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Performance and Improvement of MANETs Routing Protocols

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ABSTRACT: Mobile ad hoc networks are characterized by lack of infrastructure, random and quickly changing network topology; thus there is a need for a robust dynamic routing protocol that can accommodate such an environment. At the same time as the emergence of multimedia in mobile ad hoc networks, research for the introduction of the quality of service (QoS) has received much attention. However, when designing a QoS solution, the estimation of the available resources still represents one of the main issues. In this paper, we propose an approach to estimate available resources on a node and so of the route between a pair of source and destination. We consider several parameters to find the performance of the network as packet delivery fraction, end-to-end delay, normalized routing load and throughput. We also performed an evaluation by simulation using NS2 simulator. The simulation results confirm that the proposed extension of AODV gives assurance for QoS by utilizing the available bandwidth.

I. INTRODUCTION

Mobile ad-hoc networks have gained a lot of importance in wireless communications. Wireless communication is established by nodes acting as routers and transferring packets from one to another in ad-hoc networks. Routing in these networks is highly complex due to moving nodes and hence many protocols have been developed. Future wireless networks will carry diverse multimedia applications such as voice, video and data. In order to provide quality delivery to delay sensitive applications such as voice and video it is imperative that mobile ad hoc networks (MANETs) [1], provide quality of service (QoS) support in terms of bandwidth and delay [2]. QoS provision in MANETs is a challenging task since in addition to obeying QoS constraints we must account also for a dynamic topology and shared wireless medium.

Among the QoS issues for ad hoc networks which have recently started to receive increasing attention in the literature is the QoS routing. This is a complex and difficult issue because of the dynamic nature of the network topology and generally imprecise network state information. Algorithms that provide QoS support in MANETs should include the following features: (1) accurate measurement of bandwidth availability of the path from source to the destination and accurate measurement of effective delay in an unsynchronized environment, (2) instant QoS violation detection and (3) fast and efficient route recovery.

In order to monitor the forwarding of the packet and that a route is about to break, the communication is based on the bandwidth of the forwarding node. Therefore, the quality of the route is measured. Based on the measured quality of the route, the link breakage can be assumed.

The organization of the paper is as follows: Section 2 discusses an Overview of AODV. Section 3 discusses related work. Section 4 presents the proposed approach. Section 5 discusses simulation environment setup. Section 6 discusses simulation results and finally Section 7 conclusion of the paper.

II. OVERVIEW OF AODV

Ad Hoc On-demand Distance Vector Routing (AODV) protocol [10] is a reactive routing protocol. As a reactive routing protocol, it maintains only routing information about the active paths. Every node uses hello messages to notify its existence to its neighbours and maintains routing information in their routing tables to keep a next-hop routing table that contains the destinations to which it has a route. In AODV, when a source node wants to send packets to the destination but no route is available, it initiates a route discovery operation. In the route discovery operation, the source broadcasts route request (RREQ) packets. A RREQ includes addresses of the source and the destination, the broadcast ID, the last seen sequence number of the destination as well as the source node's sequence number.

The dynamic route table entry establishment begins at all the nodes in the network that are on the path from source to destination [9]. As RREQ travels from node to node, it automatically sets up the reverse path from all these nodes back to the source. Each node that receives this packet records the address of the node from which it was received. This is called Reverse Path Setup. The nodes maintain this info for enough time for the RREQ to traverse the network and produce a reply to the sender and time depends on network size. If an intermediate node has a route entry for the desired destination in its routing table, it compares the destination sequence number in its routing table with that in the RREQ. If the destination sequence number in its routing table is less than that in the RREQ, it rebroadcasts the RREQ to its neighbors. Otherwise, it unicast a route reply packet to its neighbor from which it was received the RREQ if the same request was not processed previously (this is identified using the broadcast-id and source address). Once the RREP is generated, it travels back to the source, based on the reverse path that it has set in it until traveled to this node. As the RREP travels back to source, each node along this path sets a forward pointer to the node from where it is receiving the RREP and records the latest destination sequence number to the request destination. This is called Forward Path Setup.

If an intermediate node receives another RREP after propagating the first RREP towards source it checks for destination sequence number of new RREP.[7] The intermediate node updates routing information and propagates new RREP only. If the Destination sequence number is greater, OR If the new sequence number is same and hop count is small, OR Otherwise, it just skips the new RREP. This ensures that algorithm is loop-free and only the most effective route is used.

