Performance Evaluation of Load Based Channel Aware Routing in MANETs with Reusable Path

A. Ayyasamy, K. Venkatachalapathy

Abstract—Mobile Ad Hoc Networks (MANETs) are wireless networks which don't require any infrastructure support for transferring the data packet between two nodes. Routing protocols for ad hoc networks has generally ignored channel fading. The existing protocol Channel Aware - Ad hoc On-demand Multipath Distance Vector (CA-AOMDV) uses one of the routing metrics as channel Average Non-Fading Duration (ANFD). This metric is useful for informing the fading detail into neighbour node. We proposed a new Load Based Channel Aware - Ad hoc On-demand Multipath Distance Vector (LBCA-AOMDV) protocol which is applied for load balancing to improve the network performances. In our routing protocol calculates the channel's non-fading duration for routing with minimum packet loss. Specifically, the faded paths can be reused rather than being discarded and also the loads are balanced on the link. The NS-2 was used to perform both simulation and performance evaluation of the proposed protocol and to compare it with the existing protocols. The simulation result demonstrates the greatly improved network performance and reduction of packet loss on routing over CA-AOMDV.

Index Terms—Mobile ad hoc networks, routing protocols, channel average non-fading duration, channel average fading duration.

I. INTRODUCTION

Now-a-days there is a rapid development in wireless Mobile Ad hoc Networks (MANETs) that doesn't support any fixed infrastructure and it is a combination of two or more devices or nodes with wireless communication and networking capability that communicate with each other without the aid of any centralized administrator. MANET has been developed for two reasons: one to implement graphics tools for data sets with missing values; the other is to provide a platform for trying out new interactive ideas. The node has the mobility that is called mobile node; mobility means roaming around the world. The challenge in building a MANET is equipping each device to continuously maintain the information required for proper route traffic. Such networks may operate by themselves or may be connected to the larger Internet. Different protocols are then evaluated based on measures such as the packet drop rate, the overhead introduced by the routing protocol, end-to-end packet delays, network throughput, etc. The packet transmission in MANETs is done using radio link and infrared [1].

In MANETs, routing is done by using many protocols [2]. These protocols have the properties to improve the efficiency of routings such as increased reliability, power efficiency, security and Quality of Service (QoS) [3].

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One of the advantages of MANETs is that it doesn't require any intermediate communication interface devices such as switch, modem and hubs. In the wireless system, the nodes are capable of managing the communication by itself without other devices. MANETs have many real time applications such as conference halls, Vehicular Ad hoc Networks (VANET) and military force.

There are many common routing algorithms used in ad hoc networks but Ad hoc On-demand Multipath Distance Vector (AOMDV) [4] is the most popular On-demand algorithm. The identified routes were used only at the time of packet transmission and not having any valid path [5]. On-demand multipath routing protocol has identified a number of paths to perform routing in MANETs [6]. All the identified paths are stored but only one of them is used for transferring data. The other stored paths will become useful once the current path is broken [7], [8].

In addition to the channel behavior, the new paths are built using the best links or if any path fails it switches to alternate path [9], [10]. The channel adaptive schemes are implemented in Medium Access Control (MAC) protocol [11], [12]. The key aspect of this work is to reuse the most feasible path again with the security mechanisms rather than discarding it at the first sign of fades [13], [14]. Due to signal fading the faded node goes out of the channel; it sends the information to the previous node, then the transmission to the faded node stops and finds another path for transmission. The main shortcomings of AOMDV consider only a number of hops while path selection and the path stability are completely ignored [15 - 17]. In CA-AOMDV, it takes two ways, one is route discovery; here each link measures its stability [18], [19]. Next is route maintenance; here instead of waiting for the active path to fail, it preempts a failure by channel prediction on path links.

This paper proposes a protocol named Load Based Channel Aware- AOMDV (LBCA-AOMDV), which is an extension of Channel Aware- AOMDV (CA-AOMDV) routing protocol. Further, we made a detailed analysis of the three protocols (LBCA-AOMDV, CA-AOMDV, AOMDV) based on the performance with respect to routing increased throughput, packet delivery ratio, packet drop and energy consumption.

