Adaptive Multi-Path Link Quality Routing Protocol For Mobile Ad-Hoc Network

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Abstract—**Mobile Ad Hoc Network (MANET) is a collection of mobile nodes interconnected by wireless media. Routing protocols for Wireless ad hoc networks have traditionally focused on finding paths with different link quality metrics such as minimum hop count, RSSI (Received Signal Strength Indication), SNR (Signal-to-Noise Ratio), BER (Bit Error Rate). However, such paths can include slow or lossy links, leading to poor throughput. A routing algorithm can select better paths by explicitly taking the quality of the wireless links in to account. But PSR (Packet Success Rate) is a good metric for characterizing link quality at a coarse-grained level, because it is highly dependent on the packet size and the transmission rate. Several approaches have been suggested to improve quality of the link especially on Dynamic Source Routing (DSR) protocol. In this paper we propose an adaptive multi-path Link Quality Routing Protocol which is based on two link quality metrics such as PSR (Packet Success Rate) and Delay. This protocol is adaptive to load distribution. The protocol will collect information about quality of the link during the route discovery phase and use them to choose a set of disjoint paths, and distributes the data based on QoS they provide. Each node has to monitor links and adaptively adds or removes paths whenever it is needed to achieve the required QoS. The simulation experiments will be conducted using NS-2 network simulator. We will compare the performance of the suggested algorithm to the performance of the conventional DSR**

Keywords:- link qualit measurement, mp-dsr, manets,WSN

1 INTRODUCTION

An Ad hoc network is a collection of nodes that are connected without any infrastructure or base station. In such network the nodes are free to enter, leave the network, move and organize themselves thus the topology of the network change unpredictably. Ad hoc networks have been potentially used in different situations, such situations include moving battlefield communications disposable sensors which are dropped from high altitudes and dispersed on the ground for hazardous materials detection [1].

With recent advances in wireless technologies, advances mobile wireless devices are attracting increasing attention from both academia and industry .In the next generation, there will be a need for the rapid deployment of independent mobile users. Since their emergence in the 1970s, they become increasingly popular in the network industry. They can provide mobile users with ubiquitous communication capability and information access regardless of locations. The vision of mobile ad-hoc networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. Such networks are envisioned to have dynamic sometimes rapidly-changing random, multi-hop and multi-path topologies which are likely composed of relatively energy-constrained wireless links. Supporting this form of host mobility requires address management, protocol interoperability enhancements, but core network functions such as hop-by-hop routing still presently rely upon preexisting routing protocols operating within the fixed network. In contrast, the goal of mobile ad hoc networking is to extend mobility into the realm of autonomous, mobile, wireless domains, where a set of nodes, which may be combined routers and hosts, themselves form the network routing infrastructure in an ad-hoc fashion.

Most of the existing ad hoc routing protocols optimize hop-count when making a route selection. Significant examples are Ad-hoc On Demand Distance Vector (AODV)[2], Dynamic Source Routing (DSR)[3], and Destination Sequenced Distance Vector (DSDV)[4]. However, the routes selected based on hop count alone may be of bad quality since the routing protocols do not disregard weak quality links which are typically used to connect to distant node s. These links usually have poor signal-to-noise ratio (SNR), hence higher frame error rates and lower throughput.

In the ordinary DSR protocol, set of paths are generated, only one path is used for packet transmission, the other are kept in the source buffer for later use when link failure occur. DSR does not take into consideration the disjoint criteria. Disjoint path are two kinds: node disjoint path or link disjoint path. Node disjoint path means that intermediate node in each path are not shared with the other generated paths while link disjoint means a link connecting two nodes is not shared with other paths.

In node disjoint routing, we will get less link failure circumstances comparing to link disjoint routing because if any link in link disjoint routing become failed due to battery power failure then there may be a chances of participating that failed node in any other routing paths.

In this paper, we propose an on demand approach to search for highly node disjoint paths, we then have to distribute the packet among these paths. We perform a simulation study on the proposed method using NS-2 and compare the result of our algorithm with the ordinary DSR. The rest of the paper is organized as follows: Link quality estimation based multi-path DSR is given in section 2. Expected results are briefly discussed in section 3. Finally a conclusion is presented in section 4.

2. LINK QUALITY ESTIMATION BASED MULTI-PATH DSR

In this paper, link quality calculation is based on PSR Packet success rate) and Delay.PSR at each node i will be calculated by the formula given in [5] i.e

$$d_i = (1-\alpha) \times d_{i-1} + \alpha \times N_s / N_t$$

Where d_i is the smoothed delivery ratio, α a smoothing constant N_s the number of successful transmissions, and N_t the total number of transmissions and retransmissions during a measurement period of the i-th cycle.

In DSR we are not having concept of HELLO packet so I am using HELLO like packet HELLOPKT.

