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A Dynamic Broadcast Restrain Algorithm Based on Neighbors in MANET

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ABSTRACT

Broadcast is one of the most important communication means in mobile ad hoc networks. Reactive routing protocols establish routes by broadcast. Conventional on-demand routing protocols suffer in terms of several issues such as rebroadcast redundancy and collisions. This paper proposes an algorithm called DBA(Density Based Algorithm) .DBA calculates sending delay and forwarding probability based on neighbors of nodes and adjusts them dynamically according to the broadcasting situation. The strategy of extending cache is adopted to solve the problem of network division. Combining with the classic AODV routing protocol, we design the AODV-DBA protocol. Computer simulation results confirm that AODV-DBA performs perfect in terms of redundancy and collisions compared with the other protocols, and the DBA algorithm could effectively reduce the cost of channel resource occupied.

Keywords: MANET, broadcast, routing protocols, delay, probability, network division

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INTRODUCTION

Mobile ad-hoc network(MANET) is a multi-hop temporary autonomous system composed of mobile terminals with wireless transmitters and receivers， and has advantages of laying simple, robust and strong, no infrastructure, etc. But because of the energy and channel restrictions, Ad hoc network is a multi-hop communication system. The mobile network nodes often cause the link breakage and routing failure, so we need efficient and reliable network routing algorithm to ensure the effectiveness and robustness of information transfer. Traditional on-demand routing protocols establish a route mainly through radio, simple flooding broadcasting causes serious channel contention and conflict, which is broadcast storm problem[1].

Broadcast storm problem has already been studied, proposing a variety of algorithms, mainly including the algorithm based on the probability, the algorithm based on the area and the algorithm based on neighbor information. These algorithms have different methods of redundant packets estimation, and different methods of collecting and forwarding information decision. Probabilistic algorithms is similar with flooding algorithms, but a node will forward a broadcast message with the probability P when receiving it. This method can reduce the redundancy, but will also reduce the coverage, so we must choose between the broadcasting redundancy limit and coverage. Algorithms based on the area primarily decide whether to forward by additional regional covered by nodes forwarding to, which can be divided into the distance algorithm and the location algorithm. The algorithms based on distance decide whether to forward by the distant between the receiving broadcast node and the sending node, which also exists the problem of low coverage. The algorithms based on distance rely on GPS and other positioning systems, which applicability is limited. The algorithm based on neighbor information will add covering nodes' information when sending a broadcast and the receiving node will determine whether to forward by the information and its neighbors' information. These algorithms add neighbor information in the broadcast, which adds some overhead.
Based on the existing broadcasting algorithms, this paper proposes a dynamic broadcast suppression algorithm DBA (Density Based Algorithm) based on neighbor degree. The node will set the delay and the probability of broadcast

forwarding according to the neighbor degree, and dynamically adjust forwarding delay and probability according to the number of received repeat broadcasts. For the existing network division problems in the sparse network, the algorithm designs broadcasting caching prolonged strategy to solve the route discovery failure problem caused by network division.

In the paper, Section II introduces the broadcasting problem related algorithms, Section III describes the DBA algorithm in detail, Section IV describes simulation analysis of the algorithm, and finally is conclusion.

Related work

Reference [9] [10] conducted in-depth analysis and research on the broadcast storm problem. Reference [1] proposed a fixed probability strategy, after the node receives the first RREQ, it will forward with a fixed probability. The strategy is simple, but does not consider the problem of node density. Reference [11] proposed a changing probabilistic algorithm SPS (Smart Probabilistic Scheme), which is improved on the basis of a fixed probability. The strategy takes into account the density of the node, which divide the density of nodes into four levels, namely sparse, generally sparse, intensive, high-intensive. Each density level corresponds to a forwarding probability, the node uses broadcast HELLO messages to collect information to establish neighborhood neighbor list, in order to determine the density level they belong, and then use the corresponding probability forwarding RREQ. Reference [12] proposed a dynamic probabilistic algorithm. The algorithm will set the forwarding probability based on node density and the nodes covered by the receiving RREQ, and send the RREQ after adding the list of its neighbors. The node receiving RREQ determined the additional nodes set covered by forwarding by comparing the node list, the more the nodes set, the larger probability of corresponding forwarding set larger, otherwise the smaller the probability of forwarding. Reference [13] proposed HPC(Hybrid Probabilistic Counter) algorithms. In HPC algorithms each node calculated a function to forward the broadcast, which function adjusted the forwarding to probability by the number of repeat broadcasts received dynamically.

