QOS Improvement by Load Balancing using Nodal and Neighboring Load in Multipath Routing

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ABSTRACT:
The Mobile Ad hoc NETwork (MANET) is a collection of wireless mobile nodes. These mobile nodes do not have any fixed network infrastructure or centralized network administration. IP routing protocols determine a route for the data packet so that it should travel across the network and reach the intended destination. The table driven routing protocol pre compute the routes initially, which become stale or invalid due to high mobility. while the on-demand routing protocols concentrate their routing load on few centrally located nodes. One similarity among them is that both use shortest path as their route selection criterion. The heavily loaded nodes in the network lead to congestion and bottlenecks because of dynamic network topology, energy limitation and bandwidth. Frequent link breakages occur due to high mobility. One solution to this problem is to have a routing strategy that could balance and distribute the traffic load more evenly through each mobile node. Existing on-demand ad hoc routing protocols such as AODV and AOMDV does not provide load balancing. Here we propose a load balancing scheme which utilizes the nodal and neighboring information to select a route for the packet to travel across the network to balance the load evenly and avoid congestion and bottlenecks. The load metrics utilized are the number of active paths the node support along with its queue length. As the load is balanced efficiently in the proposed methodology, it improves the packet delivery ratio, throughput and network life time. The overhead of the advertised messages like RREQ is reduced by forwarding them selectively.

Keywords
Load Balancing, Nodal Load Neighboring load.

1. INTRODUCTION
Wireless network are becoming more popular day by day because of mobility. Mobility enables people to move around and still be able to communicate without any physical medium. Along with advantage there are drawbacks also. Wireless networks have dynamic network topology, bandwidth and energy constraints. The network topology changes frequently due to the arbitrary movement pattern of mobile nodes and their capability of entering or exiting the network at any time. The energy constraints are due to the node's physical limit of having scarce battery power. The bandwidth again is the major constraint in lieu of high traffic flow. Mobile Ad-hoc NETworking (MANET) is one of the most common known approaches for wireless communication between two mobile nodes. A mobile ad-hoc network is a collection of wireless mobile nodes and each of these nodes is an individual portable device. Mobile nodes have a wireless interface for communicating with each other in the network through radio waves but without a fixed network infrastructure or centralized network administration.
Mobile ad-hoc networks can be self-configured and self-organized. An IP based mobile node acts as the source or destination of a route for data packets, or behave as a router (intermediate node) that operates together with an routing protocol to discover and maintain routes for forwarding packets to other nodes in the network.

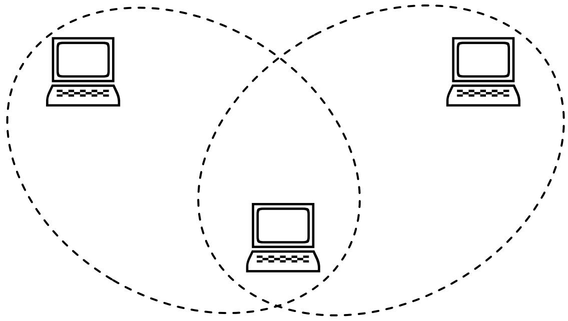

Fig 1.1 Simple adhoc network with three participating nodes

Figure 1.1 above shows the simple adhoc network with three nodes. The outer most nodes range are not within the transmitter range of each other. However the middle node can be used to forward packets between the outermost nodes. The middle node is acting as a router and the three have formed an adhoc network.

2. LITERATURE SURVEY
A load balanced route discovery method based on AODV [1], utilizes fair route relaying method to avoid unfairly burdening of a node which support many route relaying functions. The algorithm classifies the nodes into RSG and not RSG (route serving group). If a node is present in RSG then only it is eligible to receive the RREQ and in turn send RREP. This algorithm uses BPL (balanced Power Level) as a load metric to decide the route selection. AODV based load balancing with route stability [2], proposes a new protocol which utilizes link stability and reverse packet transmission. Here the data packets are balanced among the nodes and the energy consumption is distributed evenly. Stability estimation is done and applied. The proposed Modified Reverse Ad Hoc On-demand Vector (MRAODV), route request packet didn't change and it is like as AODV, but route reply packet is changed for route stability estimation purpose. Thus link stability is applied in RAODV to decrease overhead of discovery and maintenance of routing. A dynamic packet balancing agent in [3] avoids early dying of nodes and in turn network partitioning and communication failure which occurs because of energy depletion of the nodes, when the energy consumption between nodes is not balanced evenly. The HELLO packets are utilized to update energy information