When a node receives HELLOPKT it examines the HELLOPKT to know about the node who has sent this packet and records that in neigh_ID field in Neighbor table and DELETE FLAG is made 0.If node id is already present(that is node has not moved) it increments stability field by 1. If HELLOPKT packet is not received DELETE FLAG is set to 1 to show that node has moved.

The broadcasting of RREQ is similar to the ordinary DSR, but instead of broadcasting RREQ to all the neighbors we can broadcast the RREQ which satisfies stability constraint. In the below algorithm stability can be calculated based on hello packets received from neighbor. if more number of packets i.e. greater than the threshold got from the neighbor then that node is treated as high stability node.

The following is the detail description of the algorithm.

```
If (RREQ reaches an intermediate node)
then
  If (RREQ is newly seen)
  then
  If stability > stability_threshold
     then
   cumulative_cost = cumulative_cost + {PSR at j / Delay at j}
       If Minimum_value in RREQ > {PSR at j/Delay at j}
          Then
          Minimum_value in RREQ = PSR at j / Delay at j
        End if
  End if
       Else
          Discard it
 Else If (RREQ is seen before but the route traversed was different)
 then
    Store it in the cache table.
Else If (RREQ seen before and route is not new)
Then
   Discard it.
If (RREQ reaches destination node)
then
        Checks whether the route is disjoint with the routes stored in the cache by checking the first hop of the RREQ with the First hop of each route cache and also checks RREQ with Highest minimum value and highest cumulative cost .and selecting some four to five high minimum value, cumulative cost paths generating RREP to those paths. RREP always contains cumulative cost field.
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Fig 1. Link quality estimation based node disjoint multi-path

When source gets RREP it will generate the traffic proportional to the cost value present in the RREP. For example assume three node disjoint paths got from destination then If cost of path 1 50, path 2 = 100, path 3=150 then Number of packets in path 1=x/n, Number of packets in Path 2= 2x/n, Number of packets in Path 3= 3x/n,Where n is total no of packets to be sent.

3. SIMULATION ENVIRONMENT

We have used the implementation of multi-path DSR in NS2 simulator & the widely used simulation environment. In the simulation the IEEE 802.11 Distributed Co-ordination Function is used as the MAC protocol. The multi-path DSR and ALQR are to be compared in the simulation. The ALQR is extension of the multi-path DSR. Our results are based on simulation of 50 wireless nodes forming an ad hoc network moving about in an area of 1500 * 300 square meters for 100 seconds of simulated time. Nodes move according to the random waypoint model in a free space model.