III. RELATED WORK

Many proposals and models addressed quality of service (QoS) among mobile nodes of the ad hoc networks and considered the link quality in their designs and approaches. To provide QoS, AQOR [9] (Ad hoc QoS on-demand routing (AQOR) in mobile ad hoc networks)integrates (1) on-demand route discovery between the source and destination, (2) signaling functions for resource reservation and maintenance, and (3) hop-by-hop routing. In general, signaling protocols for resource reservation-based approaches, like RSVP [3](Resource Reservation protocol), contain the following three steps: connection establishment, connection maintenance and connection tear-down. Due to the dynamic feature of MANET [8v], the connection maintenance overhead (which includes violation detection, recovery and connection tear-down of the old path) usually outweighs the initial cost of connection establishment. Because of the limited bandwidth in wireless networks, end-to-end signaling should be kept at a minimum. To reduce signaling overhead, an in-band signaling approach is proposed in [4]. In AQOR, the following design decisions that reduce the connection maintenance overhead are: (1) AQOR facilitates QoS violation detection at the destination of the connection who can detect the flow's actual QoS, without the need of additional signaling; (2) the routing adjustment overhead due to QoS violations, is reduced by employing destination-initiated recovery; (3) the requirement for connection tear-down process, along the old path before route adjustment, is eliminated by the temporary reservation mechanism.

BRuIT (Bandwidth Reservation under Inerferences) [5], a passive approach as well, takes into account the whole knowledge of interferences. In fact, BRuIT is a distributed signaling protocol which achieves this goal by periodically sending messages containing information on bandwidth availability and provides a mechanism to reserve bandwidth for transmissions. BRuIT [5] provide to the nodes information about their neighbours by broadcasting periodically hello messages. Hello packet not only includes information about the transmitter but also about every node at a distance of k hops from the transmitter. k, width of the extended neighbourhood that consider (in other words the propagation range of the information) is a parameter of the protocol. The Hello packets are propagated within two hops.

Optimized Reliable Ad hoc On-demand Distance Vector [6] (ORAODV) scheme that offers quick adoption to dynamic link conditions, low processing and low network utilization in ad hoc network. By implementing Blocking Expanding Ring Search (Blocking-ERS) and retransmission of data packet in ORAODV, it provides satisfactory performance in term of packet delivery ratio (PDR), normalizing routing load (NRL) and delay for different network density in term of number of node, various mobility rates.[6]

In this paper we improved the reliability and effectiveness of the route by modifying the route selection process in the route discovery of conventional AODV routing protocol for MANET.The route selection is based on the bandwidth of the node and link delay rather than the number of hop count , that is based in the conventional AODV routing protocol.

IV. PROPOSED PROTOCOL

The proposed protocol works like the on-demand principle of route discovery. We have modified the AODV RREQ message with two additional information that are available bandwidth of the node and link delay. While a node receives the route request, it also has the information of the available bandwidth of that node and its delay. If that bandwidth value is greater than the specified threshold bandwidth value then only that node update the same RREQ message with its available bandwidth and delay values and forward the packet along the path. If the node takes part in the route reply process, then it stores these two values in the buffer if that bandwidth value is the best received value and sends RREP along the reverse path.

A. Packet formats

The RREQ packet consists of the following fields: source ID, Intermediate ID, Destination ID, Required Bandwidth, Delay, and Request ID. The source node fills the field value in the RREQ packet and broadcast it to the neighboring nodes. When an intermediate node received the RREQ packet, it compares among all other RREQ received from the neighboring nodes, and records the bandwidth information of the route that meets the required bandwidth, and has low accumulated delay. In a similar fashion, the RREQ packet are updated at every intermediate node and re-broadcasted to its neighboring nodes till it reaches the destination. Every intermediate node has a table that keeps the optimum route with best bandwidth values that meets the QoS requirements. This route will eventually be traced back using the RREP in unicast nature.

B. RREQ Packet

Source ID	Intermediate ID	Destination ID	Required bandwidth	Bandwidth	Delay	Request ID

C. RREP packet

Source ID	Intermediate ID	Destination ID	Request ID

D. Route Parameters

In order to select an optimum path this protocol uses two QoS parameters: available bandwidth (B_A) in terms of data rate and delay. The available channel bandwidth is calculated using the transmitter utilization parameter directly from the PHY layer. The available bandwidth of the node is calculated on the basis of number of transmission attempts. The link delay is calculated after reception of every RREQ by using the RREQ packet creation time information and reception time.

E. Route Discovery Process

The route discovery process begins when a source node needs a route to some destination. It places its own ID, destination ID, required bandwidth and request ID in RREQ packet. This packet also contains the node's available bandwidth and link delay. The receiving node will compare this RREQ packet and update its table entry. When processing the received RREQ from neighboring nodes, the current node selects the route that meets the required bandwidth and low accumulated delay.