along a path. The updates are done dynamically along each path and the packets are sent via the path with best energy condition. The agent attached with AOMDV outperforms plain AOMDV. Load balancing is achieved in [4], an attempt to avoid congestion by selecting the route on the basis of the queue length. By preserving higher hop count multiple paths, the advantage is increased packet delivery ratio and throughput but at the same time increased average delay because of longest path is taken to forward the traffic. [5] selectively forwards a RREQ based on the load status of a node. A node drops a RREQ within a stipulated time, if it is overloaded and decides that thus is excluded from further communication. Node can be further included when its load dissolves. The scheme utilizes interface queue occupancy and workload within a specific time period to control RREQ messages adaptively. The workload is the mixed information of the length and the residence time of packets in the interface queue. Estimating the channel conditions, [6] characterizes the traffic by considering three parameters channel load , channel access contentions and remaining energy at a node into routing decisions. Also it contributes to better performance considering stability, which is done by determining the energy level associated with a node. Using delay field and cost field [7] provides load balancing with QoS parameters. It performs well under low load conditions, but with increased mobility the delay also increases. Based on AOMDV [8] utilizes loop free and link disjoint paths. A key role is played by threshold here, where every node has to recalculate the threshold based on its current load status. The current load status is the queue occupancy of each node to which the RREQ is sent. An alternative path with minimum hopcount and whose load status is less than the threshold is selected. Based on Multipath AODV [9] reduces the number of route discoveries by distributing traffic through two node-disjoint routes. Only when the two links are broken, the source nodes restart to find new routes. A new metric Buffer size is utilized in [10] for load balancing. The summation of the buffer size determines a less congested route for forwarding packets. QoS are also improved by taking delay into account in terms of received time and transmit time. Overall PDR is increased with reduced end-to-end delay and less traffic overhead. Average aggregated load ration is calculated in[11], to select the route for further communication. This load ratio is calculated by dividing the sum of the packets in interface queue divided by queue length for each node from source to destination divided by the number of hops. This scheme offers improved throughput, reduced average end-to-end delay and improved network lifetime, but is suitable only for moderately loaded high mobility networks. The performance issues of AODV and AOMDV are referenced in [12]. AOMDV incurs more routing overhead and packet delay than AODV but it had a better efficiency when it comes to number of packets dropped and packet delivery.

3 ON DEMAND ADHOC ROUTING PROTOCOL

Currently the two On-demand routing protocols namely AODV and AOMDV are present for MANET.

3.1 AODV

AODV is a single path On-demand routing algorithm for MANET. The route selection algorithm and the routing table

Destination	Sequence Number	Advertised Hop Count	Route List			
			Hop Count 1	Next Hop1	Last Hop 1	Expiration Timeout1
			Hop Count 2	Next Hop2	Last Hop2	Expiration Timeout2
			…	…	…	…

structure is given below.

Algorithm:

If (no route or invalid route or link failure) {

Initiate route discovery;

}

Forward data packet to a route with minimum hops;

}

As shown above AODV initiates route discovery only when the route to the given destination is not present. It does not store any routes in its cache. The route table structure has hop count, sequence number and expiration timeout to determine whether the route to be taken to the destination has maximum sequence number, minimum hop count and has some lifetime remaining or not.

Table 3.1. Routing Table Of AODV

Destination	Sequence Number	Hop Count	Last Hop	Expiration Timeout

3.2 AOMDV

AOMDV is the enhanced version of AODV having multiple paths stored in its cache. If a route fails then immediately another valid route available in the cache is used to forward the packets. The route selection criteria and the routing table structure is given below.

Algorithm:

If (no route to destination) {
Initiate route discovery;
}
Else {
Forward data packet to best route as per advertised hop count and sequence number;
}

In AOMDV if no routes are present in the cache then only the route discovery process is initiated. Else the packet is forwarded as per advertised hop count and sequence number.

As seen above every destination has multiple routes to forward the packets from source towards destination

4 PROPOSED ROUTING STRATEGFY

The present On-demand routing protocols like AODV and AOMDV does not provide any support for load balancing in the network. Hence we propose a routing protocol with load balancing feature. Existing load balancing strategies proposed by different researchers had different types of impact on the overall performance of the network. We had observed that the average end-to-end delay has increased in most of the proposed load balancing strategies. Hence, here our proposed work is focused on the overall performance improvement of the network with decrease in the average end-to-end delay. Our proposed strategy utilizes nodal load and the neighbouring load of the node in the network. We avoid the complexity and keep the design of the protocol simple so that individual node spends less time on processing the packets and thus reduce the average end-to-end delay.

The proposed routing strategy utilizes nodal load and neighbouring load in terms of queue length and the number of active paths. The routing strategy is based on AOMDV with some improvements over the existing protocol. Given below are the modifications done to the existing AOMDV routing protocol.