Combining with these algorithms, we propose Dynamic Probabilistic broadcast suppression algorithm based on neighbor degree (DBA). The following section details DBA algorithm.

EXPERIMENTAL SECTION

Algorithms and Protocols

AODV (Ad hoc on Demand Distance Vector) is one of the classic on-demand MANET routing protocols. In the traditional AODV protocol, when the source node does not receive destination node routing, it will broadcast a RREQ to initiate route discovery, all the neighbors receiving this broadcast will forward. Because of the lack of effective control of broadcasting, broadcast storm problems can easily lead to in the network.

DBA algorithm mainly reduces broadcast conflict by delay algorithms, and reduces broadcast redundancy through probabilistic algorithms.

Delay and Probability Initialization

If a node receives the first RREQ message, the node will initialize a delay timer based on network density, which time is a random set. In a large node density network, there are more nodes receiving the broadcast and try to forward, so the delay should be set longer. Delay is a function of network density, adjusting delay by the density can reduce the forwarding nodes at the same time. Here, the density of the network is represent with the ratio of the local node hop count and the largest network hop number.

Initialization delay is shown in Formula 1.

$$T_i = RAND(0, 1 - e^{-\frac{D_L}{D_G}}) * t \qquad (1)$$

In the formula, T_i is the delay timer of node i, D_L is the number of one hop neighbors of node i, D_G is the maximum number of one hop neighbors of nodes, t is a random in interval [0,10-3] , for adjusting the time of timer in a suitable order of magnitude.

Seen from Formula 1, the more hop neighbors of nodes, the longer waiting time, thereby it can avoid collisions broadcast. The parameters are D_L and D_G in the formula. The node can obtain the value of parameter D_L by detecting and sensing. D_G is an experimental value, which can be obtained through the experimental method in the specific network environment. To this end, through simulating several specific network scenarios, parameter values and the corresponding results obtained are shown in Table 1.

Table 1.Network parameters under different circumstances

Numble	Nodes	Network area	D_L	D_G	T_i	P_i
1	50	500m*500m	6	8	$52*10^{-5}$	0.47
2	100	750m*100m	57	64	$58*10^{-5}$	0.41
3	200	1000m*1000m	46	60	$23*10^{-5}$	0.64
4	300	1000m*1000m	70	95	$51*10^{-5}$	0.48

Similarly, the probability of the node forwarding RREQ also needs considering the density of nodes. With the higher density of the network nodes, the more relay nodes forwarding broadcast, then the forwarding probability should be set lower to reduce the broadcast redundancy of the network; conversely, the forwarding probability should be set higher to ensure the broadcast coverage. After receiving the RREQ, the relay nodes calculate the forwarding probability by the following Formula 2.

$$P_i = RAND(0, e^{-\frac{D_L}{D_G}}) \quad (2)$$

In the formula, P_i is the forwarding probability of node i, D_L and D_G are as previously described. As we can see, the more neighbors of the node, the smaller the node's forwarding probability; the less neighbors of the node, the larger the node's forwarding probability.

Timers and probability update

If the node received repeated RREQ forwarded by other nodes before the initialized timer expired, which shows other nodes have forwarded this RREQ, the node needed updating timer parameters and forwarding probability for reducing broadcast redundancy. Timer update is shown as Formula 3.

$$T_{k+1} = T_k \times N_R \quad (3)$$

In the formula, T_{k+1} is the next waiting time of the timer, N_R is the repeated RREQ number the node received in the previous waiting time. As we can see, the timer' updating time is related with the repeated RREQ number the node received, the more number of received repeated packets, the longer waiting time.
Updating algorithm of forwarding probability is shown in Formula 4.

$$P_{k+1} = \frac{P_k}{N_R} \quad (4)$$

P_{k+1} is the forwarding probability after updating, P_k is the forwarding probability before updating, N_R is the number of the repeated packets received in the previous timer's time. Seen, the more repeated packets the node received, the smaller which forwarding probability.