Then the performance of LBCA-AOMDV is compared with other two protocols, by increasing the number of nodes, changing the size of the network and also fixing the energy level of each node in the network.

The rest of the paper is organized as follows: In section 2, we discuss the review of AOMDV and CA-AOMDV. We present the proposed methodology in section 3. Experimental results & performance analysis is given in section 4 and section 5 concludes the paper.

II. REVIEW OF AOMDV AND CA-AOMDV

A. Ad Hoc On-Demand Multipath Distance Vector (AOMDV)

The Aomdv provides a multipath for MANETs routing. When a transmission is made between the sources to destination, the source starts to send packets to its neighbor in the wireless network [20 - 22]. If the neighbor goes beyond the range of path gets disconnected and more loss of packet till the next path for transmission is identified [23], [24]. This process continues till the packets reach their destination. In case if no neighbors are found, the process stops inthe middle and it does not send the packets to the destination [25], [26].

Due to fading in the link, the path gets disconnected; so more packets are lost. We cannot reuse the path if once disconnected due to fading in the channel [27]. In Figure 1 the nine nodes are simulated; when one node goes away from the channel, there is more packet loss due to a path failure [28]. It finds the alternate path and transfers the packets through that path. If again any path fails, no neighbor is found; then the entire transmission stops. The drawback of AOMDV has been overcome using the CA-AOMDV protocol [29].

B. Channel Aware-Aomdv (CA- AOMDV)

The result of route discovery in AOMDV finds the selection of multiple loop free, link disjoint paths between source and destination node. In CA-AOMDV the channel Aware Non Fading Duration (ANFD) is used as a routing metric and measure of link stability and a path selection.

The Average Fading Duration (AFD) is utilized to determine, when to bring a path again into play, allowing for varying nature of path usability instead of discarding at the initial failure [30]. The feasible path is brought back into the play when they are available again, rather than simply discarding them at the first sign of a fade. At the time of signal fading before handoff takes place, the system waits for an acknowledgement of saying that the path is secured; it does not transfer the packet rather than it chooses another route.

This CA-AOMDV does not provide security when there is a handoff between neighbor nodes. We can't make sure that there are no intruders or hackers else any other damage to the information being transferred.

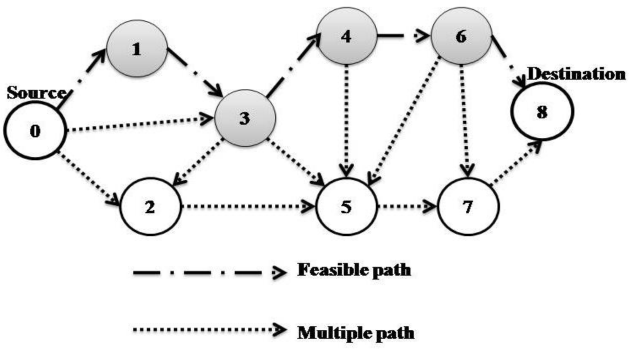

Fig. 1: Handoff in CA-AOMDV

III. PROPOSED METHODOLOGY

Transmission in AOMDV protocol results in more packet loss. To overcome this, CA-AOMDV has been proposed. Using this protocol we reduced packet loss due to an increase in the packet delivery ratio but getting throughput is about 35% and it's not sufficient, so we proposed new protocol LBCA-AOMDV as an extension of CA-AOMDV.

A. Load Based Channel Aware - Aomdv(LBCA-AOMDV)

In MANETs routing, the node failure occurs due to two reasons. One is a node link failure and the other is overloaded. Link failure occurs only because of fading in the channel; here the channel fading and non-fading duration is found. The channel's average fading duration is the period of time the channel spends below the network specific threshold value. The average nonfading duration is the period of time the channel spends above the network specific threshold value. In this LBCA- AOMDV, we have concentrated on node overloaded using the specific threshold value. In our proposed work, we fix the threshold values like 300 packets. If any node exceeds this threshold, the node comes away from the channel and gives the shortest neighbor node up to overloaded process. Then the overloaded process is completed and then the node comes to the current running path.