- *Selective Message forwarding*

The advertised messages like RREQ consume a lot of bandwidth of the channel. To reduce the overhead of these messages we choose to forward these messages selectively. Similarly data packets are also dropped or forwarded. Given below is strategy to either drop the messages or packets

Algorithm: Selective message forwarding

If(currnodeQl > thresholdQl)
Drop message or packet
Else
Forward message as per proposed routing strategy

These messages carry the neighboring node queue length and active path information which is retrieved while forwarding further to update the route information.

- *Route update rule*

Here before applying the basic strategy of updating the route as per AOMDV following algorithm is used.

Algorithm:Route update rule

if (newQl < thresholdQl) and newActvpth < thresholdActvpth) then
Update as per basic AOMDV route update rule and
oldQl=newQl
oldActvpth=newActvpth
Else
Mark the route as invalid or delete the route

- *Proposed Routing algorithm*

The proposed routing algorithm to select a route to forward and data or control packet

Algorithm: (for any message or packet)

If(no route or alternate path)
Initiate route discovery
else for each node
Forward data packet with minimum queue length and minimum active paths
Check most fresh route and best advertised hop count

- *Modified routing table structure*

To maintain the information for every route about its queue length the routing table structure is modified as given below.

Table 4.1. Modified Routing Table Structure of Proposed Strategy

Dstn	Seq No	Advertised Hop Count	Route List					
			Hop Count1	Next Hop1	Last Hop1	Expiration Timeout1	Queue length1	Active paths1
			Hop Count2	Next Hop2	Last Hop2	Expiration Timeout2	Queue length2	Active paths2
			….	…	…	…	…	…

Given below is an example of a network and its modified routing table. The network topology has 9 nodes including the source S and destination D. There are three paths to route a packet from S to D. As per AOMDV the path chosen would be with the minimum hops and the advertised hop count.

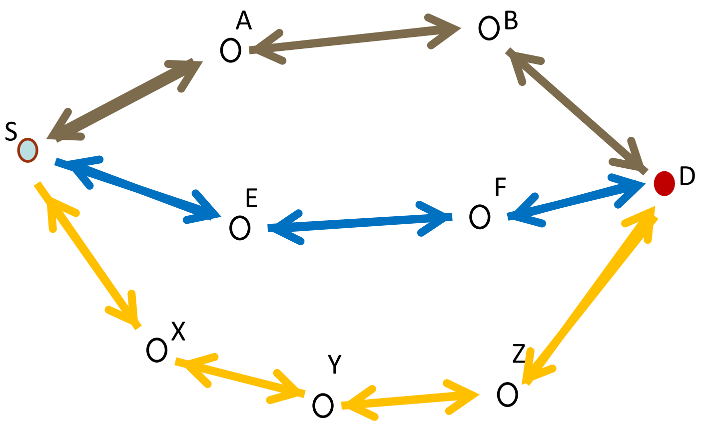

Fig. 4.1. An example of network

Here as per the proposed routing strategy the path which is chosen to route the packet from source to destination is S-A-B-D.

Table 4.2 : Example of modified Routing table

Dst D	Seq N0 1234	Advt Hop Count 4	Route List					
			Hop Count1 3	Next Hop1 A	Last Hop 1 B	Expiration Timeout1 10msec	Queue length 1 30	Active paths1 10
			Hop Count2 3	Next Hop2 E	Last Hop 2 F	Expiration Timeout2 10 msec	Queue length 2 30	Active paths2 15
			Hop Count3 4	Next Hop3 X	Last Hop 3 Z	Expiration Timeout3 10 msec	Queue length 3 50	Active paths3 10

The advantage of the proposed methodology is simplicity and effectiveness in terms of reducing the overhead of control messages and balancing the load evenly with improved throughput and increased packet delivery ratio. Also the average end-to-end delay is reduced

5 PERFFORMANCE ANALYSIS

In order to implement and analyze performance of our proposed algorithm, we used NS 2.34 [14] simulator.NS-2 protocol implementation consist of four steps: (a) Adding a new routing agent which will have base protocol as AOMDV only. (b) Modifying the C++ and OTcl code to implement the proposed routing strategy. (c) Writing and executing an OTcl script describing the network topology with respect to varying load characteristics and mobility patterns to be simulated, and the desired form of output. (d) Analyzing the trace files that are generated and plotting graphs for comparative purpose.

5.1 Experimental Setup

The experimental setup consists of 1000 x 1000 metres area containing of 50 nodes with simulation time of 200 secs. Among 50 nodes, there are 30 source destination pairs to transfer constant bit rate data with a each packet size of 512 bytes. The packet rate/sec is varying from 2,4,6,8 and 10. The pause time is fixed at 50 seconds and the node speed is uniformly distributed between 0 – 20 m/s.

5.2 Simulation results and analysis

Here we examine both the protocols with respect to their packet delivery ratio, end-to-end delay, routing control overhead and average aggregate throughput.