In a larger node density network, the number of sent broadcast packets may be large, to prevent timer wait indefinitely problems, we'll set two parameters, one is the timeout counter (Timer Counter, TC), and the other is the number of overtime threshold (Waiting Threshold, Wth). TC used to measure the times of the node reaches the timer, Wth used to limit the maximum value of the timeout counter. When the timer times out expires, the timeout counter reaches timeouts threshold, the node will cancel the timer. Wth is a manual preset parameters based on the density of the network. In the high density network, Wth should be set higher, and in the low density network should be set low.

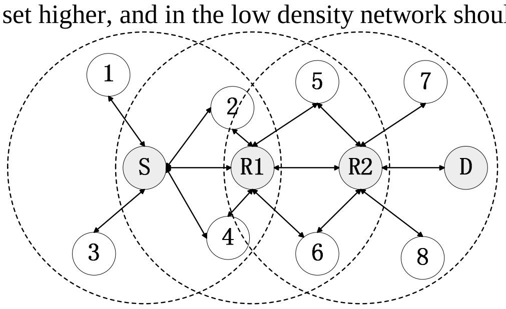

Figure 1.DBA algorithm broadcast forwarding

For example, the network distribution shown in Figure 1, the source node S will find the route to the destination node D, it sends a broadcast RREQ, the hop neighbor nodes 1,2,3,4 and R1 received the first RREQ packet and then they start running DBA algorithm. First, each node initializes the timer and get a random forwarding delay T_k. If the node R1 timer expires first, then the node R1 forwards the packet based on the initialization probability. At this point node 2 and node 4 receive the repeat RREQ R1 forwarded, the node 6 and node R2 receive this first RREQ. Nodes 2 and 4 execute DBA algorithm again to update timer and forward probability, because of receiving the repeated packets, the timer of node 2 and node 4 will be extended, the forwarding probability will be reduced. Node 5, 6 and node R2 first received forwarded RREQ from R1, initializing the timer and forwarding probability. Similarly, if node R2' timer expires first, it will of forward the broadcast with the initialized probability. Finally, the network formed the route from the source node to the destination node is S-> R1-> R2-> D after running DBA algorithm.

Network division

If the node density is low, the network may be split because of the dispersed nodes and the mobile nodes, which is a temporary network's not entirely connectivity.

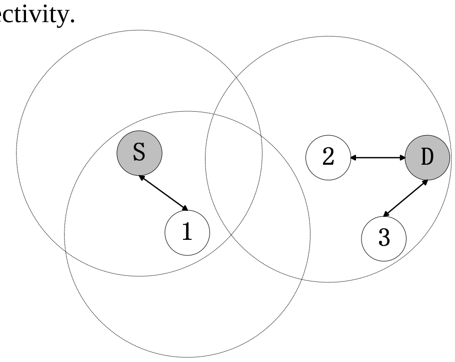

Figure 2. Network division

As shown in Figure 2, node S initiates a route to node D, but since the network split at the node 1, node 1 has no relay node, causing the routing lookup failure. To solve this problem, in DBA algorithm, when there is no relay of node 1, the RREQ will be extended a waiting time in the cache by node 1 to prevent RREQ expired. Once node 1 has other neighbors as relay, the node will forward this RREQ with one hundred percent probability.

Simulation Analysis

This section describes the simulation of the DBA algorithm, and compares with other broadcast suppression algorithms to verify the performance of the algorithm. Routing protocol AODV is one of the classic routing protocols in MANET. Given the breadth of its application and research, we will verify the performance of DBA algorithm based on AODV, and compares with the HPC algorithm in Reference [12]. The two algorithms combining with AODV protocol are called AODV-DBA and AODV-HPC.

Choosing Qualnet simulation platform, each data point will simulate 20 times for averages. To verify the algorithm' performance fairly, we will set the simulation parameters as Reference [12], specific settings shown in Table 2.