The LBCA-AOMDV protocol's flow diagram is shown in the Figure 2. Here the network has 500 fixed packets and 300 threshold points and routing starts by applying the LBCA-AOMDV protocol for finding the most feasible path. The transmission starts, if any failure in the link is due to two reasons: One is fading and the other is node overload. If the node is greater than 300, then the overloaded node will give way to the new node. After the load is unloaded, it enters into the same path. Meanwhile the faded node enters again the channel and it can also join the path. After all the transmission of information from source to destination completed, the entire process stops.

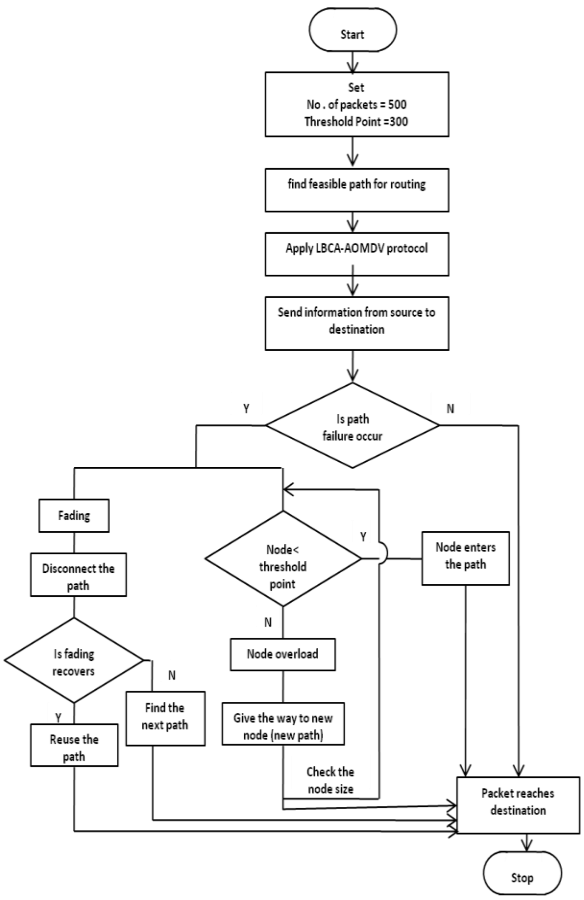

Fig. 2: The LBCA-AOMDV protocol's flow diagram

1) Route discovery in LBCA-AOMDV

In route discovery phase, the source node starts to find its entire neighbor till destination. The neighbor is found in such a way that source node first chooses its next neighbor by sending a “hello” packet. In turn those neighbors will send the same “hello” to their next neighbors. This process continues till destination. After reaching destination, the same process is done from destination to source nodes. By that time, it finds for the most feasible paths for transmission. In our model node 2 is faded node and node 9 becomes loaded node, so that both the nodes go away from the path giving away to the new node. The transmission of packets between the source and destination using LBCA-AOMDV protocol has been indicated in the Figure 3. In this process if any node is let go out due to two reasons, one is node overload and the other one is faded node due to failure of the path. That path is replaced by one of the multiple paths which is here considered current path.
A node reusable in the LBCA - AOMDV process clearly shown in the Figure 4 node 2 and node 9 comes back into the channel after recovering from all its problems, so that the transmission starts with the feasible path. Shows about load balancing that the loaded node comes back into the play after unloading the load that particular node makes the feasible path isreused again.It improves the performance of an entire transmission process in the network using a LBCA - AOMDV protocol.

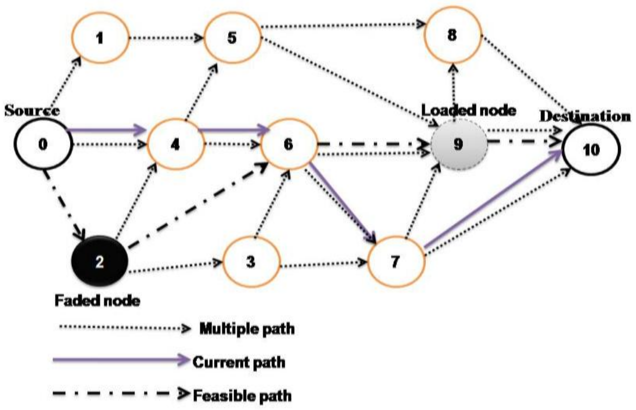

Fig. 3: LBCA-AOMDV Process.

