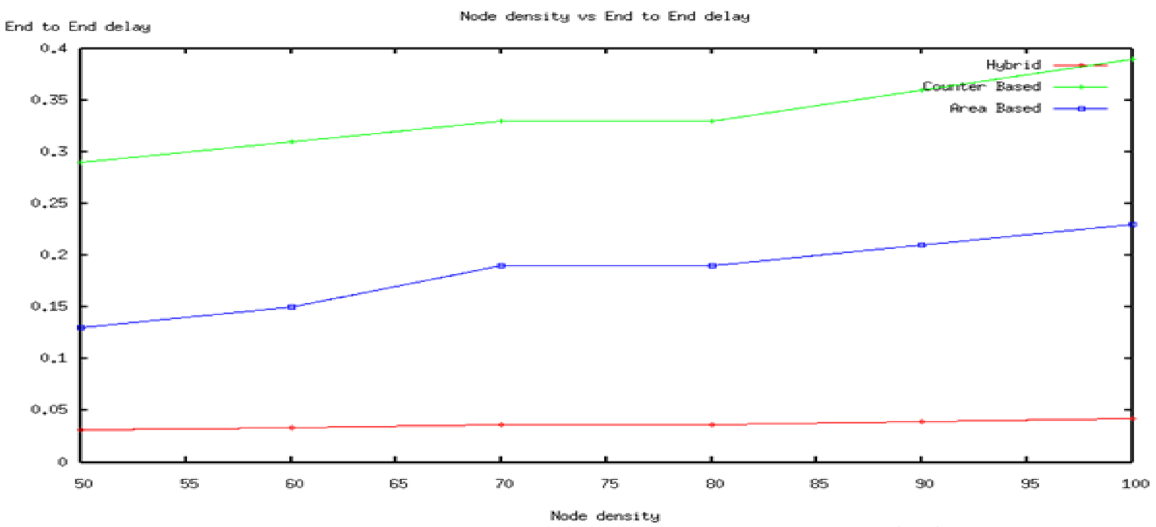

Fig. 2: End-to-End delay Vs number of connections.

Packet delivery ratio (PDR):

Fig. 3 represents the PDR for all schemes in this study. This figure shows that our proposed scheme has a higher value of PDR compared with Dynamic Counter-based and AODV flooding. Packet delivery ratio increases when increasing the number of connections for the following reason: the more the network connections, the better and more available shortest paths towards destination. This implies that there are more connections to connect two nodes offering a better transmission in each area. Hence, there is a greater chance that ensures that if the broadcast retransmission occurs successfully, resulting in an increased delivery ratio.

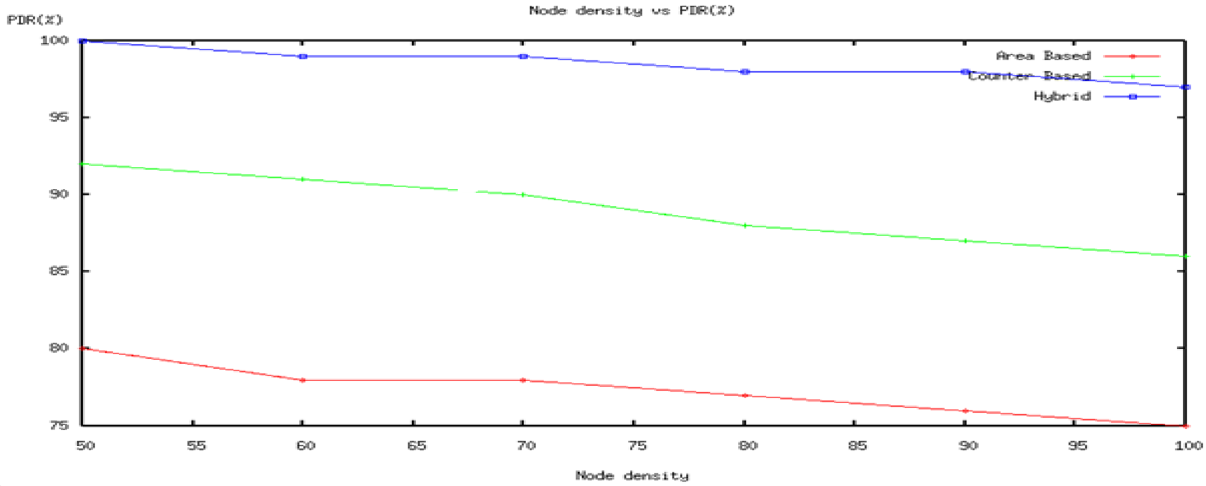

Fig. 3: Packet delivery ratio vs. traffic load

Conclusion:

This work proposes a new probabilistic counter-based broadcasting scheme to achieve efficient broadcasting by adaptive threshold with a probability p which can be fixed based on the local density information. The counter identifies nodes with duplicate data packet using threshold values and node removes the redundant message. The proposed approach dynamically sets the value of the rebroadcast probability for every host node according to its neighbour's information. The proposed work also adapts the random assessment delay (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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