BIJIT - BVICAM's International Journal of Information Technology
Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM), New Delhi (INDIA)

Stable Adhoc on Demand Multipath Distance Vector – SAOMDV

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Submitted in October, 2013; Accepted in September, 2014

Abstract - SAOMDV is a multipath routing protocol for mobile ad hoc network that find multiple paths for the data packet without flooding the entire network with Route request – RREQ packets, but selectively forwarding to only those neighbors that are stable in terms of distance and link. SAOMDV is based on the protocol AOMDV. SAOMDV indentifies the stable neighbors and instead of blindly broadcasting the RREQ packet it receives, it only forwards the RREQ to these stable nodes.

Index Terms – Multipath, On-demand, Selective flooding, Stable routes.

1.0 INTRODUCTION

A Mobile Ad hoc Network (MANET) is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration. MANET nodes are typically distinguished by their limited power, processing, and memory resources as well as high degree of mobility. Routing in one of the main area of research, many routing protocols have been proposed both unipath as well as multipath. The basic categories of routing protocol is either table driven or on demand. All protocols proposed so far fall in one of the category, the basic being Destination sequenced distance vector [1], Wireless routing protocol [2], Dynamic source routing [3], Ad-hoc on demand distance vector [4] to name a few. Various routing protocols are being proposed by incorporating swarm intelligence as in [5], where the routes are selected based on ant agents. Application based routing protocol has been proposed in [6] where route is selected based on the application, it uses a home agent for the selection of the optimal network depending upon the type of session of the mobile nodes.In order to make the best use of the scarce resources that are available in a MANET multipath routing protocols are proposed. Multipath routing protocols provide many benefits in the overall performance of the network in terms of fault tolerance, load balancing, usage of bandwidth and lower delay. Load balancing can be achieved by spreading the traffic along multiple routes. This can alleviate congestion and bottlenecks. Multiple paths are used simultaneously to route data, the aggregate bandwidth of the paths may satisfy the bandwidth requirement of the application [7]. Also, since there is more bandwidth available, a smaller end-to-end delay may be achieved. Results of [8] show that using multipath routing in adhoc networks of high density results in better throughput than using unipath routing.

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We propose an on demand multipath routing protocol Stable Ad hoc On demand Multipath Distance Vector - SAOMDV, based on AOMDV. SAOMDV is capable of finding link disjoint multiple paths which are more stable and robust. In SAOMDV, the mobile ad hoc network is not flooded by RREQ storm for route discovery as flooding route requests often results in broadcast storm (especially when nodes or connections increase) [9]. The remainder of the paper is organized as follows: in thenext section we give a brief overview of the AOMDV protocol. Section III illustrates our protocol SAOMDV in more detail. Section IV presents evaluation of the proposed protocol by simulation in NS2. Section V puts light on future work.

2.0 ADHOC ON DEMAD MULTIPATH DISTANCE VECTOR ROUTING

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) [10] protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. In AOMDV, *RREQ* propagation from the source towards the destination establishes multiple reverse paths both at intermediate nodes as well as the destination. Multiple *RREP*s traverse the reverse paths back to form multiple forward paths to the destination at the source and intermediate nodes. Intermediate nodes also keep track of alternate paths to the destination node. Nodes cannot broadcast duplicate *RREQ*s, so any two *RREQ*s arriving at an intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number. When a route advertisement is received for a destination with a greater sequence number, the nexthop list and the advertised hop count are reinitialized.

AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate *RREQ*s, so any two *RREQ*s arriving at an intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link disjoint routes, the destination replies to duplicate *RREQ*s, the destination only replies to *RREQ*s arriving via unique neighbors. After the first hop, the *RREP*s follow the reverse paths, which are node disjoint and thus link-disjoint.

3.0 STABLE ADHOC ON-DEMAND MULTIPATH DISTANCE VECTOR

3.1 Stable-Neighbor Discovery

The neighbor discovery in SAOMDV is done by broadcasting the Hello packets periodically at the time interval of 1 second [11]. When a node receives a hello packet it examines the received signal strength indicator (rssi), if this value is above the predefined threshold value then the receiving node adds the sender of the Hello packet as a Stable Neighbor. If the rssi value is below this threshold value, then the sender of the hello packet as a Neighbor. The RSSI value for two ray ground model is calculated as given in (1).