2) Route maintenance in LBCA-AOMDV

In this model, instead of waiting for the active path to fail, we preempt a failure by using channel prediction on path links, allowing a handover to one of the remaining selected paths. If there is an occurrence of path failure due to channel fading, the packets are saved in the previous node itself and consequently smaller delays.

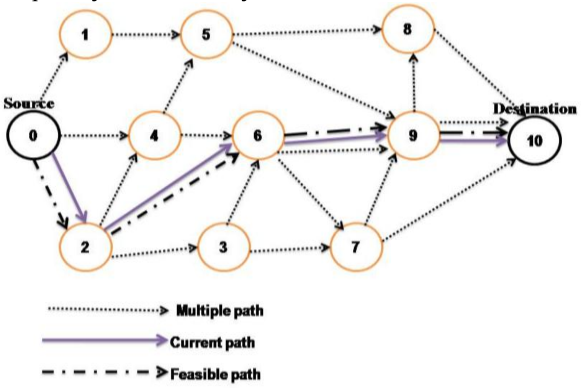

Fig. 4: Process of node reusable in LBCA-AOMDV.

The average fading duration and also average non-fading duration in the channel calculates the drop in the channel. Before any neighbor goes out of the range, it intimates the information to its next neighbor. In this process the packet loss should be reduced. It is assured that the source packets are transferred to the destination. When the neighbor goes out of the range and comes back to the path taken by the channel, the packet starts to transmit through the same path. This occurs on the channel, because the first path will be the most feasible path. Hence, the first path will be reused when it comes into the channel. If the number of node overload and faded link increases, automatic throughput, packet delivery ratio and energy consumption are reduced and vice versa in other cases.

IV. EXPERIMENTAL RESULTS & PERFORMANCE ANALYSIS

In our experiment, we used NS-2.34 simulator to analyze the result with a routing protocol LBCA-AOMDV with 25 nodes. We set the maximum size of a packet 500 and applied MAC protocol 802.11. The network channel areas were 1000m x 400m. For simulation purpose, we initially set threshold point 300 and energy for each node as 100. We analyzed the result with various network performance metrics. Some of the metrics are defined as follows, and the results are given in the following sub-sections.

A. Throughput

It is the measure of how fast we can actually send the packets through the network. The number of packets delivered to the receiver provides the throughput of the network with respect to time. Table 1 shows the throughput comparison for three routing protocols. AOMDV provides 35% throughput, and CA-AOMDV provides 25.5-12.2% improvement [1]. LBCA-AOMDV provides 44-29% improvement. Figure 5 shows that the throughput increases with increasing time while using LBCA-AOMDV.

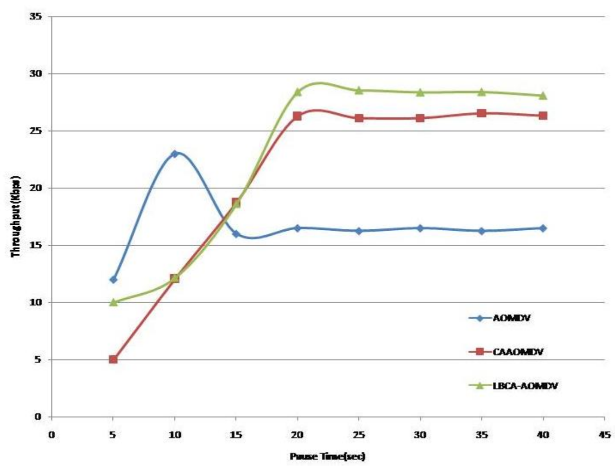

Fig. 5: Throughput comparison

B. Packet delivery ratio

The packet delivery ratio is the ratio of data packets delivered to the destination to those generated by the constant bit ratio in (1). The time taken to connect from source to destination is in two parts. One is the time taken to connect the path and the second is the connection delay. Further the connection delays have two processes, one is for channel access and the other reconnects due to channel fading. The handoff in CA-AOMDV is done only when there is link failure due to fading in the channel, whereas in LBCA-AOMDV the handoff is due to both fading in the channel and also the overload of the nodes in the channel. So, the packet delivery ratio of LBCA-AOMDV is higher than CA-AOMDV. Table 2 shows the packet delivery ratio comparison for three routing protocols. LBCA-AOMDV provides a 6.1% improvement from AOMDV. Figure 6 shows that the packet delivery ratio increases with increasing time while using LBCA-AOMDV.

