Congestion Avoidance in AODV Routing Protocol Using Buffer Queue Occupancy and Hop Count

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Congestion avoidance in AODV routing protocol using buffer queue occupancy and hop count

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Abstract. Owing to network congestion, data could be loosed when its transmitted from source to destination.The reactive routing algorithm Ad hoc On-Demand Distance Vector protocol (AODV) uses number of sequences and hops to select an optimal path. However, it doesnt consider nodes loads to choose the suited route .In addition, its efficiency declines sharply when dealing with high load and fast mobility. To face this problem, this paper presents , an improved protocol Buffer Queue Occupancy-AODV(BQO-AODV) which selects optimal routes by considering the minimum value of BQO metric instead of minimum hop count.the results of tasting have shown better performance of our proposed protocol (BQO-AODV) comparing to AODV routing protocol in terms of average end to end delay, packet delivery ratio and normalized routing load.

Keywords: MANET,AODV,CONGESTION,BUFFER.

1 Introduction

It is well known that congestion is one of the most critical problem in routing in Ad-Hoc networks [1]. It was defined as an overcrowding or blockage result of overloading which is similar to traffic jam caused by many cars on a narrow road. Congestion occurs mainly, at any intermediate node, when the packets number exceeds buffer capacity. Thus, node becomes congested and starts losing packets.Routing protocols [2], during transmission, are needed in order to define routes and deliver packets from the source to the final destination. In this work, we will focus on avoiding congestion for AODV distance vector routing algorithm [3]. AODV protocol is a reactive routing algorithms characterized by the use of serial number to identify whether the routing is new or old then avoiding routing loop. Moreover, each intermediate node could save the routing request and response results while remaining update to network structure changes.
Since Mobile ad hoc network nodes are highly dynamic in nature, congestion is the main factor for more packet loss and longer delay. AODV uses hop count as route selection metric which is not an efficient method under this situation in ad hoc networks. In fact, it doesn't take mandatory precautions to handle the nodes which become congested under heavy network traffic. We can find in

the literature, many routing algorithms in mobile ad hoc networks for routing and congestion free networks.For example, K. Kumar. et. al. [4] have proposed a new mechanism for selecting routes called ETR-AODV which optimizes node energy and traffic by adding a congestion field and energy field in RREQ or RREP packet. Then the destination node select route which contains a maximum value of energy and minimum value of congestion and unicast a reply with this path selected. Another approach was presented by YuHua Yuan .et .al.[5] which is an adaptive load-balancing approach, which presents an effective scheme to balance the load in ad hoc network. It is implemented in the process of route request. When route request (RREQ) messages are flooded to acquire routes, only the qualified nodes, which have a potential to serve as intermediate forwarding nodes, will respond to these messages, so that the established path will not be very congested, and the traffic will be distributed evenly in the network. In this scheme, a threshold value, which is used to judge if the intermediate node is overloaded, is variable and changing along with the nodes interface queue occupancy around the backward path. S. J. Lee. et .al. in [6] proposed Dynamic Load Aware Routing protocol (DLAR), which considers the load of intermediate nodes as the main route selection metrics. The load of a route is defined as the number of packets buffered in the queue of the node. L. Shrivastava et. al.[7] presented a survey of various congestion aware and congestion adaptive routing protocols. Some of such routing algorithms discussed are congestion aware distance vector (CADV), congestion aware routing protocol for mobile adhoc networks (CARM), hop-by-hop congestion ware routing protocol for heterogeneous mobile ad hoc networks, congestion adaptive routing protocols (CRP), etc. The paper suggests that the problem of congestion is associated with the network and it has to be solved by having compromised solution rather than elimination. AOMDV routing protocol in [8] used Queue Length and Hop Count value together to select a route from source to destination that avoids congestion and load balancing. A threshold value is defined after a threshold alternate path is chosen. Intermediate nodes avoids broadcast of RREQ if the routes are already congested. In this paper, we propose a modified AODV protocol designed to avoid congestion in network taking in consideration the route which has the smallest maximum node Buffer Queue Occupancy (BQO) metric. This paper is organized as follows: Section 2 presents the proposed routing protocol.Section 3 shows the simulation and analysis of the obtained result Finally, Section 4 concludes the paper.