$$P\tau(d) = \frac{Pt * Gt * Gr * ht^2 * hr^2}{d^4 * L} \quad (1)$$

Where Pr: Power received at distance d, Pt: Transmitted signal power, Gt: Transmitter gain (1.0 for all antennas), Gr: Receiver gain (1.0 for all antennas), d: Distance from the transmitter, L: Path loss (1.0 for all antennas), ht: Transmitter antenna height (1.5 m for all antennas), hr: Receiver antenna height (1.5 m for all antennas). In SAOMDV routing protocol each node of the network maintains two neighbor list one is the normal neighbor list and another as Stable neighbor list. Also, the neighbor list has an extra field which is a Boolean variable that is set initially as 0 for all nodes and it is set as 1 for stable neighbor. The Stable neighbor cache contains the stable neighbor address, stable neighbor status which is 1 and stable neighbor link. The normal neighbor cache contains the same fields but its neighbor status is set to 0. The algorithm for stable neighbor discovery is given in fig1.

Algorithm 1: Stable Neighbor Discovery
Step1. When a node receives Hello packet, it calculates it rssi value
Step 2.If
rssi value > threshold value
Add the sender node as Stable neighbor, set its status as 1
Else
Add the sender node as normal neighbor, set its status as 0
Step 3. Maintain separate neighbor cache for both types of neighbors
a) Stable Neighbor Cache
b) Neighbor Cache

Figure 1: Stable Neighbor Discovery

3.2 Route Discovery & Maintenance Phase

When a node wants to send a data packet to some other node and it does not have a valid path for that destination node then SAOMDV being an on-demand routing protocol initiates route the discovery phase. In the route discovery phase the source node broadcasts a route request packet (RREQ) in the network. When this RREQ packet reaches a node then this nodes first checks whether or not it has received this rreq before. If it has already received this rreq packet before then it does not forward it because it is a loop. The nodes check whether the rreq packet is destined for itself it generates a route reply packet (RREP) and uni casts it towards the source node via the reverse route formed by the RREQ packet.If the receiver of the RREQ packet is just a intermediate node then it forwards the RREQ packet to the set of stable neighbors instead of broadcasting it in the entire network. By doing so the network is stormed by RREQ packets saving the networks resources like energy of the nodes, congestion of the network and reduction in control overhead. Also from the list of stable neighbors only those stable nodes are chosen whose link queue occupancy is below a particular threshold value. By doing so only those nodes are allowed to take part in route discovery whose link quality is good as compared to other nodes.Also before forwarding the RREQ packet we adopt a cross layer approach by forwarding the RREQ only if the MAC layer is idle and not otherwise. By doing so again the number of retransmissions of RREQ packet is reduced. As retransmission of control packets only add up to the network congestion level. The algorithm for forwarding the RREQ packet at the intermediate node is as given in figure 2.

The reverse path links are also set up as the RREQ packet traverses the network. If the intermediate node has a path to the desired destination then it can generate a route reply packet and unicast it to the source node.

Algorithm 2: Forwarding of RREQ packet
When a node recives rreq packet
Step 1. Checks whether it has received rreq packet before.
A) If yes, the rreq packet is dropped.
B) If no, it checks if it is the destination node, if it is then it generates a rrep packet for the source node.
Step 2. If it is not the destination node then it should be one of the intermediate node
Step 3. It looks up in its stable neighbor cache and selects only those stable neighbors for forwarding the rreq packet whose link buffer occupancy is below a threshold value.
Step4. Before actually forwarding the rSreq packet the node senses the medium and forwards only when the mac layer is idle.

Figure 2: Forwarding of rreq packet

Once the stable routes are established between a source and a destination pair of nodes via stable neighbors as intermediate nodes, they are used for data transfer in the mobile ad hoc network. SAOMDV finds link disjoint paths which are more stable, thus lowering the probability of failure. If there happens a link breakage as it is common in mobile ad hoc networks because of changing topology and unpredictable nature of the wireless medium. In the case of route breakage, a route error (RERR) message is generated by the intermediate node and is sent upstream to inform other nodes about the route failure.

The route maintenance in SAOMDV is similar to that of AOMDV.

4.0 PERFORMANCE EVALUATION

4.1 Simulation Environment

Comparative simulation for both the protocols AOMDV and SAOMDV are carried out on Network Simulator-2 [12]. The simulation scenario is summarised in table 1. The traffic is constant bit rate (cbr) at 4.0 packets/s, size 512 bytes. The traffic density is dense comprising of 50 sources. The node's maximum speed of 20m/s, the variation in mobility is achieved by changing the pause time of the nodes from 0 (highly mobile) to 500 (quasi static). The dimension of the topography is 1000 x 1000 and the simulation is carried out for 500 s. The radio propagation model used is Two Ray Ground and the Mac is specified as IEEE802.11.