The traffic pattern consists of 20 Control Bit Rate sources sending 512 byte packets at a constant rate four packets per second. The random way point model was used to perform node movement. The movement scenario files used for each simulation are characterized by a pause time. Each node begins the simulation by selecting a random destination in the simulation area & moving to that destination at a speed distributed uniformly between 0 & 20 meters per second. It then remains stationary for pause time seconds. This scenario is repeated for the duration of the simulation. We carry out simulation with movement patterns generated for five different pause time. Like 10, 20,30,40,50 second, similarly with respect to Load changing the values of load like 50,100,150,200,250 kb. Each scenario is repeated five to ten times and the average values of the results are computed Control Bit Rate sources are used in the simulations. The packet rate is 4 packets per second when 10, 20,30,40,50 sources are assumed & it is 3 packets per second for 40 sources.

3.1 Simulation parameters and Performance analysis

Packet Delivery Ratio The packet delivery ratio is determined by dividing the number of packets received by the number of packets sent.

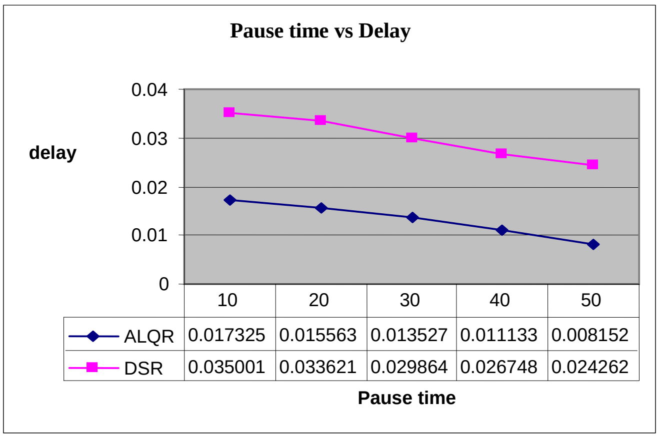
Control Overheads: Control overhead is defined as total number of received packets divided by total number of control packets **.**

End-to-End Delay: The average time interval between the generation of a packet in a source node and the successfully delivery of the packet at the destination node. It counts all possible delays that can occur in the source and all intermediate nodes, including queuing time, packet transmission and propagation, and retransmissions at the MAC layer. The queuing time can be caused by network congestion or unavailability of valid routes.

Average Energy consumption: The total consumed energy divided by the number of delivered packet.

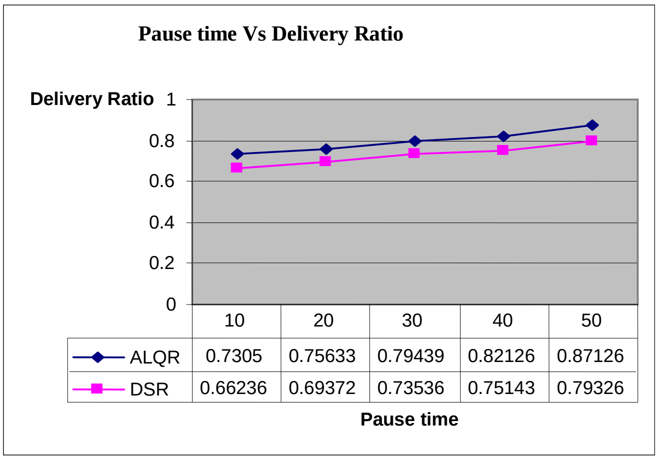
Pause time: Time to which nodes moved.

3.2 Simulation Results



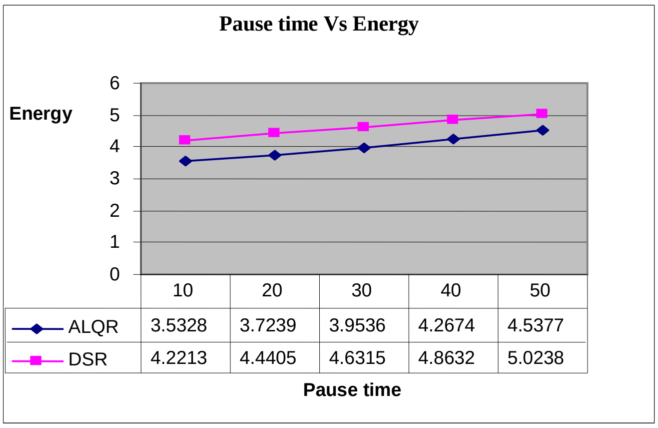
Pause time	10	20	30	40	50
ALQR	0.017325	0.015563	0.013527	0.011133	0.008152
DSR	0.035001	0.033621	0.029864	0.026748	0.024262

Fig. 2 Pause time Versus Delay



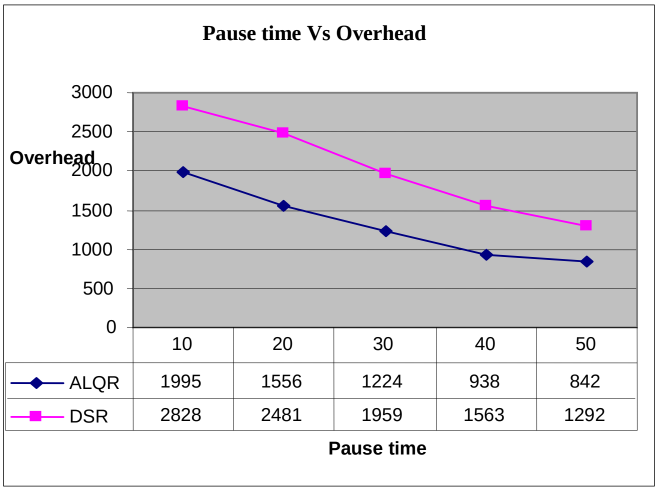
Pause time	10	20	30	40	50
ALQR	0.7305	0.75633	0.79439	0.82126	0.87126
DSR	0.66236	0.69372	0.73536	0.75143	0.79326

Fig. 3 Pause time Versus Delivery Ratio



Pause time	10	20	30	40	50
ALQR	3.5328	3.7239	3.9536	4.2674	4.5377
DSR	4.2213	4.4405	4.6315	4.8632	5.0238

Fig. 4 Pause time Versus Energy



Pause time	10	20	30	40	50
ALQR	1995	1556	1224	938	842
DSR	2828	2481	1959	1563	1292

Fig. 5 Pause time Versus Overhead

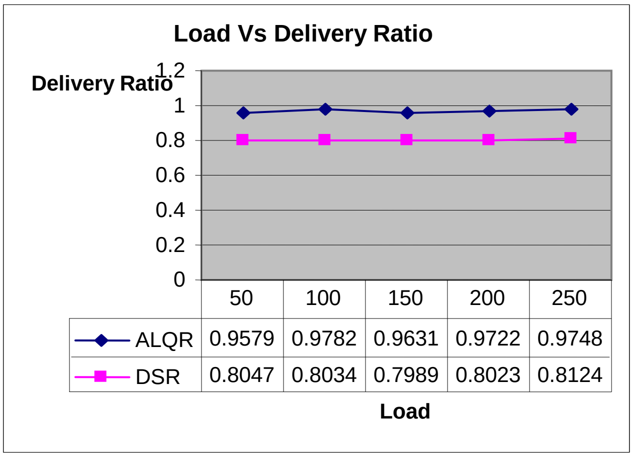