2 Proposed Approach

Most on-demand routing protocols include route request, route reply and route maintain procedure. Changes in our approach BQO-AODV is carried out in route request and route reply procedure, where a reserved forward BQO field and backward BQO field of node are inserted in the RREQ and RREP respectively. Whenever a node receives a RREQ or RREP, it compares its BQO_j with the forward BQO and backward BQO. If it is greater it sets the forward BQO or backward BQO to BQO_j .

2.1 Buffer Queue Occupancy (BQO)

To calculate the buffer queue occupancy we define several terms:
Len_j: Number of data packets in interface queue of node j.
$Limit_j$: Total interface queue size of node j.
The Buffer queue occupancy of node j is calculated by the following equation:

$$BQO_j = \frac{Len_j}{Limit_j} * 100 \tag{1}$$

Buffer queue occupancy in equation (1), is the percentage of the network interface queue that is occupied.

2.2 Enhanced route discovery mechanism

Whenever a source node requires communicating with another node for which it does not have a route, it initiates the route discovery phase by broadcasting a Route Request (RREQ) packet to all its neighbors, where the forward and backward BQO values are initialized to zero. When a neighboring node received the route request message, it calculates the parameter BQO_j defined in (1) and stored it in the forward BQO field of the ROUTE REQUEST packet. As the RREQ is broadcasted in the whole network, upon receiving the RREQ, an intermediate node first checks whether it has received this RREQ before. If so, it drops the RREQ. The intermediate node compares its BQO_j with forward BQO field if it is greater it sets the Forward BQO to BQO_j. When the destination receives a RREQ packet, if there is no route in its routing table, it sends a RREP using the reverse route. But, if there is a route to the source, the destination compares the forward BQO value in the RREQ received with the forward BQO value of the route currently in use. If it is smaller, the destination replaces its current route information with the RREQ packet route and sends a RREP to the source. Each intermediate node that receives a RREP packet checks to see if the RREP is the first reply or not. If it is, the intermediate node compares its BQO_j to the backward BQO value contained in the RREP header, updates its route table, and forwards the RREP to the next hop towards the source. If the received RREP is not the first reply, the intermediate node checks the freshness of the route in the RREP. If it is fresher than the current one, it updates its route table and forwards the RREP to the next hop towards the source. But, if the route in the received RREP is as fresh as that of the current route, the intermediate node compares the backward BQO with the backward BQO value of the current route, and uses the best one (the least congested one) for sending data. When a source node receives a RREP packet, it checks its route table to determine if it is the first reply to a route request or not. If it is, the source starts using the route received otherwise it checks the route freshness. If the new route received is fresher than the one currently in use (has a destination sequence number larger than that of the route is being used), the source updates its route table and starts using the new route for sending data. But, if the two routes have the same freshness, the source compares the backward BQO value in the RREP with that of the current route, and starts using the best one (the least congested one) for sending data. If the two routes have the same backward BQO the path with minimum number of hops will be selected.