At the destination multiple RREQs will arrive and it may have a list of qualified routes. In this case, destination will choose the best path which meets the requirements and send RREP packet. When the next node receives the RREP sent by destination, it shall check the Request-ID to search for corresponding table-ID and then update the intermediate-node-field in the RREP and unicast again. This process is repeated and RREP fields are updated from node to node until the original source is reached.

V. SIMULATION ENVIRONMENT

The simulation experiment is carried out in LINUX (ubuntu 10.4). The detailed simulation model based on network simulator-2 (ver-2.35), is used in the evaluation. Table 1 shows the simulation parameters. In this simulation, each packet starts its journey from a random location to a random destination with a randomly chosen speed (uniformly distributed between 0–20 m/s). Simulations are run for 50s, 100s, 150s, 200s, 250s and 300s simulated for 100 nodes under CBR traffic pattern. The weight factor α is defined as 0.65.

Table 1: Simulation Parameters.

Parameter	Values
Dimensions	1000m×1000m
Traffic type	CBR
Number of nodes	100
Simulation Time	500s
Pause Time	50, 100, 150, 200, 250, 300, 350, 400, 450, 500
Total Sources and Connections	49 and 71
Maximum Speed of Nodes	20m/s
Packet rate	4pkts/s
Packet size	512 byte
Mobility model	Random Waypoint Model
Channel bandwidth	2Mbps

A. Performance Metrics

To evaluate the performance of routing protocols, we use three different metrics to compare the performance of the new protocol with the existing AODV routing protocol. They are:

(i) Packet delivery fraction (PDF). The ratio of the data packets delivered to the destinations to those generated by the sources.

(ii) End-to-end delay (E2E Delay). The end-to-end delay of data packets refers to the time taken for a packet to be transmitted across a network from source to destination.

(iii) Normalized routing load (NRL). The normalized routing load measured by the total number of routing packets sent divided by the number of data packets delivered successfully.

(iv) Throughput (THPT). The amount of data packets received at the destination per unit time.

VI. SIMULATION RESULTS

The performance results of AODV and B-AODV for 100 nodes and the comparison of new protocol with the existing AODV protocol are given below in Table 2.

Table 2.

Simulation time (s)	B-AODV				AODV			
	PDF (%)	E2E Delay (s)	NRL	THPT	PDF (%)	E2E Delay (s)	NRL	THPT
50	95.7252	0.179618	2.33675	741.715	97.7077	0.394327	0.926	576.1033
100	97.78908	0.096828	1.225	1341.11	94.81823	0.4145	2.167333	898.3833
150	98.60465	0.064854	0.9725	1849.96	91.95667	1.483067	2.874	984.6033
200	98.96743	0.04293	0.6425	2383.583	86.753	2.4053	2.983	1112.53
250	99.29373	0.043565	0.55575	2806.363	84.23907	3.163833	4.09	1234.977
300	99.2892	0.033887	0.50725	2957.393	82.91017	3.84716	5.063667	1296.73
350	99.2877	0.034037	0.44425	3246.37	82.18467	4.296667	5.823333	1350.05
400	99.6626	0.06817	0.45075	3269.065	80.44433	4.45497	5.359	1396.127
450	99.37828	0.060557	0.411	3519.255	79.03667	5.247	5.901667	1409.583
500	99.6213	0.018112	0.36175	3531.238	74.564	6.16	5.792667	1435.383

A. Packet Delivery Fraction

Fig.1 compares the packet delivery fraction of AODV and proposed modification in varying pause time and random node speed. The graph demonstrates that proposed modification performs better than the AODV at nearly all pauses of time. The AODV perform well at less pause time but degrade at high pause time, while the proposed protocol does not degrade too much. Higher packet delivery fraction of new protocol is because of the availability of the bandwidth utilization among alternate paths to forward the packets when the source switched from its primary path.

B. End to end delay

Fig. 2 compares the End to end delay of AODV and proposed modification in varying pause time and random node speed. The graph demonstrates that proposed modification results in less delay than the AODV at nearly all pause time. The AODV perform well at less pause time but delay increase at high pause time, while the proposed protocol does not increase the delay at almost all pause time.

C. Normalized Routing Load

Fig. 3 compares the Normalized Routing Load of AODV and proposed modification in varying pause time and random node speed. The graph demonstrates that proposed modification results in less normalized routing load than the AODV. The AODV perform well at less pause time but load increase at high pause time, while the proposed protocol results high normalized load at less pause time but normalized routing load is decreased as the pause tme is increased.