PDR% = No. of packets received/No. of packets sent (1)

Table 1Throughput Comparison for Three Routing Protocols.

Time (sec)	AOMDV	CA-AOMD V	LBCA-AOMD V
5	12	5	10
10	23	12.06	12.1536
15	16	18.7456	18.6048
20	16.5	26.3024	28.408
25	16.25	26.1248	28.5504
30	16.5	26.1248	28.3728
35	16.25	26.5504	28.408
40	16.5	26.3376	28.0896

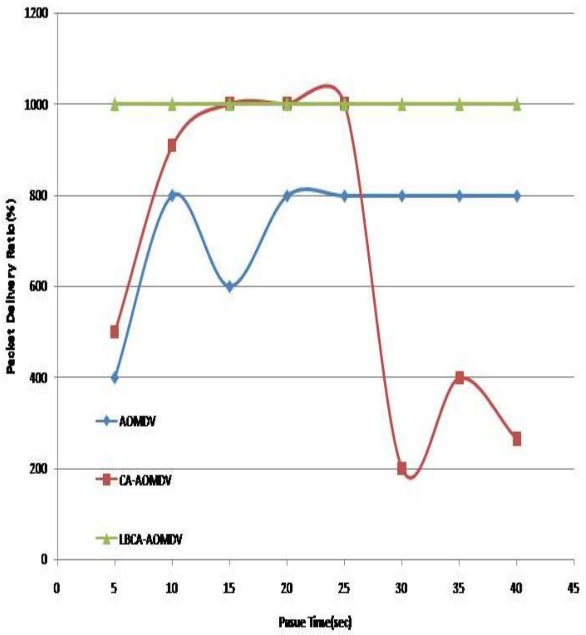

Fig. 6: Packet delivery ratio comparison

C. *Packet drop*

Packet drop is the number of packets lost with respect to time between the source and destination. The total number of packet loss is reduced, since we have concentrated on both channels fading and also the node overload. Channel fading and the node overload are the only two reasons for the packet drop in the network channel. LBCA-AOMDV provides only the 0.800% drop from CA-AOMDV as mentioned in Table 3. Figure 7 shows that the packet drop decreases with increasing time while using LBCA-AOMDV.

Table 2 The Packet Delivery Ratio Comparison For Three Routing Protocols.

Time (sec)	AOMDV	CA-AOMDV	LBCA-AOMDV
5	400	500	990
10	800	908	999.5
15	600	1000	1000
20	799	1000	1000
25	799	1000	1000
30	799	200	999
35	799	397.5	1000
40	799	264	989

D. *Energy consumption*

Energy consumption is measured as the amount of energy (J) which is being used by a particular node at the time of transmission with respect to time. LBCA-AOMDV provides only 23% of energy loss from the total energy of 100% for each node. Hence, LBCA-AOMDV consumes 77% of total energy from CA-AOMDV. It is mentioned in Table 3. Figure 8 shows that the energy consumption decreases with increasing time while using LBCA-AOMDV.