Figure 5.1 shows the packet delivery ratio comparison between each of AOMDV and LBMPR protocols under different traffic loads. The proposed strategy show minimal improvements against the ordinary AOMDV at higher packet rates conditions. This indicates that forwarding packets to different paths according to their load status does improve performance on highly loaded networks, even though the improvement is minimal.

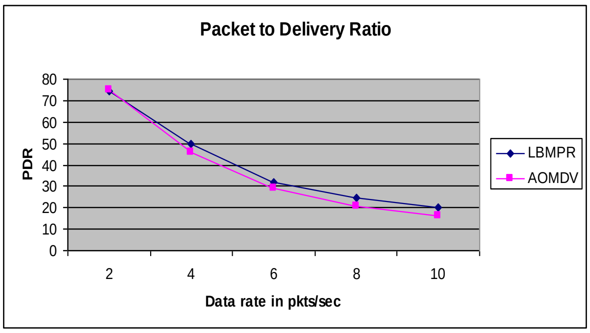

Fig 5.1. Packet delivery ratio with varying packet rate

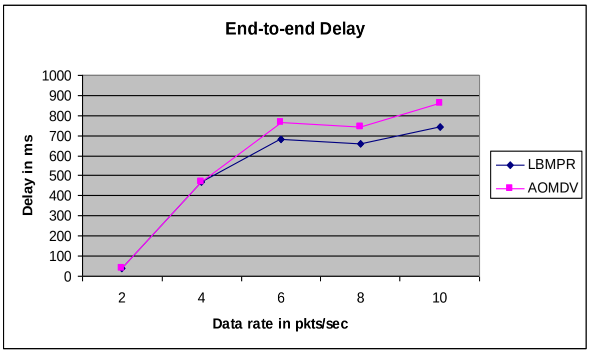

Fig 5.2. End-to-end delay with varying packet rate

Figure 5.2 shows that our strategy reduce the end-to-end delay towards high load conditions, which further proves that our strategy can improve the performance of a network with high traffic load.

Figure 5.3 shows the routing overhead for each AOMDV and LBMPR protocol with minimal improvement.

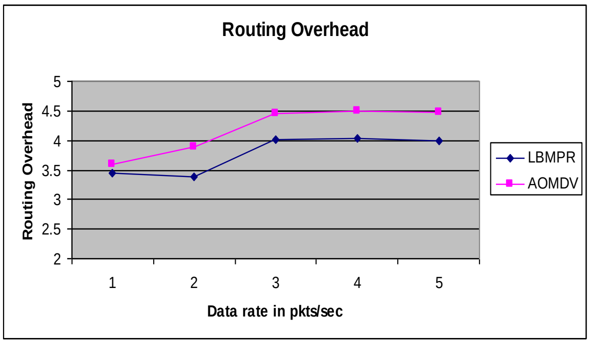

Fig 5.3. Normalized routing overhead with varying packet rate

Figure 5.4 shows the average aggregate throughput for both AOMDV and LBMPR. The proposed routing protocol has improved performance over AOMDV.

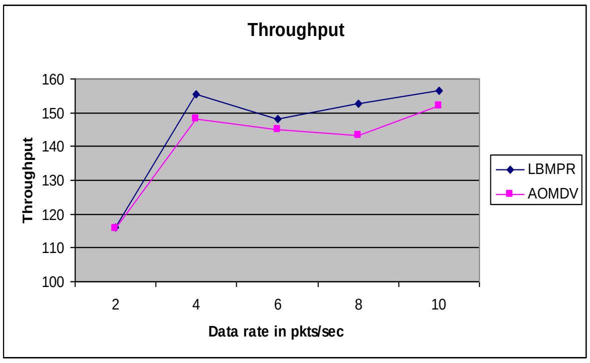

Fig 5.4 Throughput with varying packet rate

6. CONCLUSION

In ad hoc networks, when the load is heavy, the performance of on-demand and table driven routing protocols suffer large degradation in absence of even load balancing. Protocols such as AODV are single path routing protocols has high overhead in terms of more frequent route discoveries due to link breakages under heavy load. AOMDV is an on-demand multipath routing protocol which has better performance as compared to AODV protocol, but this also does not provide load balancing. Under heavy load it is necessary to balance and divert the traffic to avoid congestion and hence reduce packet loss. There are various load metrics used to balance the load in wireless network. The proposed scheme utilizes load metrics as per the load type namely the nodal load and the neighboring load in terms of queue length and number of active paths through the node respectively. The nodal load and neighboring load is useful in determining the load status of a node correctly. Hence depending on the load status of a node the traffic can be balanced without overloading any single node or path. As a result the performance is improved in terms of throughput, packet delivery ratio, average end-to-end delay and network life time as compared to AODV and AOMDV routing protocols.

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