QoS Improvement in AOMDV Through Backup and Stable Path Routing

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***Abstract*—A Mobile Ad-Hoc Networks (MANET) is a collection of mobile nodes that can communicate with each other using multi-hop wireless links without utilizing any fixed base-station infrastructure and centralized management. Each mobile node in the network acts as both a host generating ows or being the destination of flows and a router forwarding flows directed to other nodes. Selecting a long route that satisfy the quality of service criteria in MANET is very critical task. In this paper we propose a new Backup and Stable path Ad-hoc on Demand Multi-path Distance Vector (BSAOMDV) routing which is an enhancement of ad-hoc on demand multi path distance vector routing (AOMDV) protocol. It design in such a way so that it selects the long lasting , and delay sensitive path for data communication. In BSAOMDV we also modified the protocol in such a way so that it generates the destination of the source node when the number of alternate path becomes zero.This protocol is compared with the Ad-hoc on demand multi-path distance vector routing protocol. we use ns2 simulator for simulation. From the simulation we obtained that our new protocol BSAOMDV outperform than AOMDV in packet delivery ratio and throughput. And also similar or better for lower mobility i.e. mobility speed less than 15 m/s.**

Keywords: AOMDV, BSAOMDV, QoS(Quality of Service), backup path routing, stable path.

I. Introduction

A Mobile Ad-Hoc Networks (MANET) is a collection of mobile nodes that can communicate with each other using multi-hop wireless links without utilizing any fixed base-station infrastructure and centralized management. Each mobile node in the network acts as both a host generating flows or being the destination of flows and a router forwarding flows directed to other nodes.

A fundamental problem in ad hoc networking is how to deliver data packets among nodes efficiently without predetermined topology or centralized control, which is the main objective of ad hoc routing protocols. Each node in the network functions as both a host and a router, and changes of network topology are distributed among the nodes. Design of efficient and reliable routing protocols in such a network is a challenging issue.

MANET routing protocols could be broadly classified into two major categories: Proactive , Reactive and hybrid routing protocol. Pro-active routing: In which nodes in a wireless ad hoc network should keep track of routes to all possible destinations so that when a packet needs to be forwarded, the route is already known and can be used immediately. examples are DSDV (destination sequenced distance vector routing) protocol [1],OLSR(Optimized Link State Routing Protocol) [2]. Re-active routing: When a node wants to send packets to some destination but has no routes to the destination, it initiates a route discovery process within the network. Once a route is established, it is maintained by a route maintenance procedure until the destination becomes inaccessible or until the route is no longer needed. Examples are DSR (dynamic source routing) [3], AODV (Ad-hoc on demand distance vector) [4] Re-active routing protocols are more efficient than pro-active routing protocol because in re-active protocol the node is active when it have something to send and it does not maintain continuously updated routing table for the node whom it never communicates. Hybrid Routing protocols combine the advantages of both pro-active and re-active routing, by locally using pro-active routing and inter-locally using re-active routing. This is partly based on the assumption that most communication in mobile ad hoc networks takes place between nodes that are close to each other, and the assumption that changes in topology are only important if they happen in the vicinity of a node. When a link fails or a node disappears on the other side of the network, it has only effect on local neighborhoods, nodes on the other side of the network are not affected. The ZRP [5] is an example of a hybrid routing protocol.

Also routing protocol can be classified in single path and multipath routing. single path routing protocol maintains a single path for communication like AODV, DSR, DSDV etc. While on multipath routing allows the establishment of multiple paths between a single source and single destination node during a single route discovery. Like Adhoc on demand multipath distance vector routing (AOMDV), Multipath source routing (MSR) etc. QoS is a collection of characteristics or constraints that a connection must guarantee to meet the requirements of an application [6]. A connection can be characterized by a set of measurable requirements such as minimum bandwidth, maximum delay, maximum delay variance (jitter), and maximum packet loss rate. After accepting a connection request from the user, the network has to ensure that the requirements of the users flow are met throughout the duration of the connection [7]. Challenges those affect the QoS provisioning in ad-hoc network are

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(1) Limited wireless transmission range (2) Routing Overhead (3) Battery constraints (4) Asymmetric links (5) Time-varying wireless link characteristics (6) Broadcast nature of the wireless medium (7) Mobility-induced route changes and (8) Potentially frequent network partitions. In the next section we give a brief introduction about AOMDV which is our basic routing protocol which we will modify. Figure 1 shows the classification of Adhoc routing protocols:

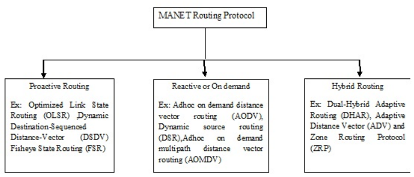


Fig. 1. Simulation Results

A. Ad hoc On-demand Multipath Distance Vector(AOMDV)

AOMDV [8] is an extension to the AODV protocol for computing multiple loop-free and link-disjoint paths. The protocol computes multiple loop-free and link-disjoint paths. Loop-freedom is guaranteed by using a notion of advertised hop count. Link disjointness of multiple paths is achieved by using a particular property of flooding.