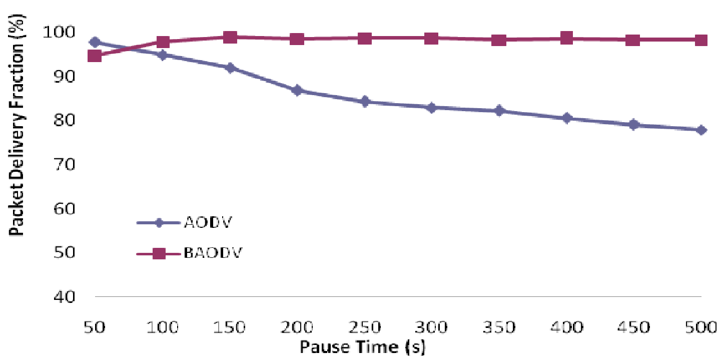

Fig.1. Packet delivery fraction .

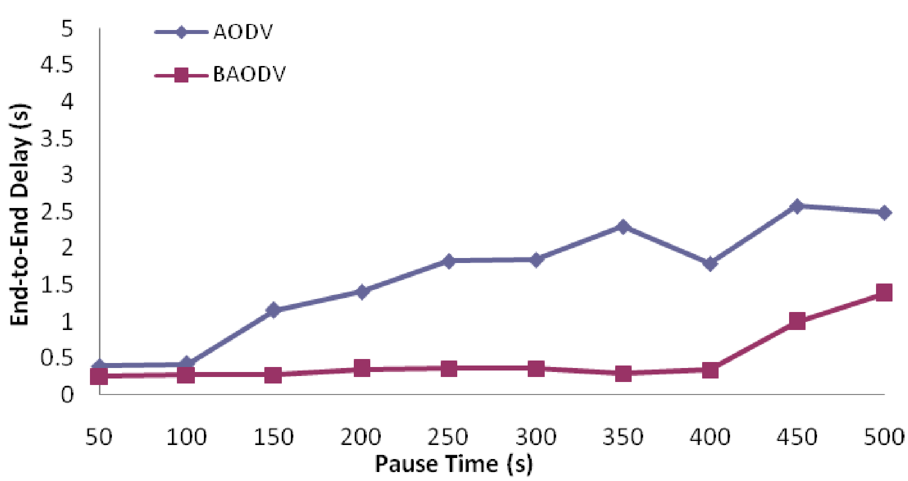

Fig. 2. End-to-End Delay.

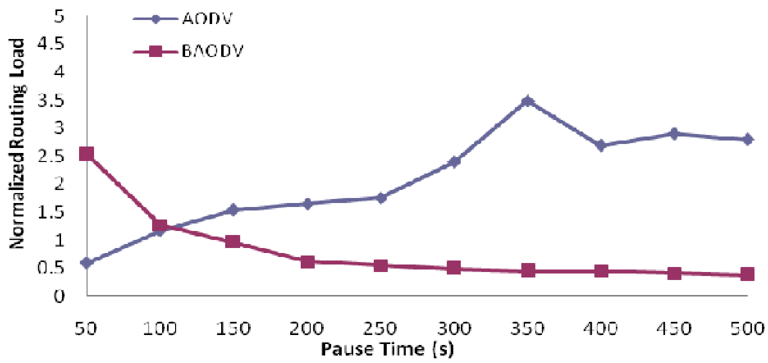

Fig. 3. Normalized Routing Load.

Throughput : Fig. 4 compares the throughput of AODV and proposed modification in varying pause time and random node speed. The graph demonstrates that proposed modification results in high throughput than the AODV. The AODV performs well at less pause time but at high pause time, the new protocol results high throughput as compared to AODV protocol.

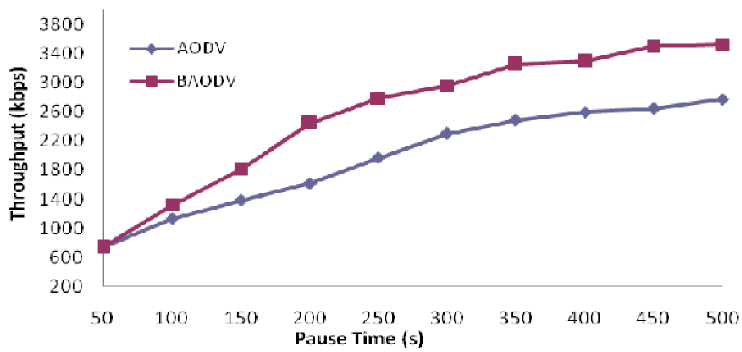

Fig. 4. Throughput.

VII. CONCLUSION AND FUTURE SCOPE

In this paper, we proposed an approach for mobile ad-hoc networks by utilizing the available bandwidth of the node and delay of the link , which improves the reliability of the selected in route discovery process , so, that the best route will be selected for better data transmission. Simulation results shows that the performance of this protocol is superior to the AODV in all most to the all scenarios. Future research will focus on optimally distributing traffic over multiple paths to upgrade the performance of the protocol.

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