3 Performance evaluations

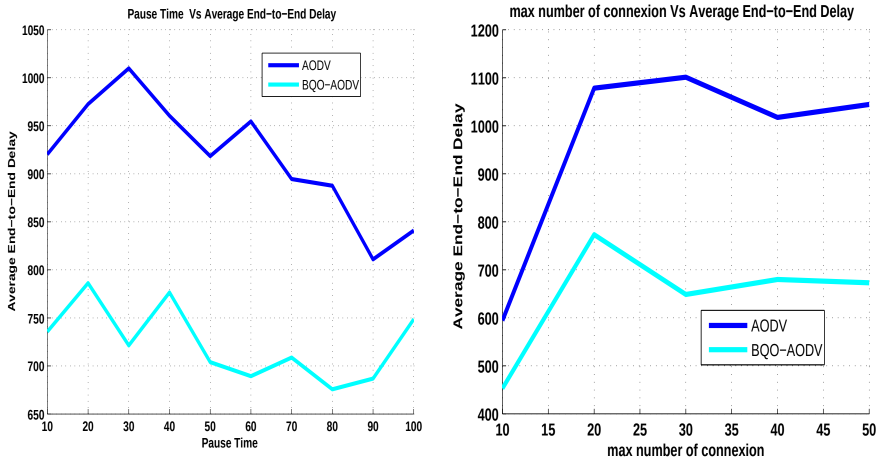
In this section, we evaluate BQO-AODV and AODV performances under the same environment. We will start by displaying configuration of the used environment parameters. Next, various traffic load conditions and nodes mobilitys are explored in order to study the effectiveness of our approaches.

3.1 Simulation Environment

To evaluate the performance of BQO-AODV, Each simulation is run for 200 seconds and repeat 10 times. These performances are evaluated by increasing the maximum number of connections and pause time. We compare it with AODV by using NS2.34 [9]. In the process of simulation, we assume every protocol shares the same model and node configuration. Their initial parameters are shown in Table1. We evaluate the performance of BQO-AODV through tree metrics: Packet delivery ratio, average end to end delay and normalized routing load [10].

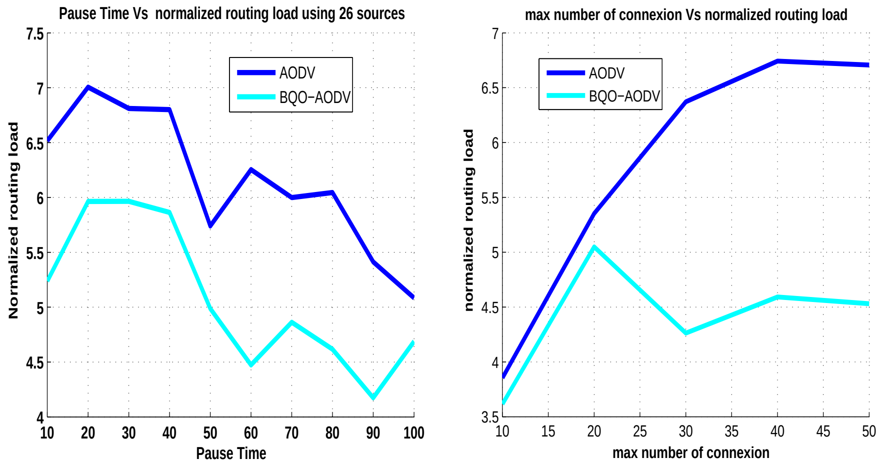
Table 1: Simulation parameter

Parameter	value2
Dimensions	$1200m * 1200m$
Number of nodes	50
Source type	CBR
Antenna Type	Omni directional
Spread type	Two Ray Ground
Wireless channel capacity	2 Mb/s
Communication radius	250 m
Packet size	512 bytes
Packets Rate	8 Packets/s
Buffer size	50
MAC Layer	IEEE802.11
Transport Layer	UDP
Max. Number of connections	$10, 20, 30, 40, 50$
Pause time	$10, 20, 30, 40, 50, 60, 70, 80, 90, 100$



(a) (b)

Fig. 1: Average en-to-end delay vs.: (a) pause time with 26 sources (b) Maximum number of connections.