Table 2 Simulation parameters

Numble	Parameter	Parameter values
1	Simulation Platform	Qualnet
2	Communication distance	300
3	Physical channel bandwidth	2Mbit
4	Network Range	1000*1000m2
5	Mobile speed	20m/s
6	Nodes	30--200
7	Connections	1--40
8	Application layer	CBR

In the simulation we will investigate the following two indicators mainly to investigate the performance of broadcast algorithms:

RREQ conflict number: is the number of sending failed broadcast in the network due to collisions. This indicator can verify delay mechanism of DBA algorithm. Good broadcast algorithm should be able to avoid a collision by random delay, to improve the success rate of the broadcast.

RREQ replay number: Indicates the number of nodes repeat broadcast in the network. This indicator verifies accuracy of the DBA probability algorithm. Good broadcast algorithm should be able to reduce the radio broadcast redundancy in the premise of ensuring coverage, to save channel resources.

To verify the performance of the algorithm, set up two scenarios for protocol emulation.

Scene One: simulation of different node densities. In this scenario, in the range of 1000 * 1000 m^2, network nodes increased from 30 to 200, Node maximum speed is 1m / s, setting 20 pairs of CBR stream in the application layer, flow rate of 8 packets per second. The simulation results are shown in Figures 3 and 4.

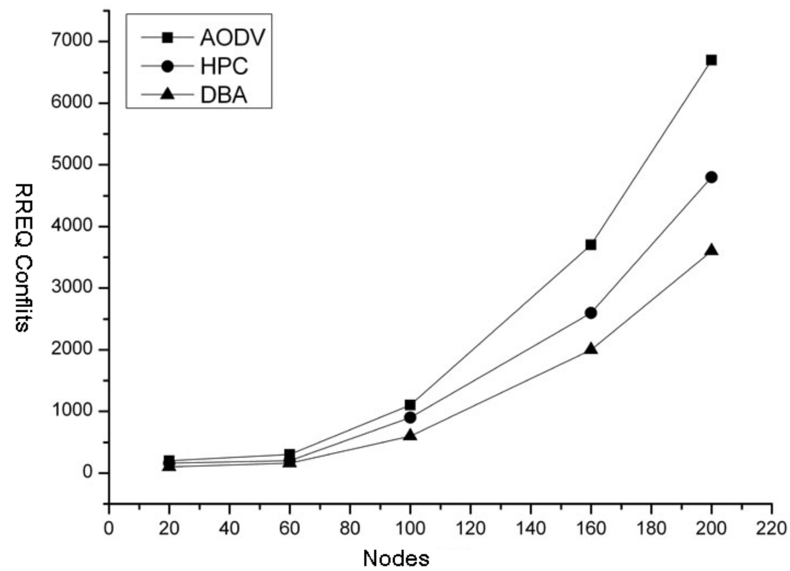

Figure 3. Comparison of RREQ broadcast conflicts in different densities

Figure 3 is a different node density networks RREQ conflict comparison chart. We can see, when the density of nodes increases, the number of the RREQ broadcast conflict in three protocols have increased. The DBA protocol delay algorithm can effectively reduce the probability of adjacent nodes send a broadcast at the same time, and significantly reduce the number of broadcast conflicts. Referring to Figure 3, AODV-DBA reduced about 45% broadcast conflict than AODV, reduced about 25% conflict than AODV-HPC.