Simulation time	500 seconds
No. of nodes	50
Topology	1000 x 1000
Traffic type	Cbr
Rate	4.0 packet/s
Pause time	0, 100, 200, 300, 400,500
No. of connections	50
Radio Propagation Model	Two Ray Ground
Mac type	IEEE 802.11

Table 1: Simulation Parameters

4.1 Simulation Results

In order to analyze the simulation results of SAOMDV in MANET, we compare its performance with AOMDV in terms of packet delivery ratio, end-to-end delay and number of dropped packets.

A. Packet delivery fraction: The fraction of the data packets delivered to the destinations to those generated by the sources.

B. Average end-to-end delay of data packets: It is defined as the mean time in seconds taken by the data packets to reach their respective destinations.

C. Number of Dropped Data Packets: Packet loss occurs when one or more packets of data travelling across a network fail to reach their destination. Reasons for packet loss can be many ranging from unpredictable nature of the wireless medium or route breakage.

Figure 4 shows the packet delivery ratio of SAOMDV being much higher than that of AOMDV as the routes used for data transfer are much more stable comprising of only stable nodes as defined in the protocol.

5.0 CONCLUSION AND FUTURE SCOPE

In this paper we have proposed a multipath routing prtocol which is capable of finding stable paths in the mobile ad hoc network. Also, by simulation we have comapred the performance of SAOMDV and AOMDV. It can be seen that performance of the proposed protocol is much in terms of packet delivery ratio, end-to-end delay and packet loss.In the future work, we will incorparate Energy conservation in SAOMDV, so as to make the proposed protocol power efficient. Also, performance of SAOMDV will be tested under varoius conditions such as by varying traffic pattern and scalibility of the protocol.

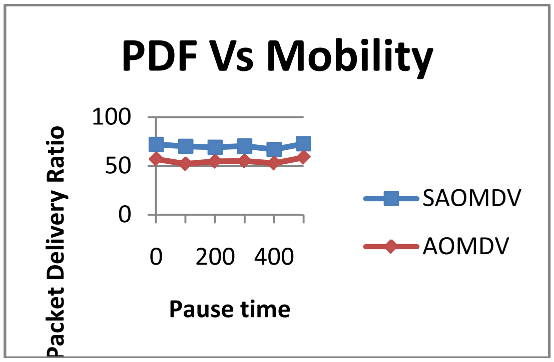

Figure 4: PDF Vs Mobility

Figure 5 demonstrates the end to end delay for the scenario that shows that SAOMDV has much lesser end to end latency as compared to the AOMDV routing protocol.

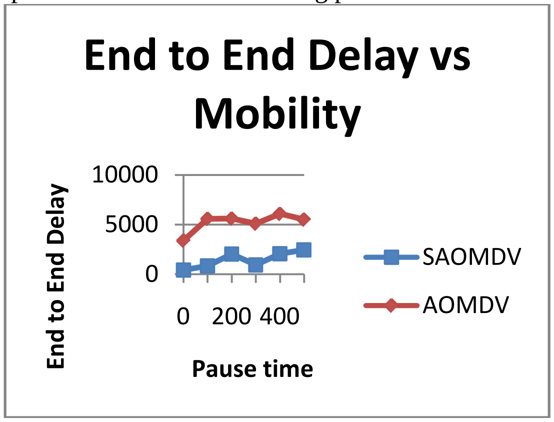

Figure 5: End to End Delay Vs Mobility

In figure 6 the number of dropped data packets are shown, again in SAOMDV the loss of data packets is much much lower than that in AOMDV.

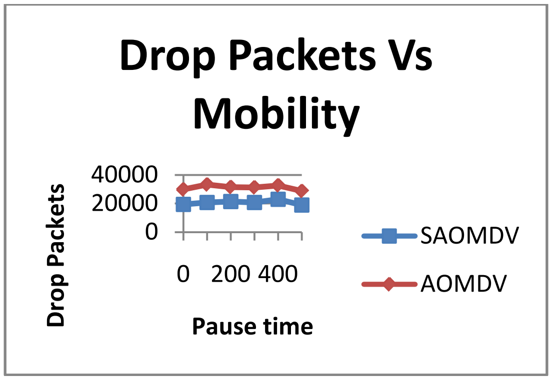

Figure 6: Drop Packets Vs Mobility

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