To keep track of multiple routes, the routing entries for each destination contain a list of the next-hops together with the corresponding hop counts. All the next hops have the same sequence number. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths. This is the hop count used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternative path to the destination. To ensure loop freedom, a node only accepts an alternative path to the destination if it has a lower 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 ame sequence number. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and advertised hop count are reinitialized. AOMDV can be used to find link-disjoint routes.

II. Related Work

A significant research effort has been observed in recent years on providing quality of service (QoS) and finding stable in mobile ad hoc networks. We can categorize them into four different types based on their working principles.

The first category of works use backup route(s) on the failure of primary route. In AODV with backup routing (AODV-BR) [10] and multi-path AODV [8], source nodes create alternative routes to the destination, and on failure of any one of them, nodes deliver data packets using an alternative route; however, they suffer from two problems: stale route and duplicate packet transmission. In AODV-based backup routing scheme(AODV-BBS) [10], each node maintains two hop neighborhood information for finding alternative routes, but the maintenance of multiple alternative paths is difficult, costly, and time-consuming, which in turn reduces data delivery performances of the network.

The second category of routing protocols uses stable routes for data forwarding. RSQR [11] to provide QoS (delay and throughput) assurance to applications in MANETs. The use of a simple route stability model in the proposed routing significantly reduces the number of route recoveries required during QoS data transmission. Stability model uses cross layer approach for finding stable path using link signal strength.

The third category of routing protocols uses multiple routes to balance traffic loads on the event of congestion or route failures and thus improve the network performance. For example, a distributed multi-path dynamic source routing (DSR) protocol [13] improves QoS with respect to end-to-end reliability; SMR [] uses multiple routes to split traffic and mitigate congestion; nodes in CRP [14] use bypass routes to mitigate congestion, AODVM/PD [16] that can find paths with lower correlation factor, optimized AOMDV [15] that can solve the route cutoff problem in AOMDV by using a new control packet RREP ACK. This control packet has been defined in AODV, but it is often ignored, and we generally do not apply it.

The Fourth category of routing protocol uses QoS matrices like throughput, delay and packet loss. Providing QoS guarantees in MANETs is a very challenging task. Indeed node movement (i.e. network topology changes), low bandwidth, interferences and collisions, make it very difficult to meet QoS constraints imposed by real-time and multimedia applications. Adaptive Quality of Service Routing (AQR) [17], QoS is achieved by coupling on-demand routing with resource reservation and maintenance. It is also point out that the problem of finding a path with two independent constraints (QoS matrices) is a NP-complete problem. AQOR [18] proposes an adaptive route recovery model when a QoS violation is detected. This model makes the destination do a reverse route exploration. AQOR also includes efficient mechanism for QoS maintenance and destination initiated recovery process. Because of its instant QoS violation detection and recovery mechanisms.

The aforementioned protocols can handle congestion, provide most stable path for data transmission as well as it also gives admission control scheme so these ensure quality of service provisioning in MANET. No papers in literature survey combine all four metric's i.e. backup route construction, multipath routing, stability aware and QoS provisioning. We propose a backup and stable path ad-hoc on demand multipath distance vector routing (BSAOMDV), in which each node check delay admission control and link information to construct path from source to destination. Also protocol uses multi-path routing to provide alternate path when the primary path fails. And also it uses backup route scheme which guarantee at least one valid path from source to destination for most of the time.

III. Backup and Stable path Adhoc Ondemand Multipath Distance Vector Routing (BSAOMDV)

A. Terminology

We calculate the received signal strength on TwoRayGround propagation model on the following formula [?].

$$P_r(d) = \frac{P_t G_t G_r {h_t}^2 {h_r}^2}{d^4 L}$$

Where ht and hr are the heights of the transmit and receive antennas respectively. Note that the original equation in assuming L = 1.

B. Assumption

We make no assumptions about the global state of the network at the nodes. Instead we propose an on-demand distributed routing algorithm where all the nodes contain only information about their one hop neighbors. The following network model assumptions are made.

1. Neighborhood is commutative property i.e. if node A can hear node B this implies node B also hear node A

2. CSMA/CA like MAC protocol is used for reliable unicast communication and it solves the hidden terminal problem with the help of RTS-CTS control packets.