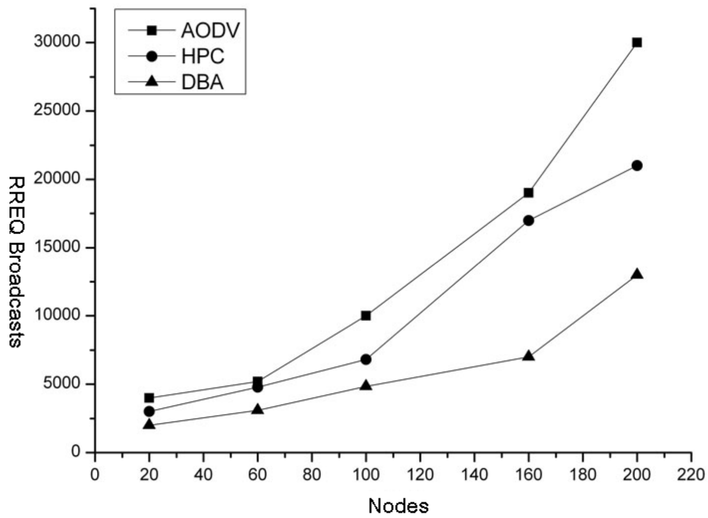

Figure 4. Comparison of broadcast RREQ in different densities

Figure 4 is a comparison chart of RREQ sent under different node densities in the network. Broadcast redundancy is one of important symbols of algorithm performance, the smaller the broadcast redundancy shows the better performance of the algorithm.

Seen from Figure 4, as the density of nodes increases, the number of broadcast transmission in the protocol are increased, AODV has the maximum number of broadcast transmission in the network because of no broadcast control, AODV-HPC algorithm is slightly better than AODV, AODV-DBA has the fewest number of broadcast, broadcasts sent by AODV-DBA 35% are less than AODV and AODV-HPC up to 65% and 35%.

Scene 2: Simulation of different network loads. The scene simulates the protocol's performance under different network traffic load, adjusting the network load by changing the number of CBR streams connections in the application layer. There are 150 nodes in the network area, source node and the destination node of the application layer CBR are randomly selected, CBR connections change from 1 to 40.

The simulation results are shown in Figures 5 and 6.

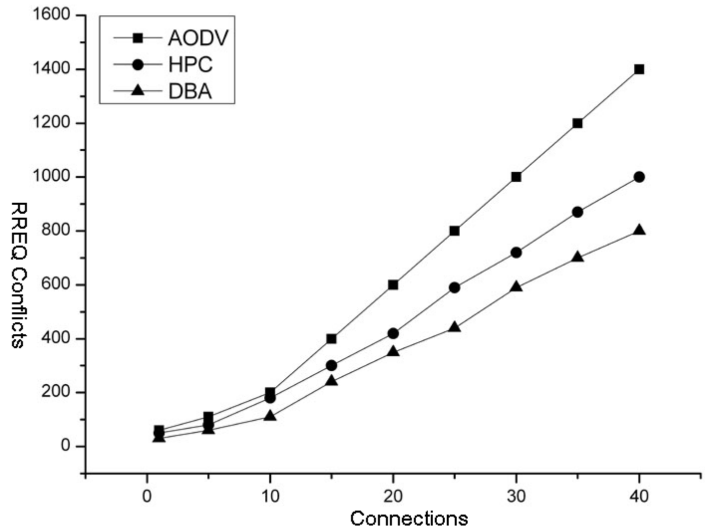

Figure 5. Comparison of broadcast conflicts under different connections

Figure 5 is the comparison chart of networks broadcast conflict under different connections Visible, with the increase in the number of connections, network load increased, the numbers of conflicts in different broadcasting protocols also increased. However, the conflicts number of DBA algorithm significantly was less than the other two, especially when the network load was high, the number of conflicts reduced up to 18% than HPC algorithm. Which is because the random delay algorithm effectively reduced the conflicts causing by the adjacent nodes sending broadcasts, accurate probabilistic algorithm also reduced the number of broadcast forwarding, but also reduces the probability of conflict.