Fig. 6 Load versus Delivery Ratio

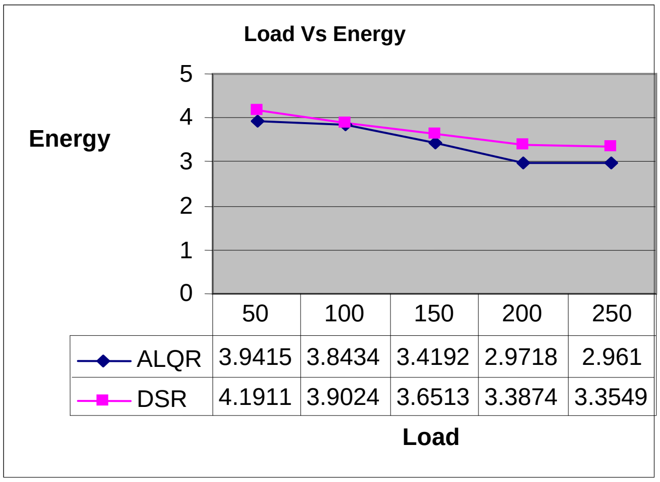


Fig. 7 Load versus Energy

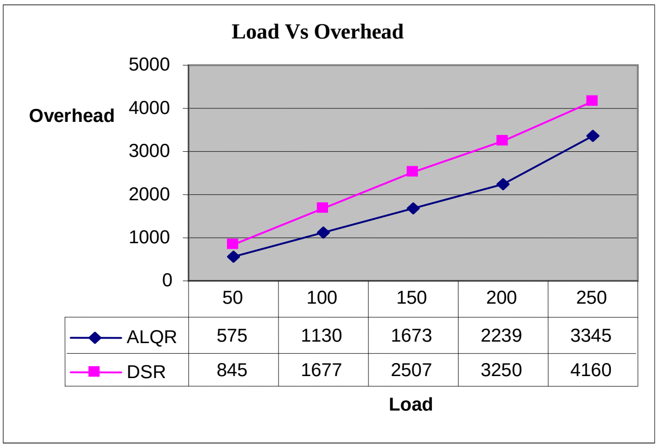


Fig.8 Load versus Overhead

In Fig 2 it is clearly seen that Delay is less in ALQR because retransmission is less in ALQR and it selects high Packet Success Rate nodes by calculating minimum value and cumulative cost compared to DSR. In Fig 3 Packet delivery ratio of ALQR is high compared to DSR when number of nodes is 50 because when the node density is low, number of routes is lower. Therefore route selection is done over strong links only i.e. high cost path. So ALQR chooses congestion free paths and high throughput paths through that paths we are distributing the load proportional to the cost of the path. ALQR has high Packet Delivery Ratio under low density of nodes. In Fig 4 Energy consumption of ALQR is less compared to DSR because retransmission is less in ALQR and also we are checking neighbor stability i.e. .number of HELLO packets received. If the stability is greater than stability threshold value then only we are transmitting the RREQ so the chance of getting link failure is less. Fig 5 shows number of control packets introduced into the network by each routing protocol, for 20 CBR sources. Overhead is less in ALQR compared to DSR because ALQR selects node disjoint paths at destination in low node density. But in DSR we are not selecting any node disjoint paths at destination and we are not calculating stability in DSR just like in ALQR.

In Fig 6 Packet Delivery Ratio of ALQR is high compared to DSR with respect to Load because ALQR selects high throughput paths. In Fig 7 it is clearly seen that as Load increases energy decreases but ALQR is having less energy Consumption rate compared to DSR because retransmission rate in ALQR is less. In Fig 8 it is clearly seen that as Load increases Overhead increases but ALQR is having less Control overhead due to selection of node disjoint paths at destination compared to DSR.

4. CONCLUSION

We have presented an Adaptive Link Quality Routing mechanism in mobile ad hoc networks. In this we introduced the use of multi-path to improve the quality of the link of the conventional DSR. The resultant mechanism will generate set of highly node disjoint paths and calculate the link quality metrics for each path. This Protocol will adaptively monitoring the paths link quality and distributing the traffic according to path link quality measures. This will improve the overall performance of the network such as reducing the paths drop and will improve the service continuity. The proposed protocol will create a network with better performance, less number of packets dropped, and throughput will be increased compared to conventional DSR.

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