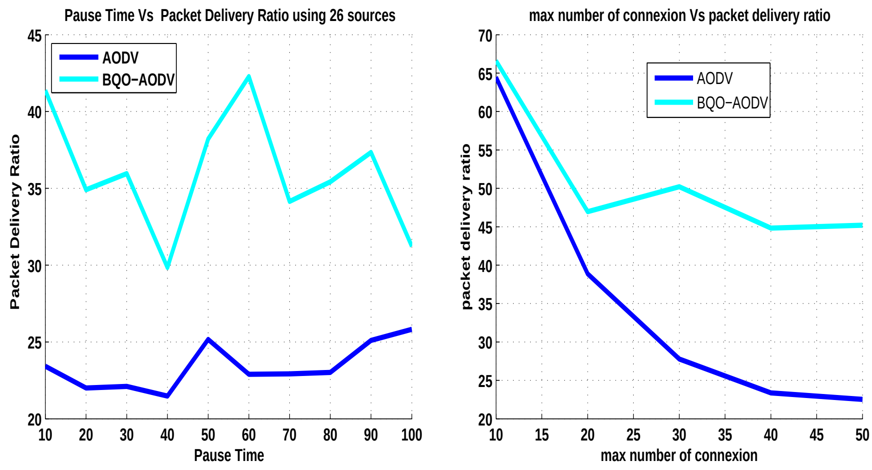


(a) (b)

Fig. 2: Normalized routing load vs.: (a) pause time with 26 sources and (b) Maximum number of connections.

3.2 The effect of mobility

To analyze the effect of mobility, pause time was varied from 10 seconds (high mobility) to 100 seconds (low mobility). The number of nodes is taken as 50 and the maximum number of connection as 50. Graphs showed in Figure 1(a), 2(a)



(a) (b)

Fig. 3: Packet delivery ratio vs.: (a) pause time with 26 sources (b) Maximum number of connections.

and 3(a) shows the effect of mobility for AODV and BQO-AODV protocols with respect to various performance metrics. The average end to end delay of BQO-AODV in figure 1(a) shows a better results than AODV for almost all mobility levels (pause times of 10,20,30,40,50,60,70,80,90, and 100 seconds). Figure 2(a) shows the packet delivery ratio of the tow protocols AODV and BQO-AODV. The pdr of BQO-AODV is greater than AODV At low and high mobility. the protocol BQO-AODV generates less normalized routing load than AODV protocol as shown in figure 3(a). The reason is that the protocol BQO-AODV uses the route that contain less congested node accordingly it uses RREQ packets often.

3.3 The effect of traffic load

In this simulation, the number of connection (source and destination) was varied from 10 to 50, CBR sending rate 8 packets per second, maximum node speed 10 m/s and pause time 0s. Figure 1 (b), 2(b) and 3(b) had shown the average end-to-end delay, the normalized routing load and the packet delivery ratio for BQO-AODV and AODV respectively. Figure 1 (b), shows the average packet arrival time for each protocol. We can see that BQO-AODV has a lower delay than AODV, when the number of flows increased from 20 to 50. The end-to-end delay had increased from 1078 seconds to 1044 seconds. The corresponding variation for BQO-AODV was from 773 to 672. The ratio of packets delivered by AODV and BQO-AODV is affected by the traffic load. When the numbers of flows were less than 20, BQO-AODV did not show much improvement over AODV. When the number of flows increases from 20 to 50 the packet delivery ratio of AODV had a sudden fall from 39% to 23% when compared with the above packet delivery ratio, the figures of the BQO-AODV fall only a gradual fall from 47% to 45% as shown in Figure 2(b). In figure 3 (b) when the numbers of flows were less than 20, BQO-AODV did not show much improvement over AODV. When the number of flows increases from 20 to 50 the normalized routing load incurred by BQO-AODV is very less when compared to AODV routing protocols.

4 Conclusion

In this paper, we have proposed a new routing protocol take into account the buffer queue occupancy (BQO) of intermediate nodes and try to avoid using routes that go through congested nodes, here the BQO is the number of packets in interface queue of intermediate node. Source and destination make routing decisions by selecting the least congested route, where the congestion of a route is determined as the maximum BQO value at the intermediate nodes. Detailed simulations were used to evaluate the performance of the proposed congestion mechanism and to compare it with AODV routing. The simulation results show that the proposed protocol can result in substantial improvement in the packet delivery ratio average end-to-end delay and normalized routing load.

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