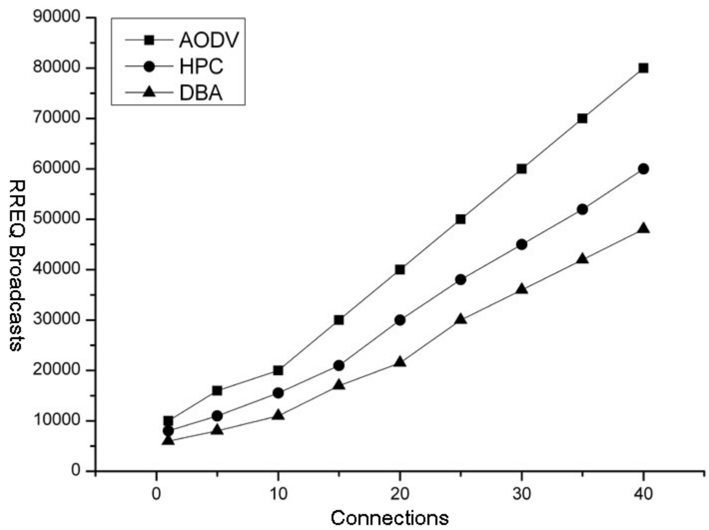

Figure 6. Comparison of broadcasts under different connections

Figure 6 shows broadcasts transmitted in the network under different connections. With the increase of network load, the number of RREQ sent across the network increased significantly, but the broadcast redundancy of AODV-HPC protocol and AODV-DBA protocol are lower than AODV, wherein the broadcast inhibition of DBA algorithm is the most effective, the optimal number of broadcast transmission in the network is reduced by about 20%, the number of broadcast sent in the network reduced approximately 20% Under optimal circumstances.

CONCLUSION

Studying broadcast suppression algorithm is important for on-demand routing protocols. This paper presents a new broadcast suppression algorithm based on neighbor degree---- DBA algorithm, which uses the neighbor degree to initialize forwarding delay and probability, and updates the sent delay and probability using the received repeat broadcasts, in order to avoid conflicts and reduce broadcast redundancy. Simulating the algorithm on Qualnet simulation platform, the results show that the DBA algorithm based on AODV-DBA protocol has significantly less broadcast conflicts and lower redundancy than other protocols, when the network load is high density and a larger advantage is particularly evident. The advantage is particularly evident when the network density is higher and load is larger.

DBA algorithm is fully distributed computing without taking up extra channel resources, no modifying data formats of routing protocol, and loosely coupled with routing protocol allows the protocol's application more flexible. The algorithm with good performance, has broad applicability.

REFERENCES

[1]T seng Yu Chee,Ni Sze Yao, Chen Yuh Shyan, et al. *Wireless Networks*, **2002**, 8(2):153-167.
[2]Haas Z J,Halpern J Y,Li L,Gossip-based Ad hoc routing[C]. Proceedings of INFCOM **2002**,New York, 2002: 1707-1716.
[3]Sasson Y, Cavin D, Schiper A. Probabilistic broadcast for flooding in wireless mobile Ad hoc networks[C], Proceedings of the IEEE Wireless Communications and Networking Conference(WCNC`03), New Orleans, **2003**: 1124-1130
[4]Cartigny J,Simplot D. *Telecommunication Systems*, **2003**, 22(1-4):189-204.
[6]Wang S H, Chan M C, Hou T H. Zone-based controlled flooding in mobile Ad hoc networks[C]. Proceedings of IEEE WirelessCom, Hawaii, **2005**:421-426.
[7]Yi Y,Gerla M, Kwon T J. The selective intermediate nodes scheme for Ad hoc on-demand routing protocols[C]. Proceedings of IEEE ICC, New York, **2002**:3191-3195.
[8]Hhiang T C, Wu P Y, Huang Y M.A limited flooding scheme for mobile Ad hoc networks[C]. Proceedings of WiMob2005, Montreal, 2005:473-478.
[9]P. Ruiz , P. Bouvry, "Enhanced distance based broadcasting protocol with reduced energy consumption[C], International Conference on High Performance Computing and Simulation (HPCS), pp. 249 –25828, July 2010.
[10]P. Y. Taifei Zhao, Xizheng Ke, *International Journal of Digital Content Technology and its application*, vol. 4, pp. 101–109, **2010**.
[11]M.Bani Yassein,M.Bani Khalaf, and A.Al-Dubai, *The Journal of Supercomputing*, vol.53,pp.196-211,**2010**.
[12]J.-D. Abdulai, M.Ould-Khaoua, L. Mackenzie, and A.Mohammed, *International Symposium on Performance Evaluation of Computer and Telecommunication Systems*(SPECTS), pp.165-172, June **2008**.
[13]A. Mohammed, M. Ould-Khaoua, and L. Mackenzie, An Efficient Counter-Based Broadcast Scheme for Mobile Ad Hoc Networks[C], in Proceedings of the 4th European Performance Engineering Workshop(EPEW 2007),vol.4748,pp.275-283,**2007**.