3. There is a close interaction between MAC layer and Network layer

4. Hello intervals to update neighbor information is reasonable to capture the dynamics of the network

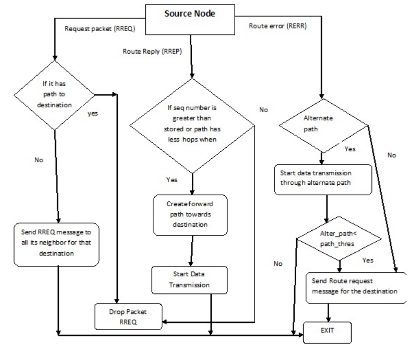
5. Transmission range and carrier sensing range are assumed to be same for available bandwidth calculation at a node

6. Initial route discovery latency is tolerable in applications.

C. Protocol Working

Protocol behavior can be classified in two ways (1) Route Discovery (2) Route maintenance. Route discovery and maintenance mechanism are done in source intermediate and destination node respectively.

1) Operation performed at source node: In this section, we outline the algorithms that need to be executed at each node to compute a Route Stability based QoS route between a given pair of source and destination. If node have to send data packet to any other node it will firstly find out the route available in the routing table. If path from source to destination does not exist then generate route request (RREQ) message for the destination. To compute a QoS route to a destination D, the source S generates Route Request (QRREQ) packet with values for Dmax from the applications requirements. The other fields are specified as 0 for ADELAY and seqno field is incremented. Rest of the fields are used as in AODV. If the source node does not receive route reply (RREP) message with in timeout period then it regenerate RREQ message for destination. If it receives RREP message from destination then it updates the route and start data transmission. If the source node receives RERR message in between the data transmission



node.jpg

Fig. 2. Operation performed at source node

then it uses alternate route for data transmission. If the number of alternate route is less than path_thresh then it re-initiates RREQ so that node has route for the destination most of the time. Figure 2 shows the operation at source node.

2) Operation at Intermediate node: An intermediate node i , after receiving a RREQ packet, check the signal strength of RREQ and simply drops the packet if its strength is very poor (less than a threshold Thr1). Otherwise, the node i perform the delay admission control. If the RREQ passes delay admission control, node i update signal information in RREQ packet and forward it to their neighbors. An intermediate node I , after

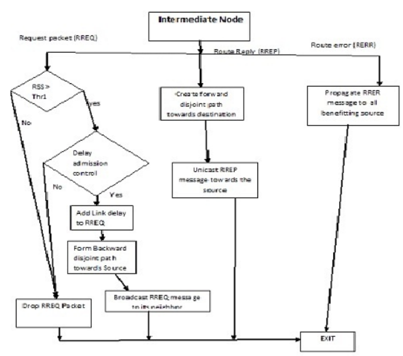


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Fig. 3. Operation at Intermediate node

receiving a RREP packet, check the signal strength of RREQ and simply drops the packet if its strength is very poor (less than a threshold Th12). Otherwise, the node i perform the delay admission control. And then interme- diate node unicast the RREP packet to its upstream neighbor. When the route break is detected in the intermediate node it will start sending local repair message to its neighbor if alternate route is found then use that route for data transmission otherwise send route erreor message to the source. Operation at intermediate node is shown in Figure 3.

3) Operation at Destination node: Destination node may receive multiple RREQ packets that reach the destination by following different candidate routes. Destination node, after receiving a RREQ, performs admission control and computes route stability as performed by an intermediate node. After that add total signal strength value in RREP and send RREP for each RREQ request as performed in AOMDV. Operation at Destination node is shown in Figure 4. Receiving the route

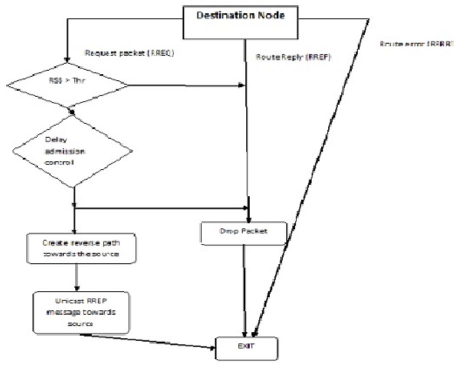

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Fig. 4. Operation at Destination node

reply and route error message it simply discards the RREP and RERR message respectively.

IV. Result and Discussion

A. Performance Metrics

Packet Delivery Ratio The packet delivery ratio in this simulation is defined as the ratio between the number of packets sent from constant bit rate sources (CBR, application layer) and the number of receiving packets by the CBR sink at destination. End to end Delay: this metric represents an average end -to-end delay and indicates how long it took for a packet to travel from the source to the application layer of the destination. Throughput: Throughput is total packets successfully delivered to individual destinations over total time. Normalized Routing overhead: the total number of routing packets transmitted per second. Each hop-wise transmission of a routing packet is counted as one transmission.

B. Simulation Scenario

The extended backup and stable path adhoc on demand routing protocol is implemented using the NS-2 network simulator [18] by modifying the code of AOMDV protocol. AOMDV protocol already exists in the network layer. A modification is also done in the MAC layer to capture the signal strength. In BSAOMDV the packet structure of RREQ is changed to carry required delay information. Simulations are run for scenarios with different mobility of a node.