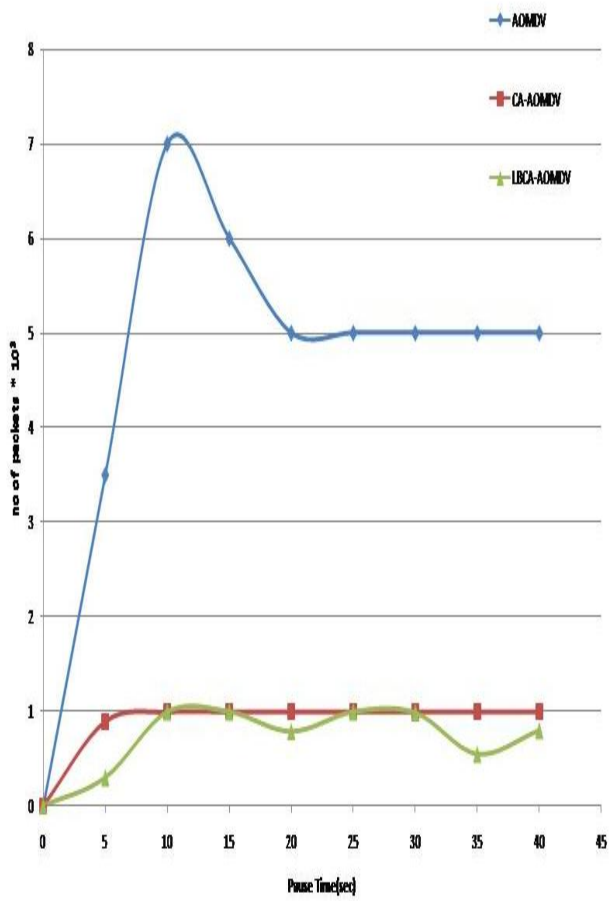

Fig. 7: Packet drop comparison

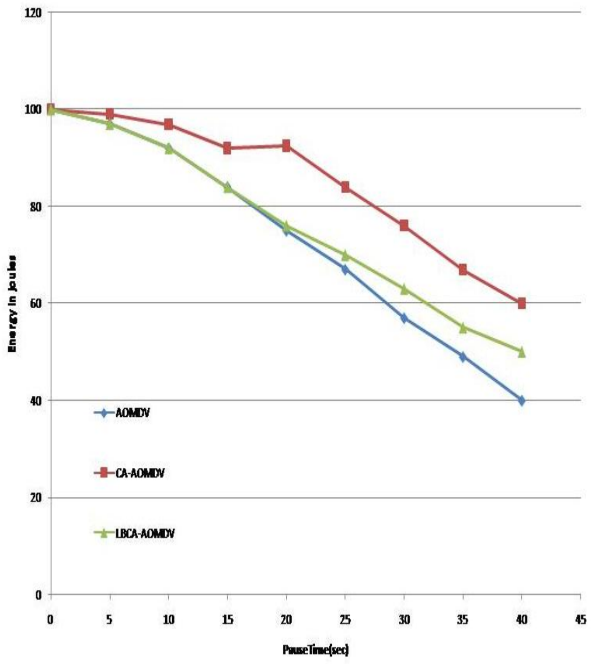

Fig. 8: Energy consumption comparison

Table 3
The Performance of Proposed LBCA –AOMDV with Varying Alpha
(Alpha is the propagation loss coefficient.)

Alpha	Throughput	Packet delivery ratio	Packet drop	Energy consumption
2.58	43	0.10	0.30	23
2.30	44	0.00	1.00	23
2.14	36	0.00	1.00	23
2.19	35	10.00	0.79	23
2.99	33	0.00	1.00	23
2.33	44	0.00	1.00	23
2.4	36	1.00	0.99	23
2.7	29	31.00	0.55	23
Total (%)	36.57	6.01	0.800	23

V. CONCLUSION

Current research on routing protocols for Mobile Ad hoc Networks (MANETs) has converged to several dominating routing protocols. The recent research efforts have made big progress on ad hoc network routing, both in theory and in practical implementation. In our proposed work, a routing protocol reuses the path and also increases the throughput level more than 44-29% of AOMDV and CA-AOMDV protocol. Further it provides an improvement of 6.1% of packet delivery ratio. Theoretical analysis and simulation results show that the proposed LBCA-AOMDV protocol performs better. This yields that the protocol adopts some changes in a network like varying speed of nodes and increased size of the network. The network performance metric gives a better result for the proposed method. Further LBCA-AOMDV protocol will be applied to Quality of Service (QoS). It will be tested with more number of packets and with other network quality metrics.

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