C. Simulation Result

In figure Throughput of BSAOMDV gets increased significantly when compared with AOMDV. In Figure 6 throughput of BSAOMDV is high than AOMDV for the entire simulation time. As well as Packet delivery ratio value is also better than AOMDV due to the effect of adding signal strength and delay as a constraints for a node to choose QoS path from the source

TABLE I
SIMULATION PARAMETER

Simulation Parameter	Value
Simulation area	1000mX1000m
Number of nodes	50
Number of flows	10
Mobility model	Random WayPoint
Pause time	0
Rate (kbps)	70
Thr2	1.2*RxThr
Packet size (B)	512
Simulation time (s)	400
Traffic type	CBR (Constant bit rate)
Maximum node speed (m/s)	0-20
MAC layer	IEEE 802.11 DCF
Propagation model	Two-ray Rayleigh fading25-200

to the destination. As well as we also apply Bakup path routing , that guarantees, BSAOMDV provide alternate path to a node by its routing strategy most of the time. Figure 5 and Figure 6 is shown the behavior of AOMDV and BSAOMDV on mobilty variation of node.

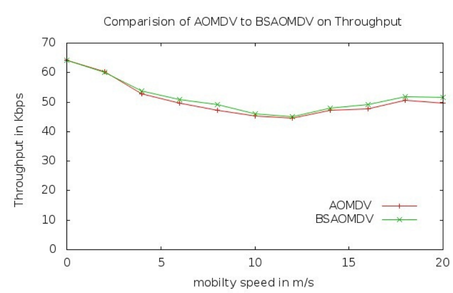

Fig. 5. Throughput over speed

From the simulation result of Figure 7 we see that CONTROL OVERHEAD OF BOTH THE PROTOCOL are same but for higher mobility the control overhead in the network is increased due to the frequent route breakage so nodes are frequently generate route request, route reply and route error message. But the increasing of the control packet is not more exceeded because stability constraint as well as delay admission control in the protocol functions. In Figure 7 shows control overhead in both AOMDV and BSAOMDV on varying mobility speed. The other quality of service metric is end to end delay. In Figure 8 we see that end to end delay of both protoc is similar for mobility speed of 15 but for higher

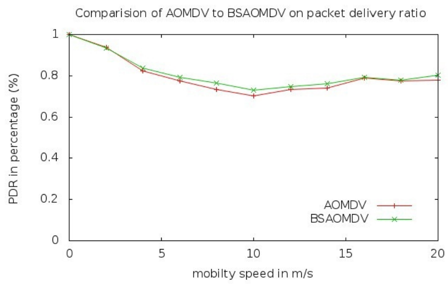

Fig. 6. Simulation Results on PDR over mobility speed

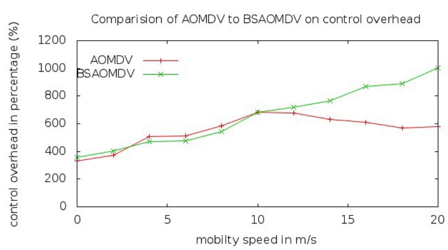

Fig. 7. control overhead over mobility speed

mobility BSAOMDV end to end delay is greater than AOMDV because in BSAOMDV we apply delay admission control in formation. This delay admission control guarantees that BSAOMDV selected path is always satisfy the delay quality of service. On the other hand AOMDV does not guarantee about that. End to end delay with varying mobility is shown in Figure 8.

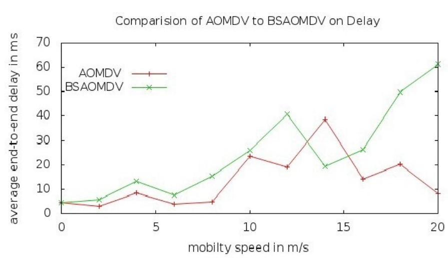

Fig. 8. Simulation Results on Delay over mobility speed

V. Conclusion

A novel Backup and Stable path AOMDV protocol is proposed, Algorithm have been discussed for the processing of route request and route reply as the source , intermediate and destination node. The proposed protocol has been following features:

1. The proposed protocol BSAOMDV is multi-path routing protocol which provides increased reliability, enhanced fault tolerance and efficient load balancing on a different path.

2. It provides guaranteed quality of service (QoS) in terms of delay.

3. It provides alternate backup path (through backup routing) which help in the continuous flow of data.

4. It finds the stable path by using received signal strength metric, this helps to reduce link breakage which occurs frequently due to dynamic network topology.

simulation result shows that proposed protocol performs better than AOMDV in terms of performance metrics like throughput, packet delivery ratio and end to end delay.

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