

Interference Aware Hybrid Multipath Protocol for Mobile Ad hoc Network

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Abstract

Routing is a necessary feature of Mobile Ad hoc Network (MANET). Reducing interference and designing an efficient routing protocol considering battery life, mobility, quality of service features of MANET is challenging. Interference is a significant characteristic of network. We have proposed Interference Aware Hybrid Multipath Dynamic Source Routing protocol (IAHM-DSR) that finds a minimum interference path considering the link expiry times. Simulation is done using Java program. Observations show that the proposed protocol performs better in terms of packet delivery and throughput than the traditional DSR protocol.

Key Words: DSR, Hybrid Protocol, Interference, MANET, Reactive Protocol;

1 Introduction

Mobile ad hoc network (MANET) is an infrastructure-less network where the nodes mobility is stochastic. Attempts were made for the design of multipath routing protocols to handle the traffic load using node multiple node-disjoint paths. The developed protocols have varied in load balancing, energy saving, growth in the packet delivery and throughput which are LS-AOMDV [1] and NDM_AODV [2].

handled the problem of scalability and security [4]. In MANETs interference takes place because of signal propagation disturbances between the sender and receiver. The multiple node-disjoint paths that occur between the sender and receiver change the performance of MANETs by many ways. They are data loss, conflict, retransmission, channel distribution etc. Hence interference is most critical feature that should be taken for designing a multiple path disjoint method. With formal definition of interference, geographical position of nodes and link state information many protocols were developed to minimize routing overhead. Using link disjoint multipath with interference [5] work was done to address the challenges of routing to progress the throughput and improve in packet delivery ratio. In this paper we have designed a hybrid multipath protocol that considers link expiry times. The paper is organized as follows. Section 2 introduces the problem statement. Section 3 describes the proposed work. In section 4 simulation and results are shown, Section 5 concludes the paper in brief.

2 Problem Statement

Interference is a crucial feature in MANET. To decrease the interference caused during data transfer to increase the packet delivery and throughput is essential. Additional decrease in the end to end jitter improves the developed protocol. An efficient multipath hybrid protocol based on existing DSR resolves the problem by considering a minimum interference path and link expiry to route the packets from a given source to destination.

3 Proposed Work

3.1 Poisson Signal to Noise Interference Model

Multiple-hop MANET nodes are placed using Poisson point process with a constant spatial intensity λ [6][7]. Based on number of neighbors and the position, and power capacity, each node i gets adjusted its emitting power E_i within the value of range $[0, E]$, where E is the finite maximal power of a node. Depending on the positions p_i and p_j the signal power emitted and received by respective nodes i and j is $E_i A(p_i - p_j)$, where $A(.)$ is the attenuation function in the wireless environment. Considering Node j gets the transmitted data from node i provided, the signal received by j is high enough in comparison with the thermal noise. The equation is

$$E_i A(p_i - p_j) / (N_0 + \eta \sum_{k \neq i, j} E_k A(p_k - p_i)) \geq \alpha \quad (1)$$

In the equation (1) for successful decoding, N_0 is considered as the noise power of the thermal location and α is the signal to noise ratio. The effect of interference is given by the coefficient η which is the inverse of the processing gain of the system which is determined by the orthogonality between codes utilized during instantaneous transmissions. In a system that uses CDMA it is equal to 1 in a narrowband and is smaller than 1 in a broadband. The physical model of Gupta and Kumar [7] assumes; other models [8][9] allows the value to be lesser than 1. In the same way, transmission of data from Node i to Node j can take place, if they satisfy the following,

$$E_j A(p_j - p_i) / (N_0 + \eta \sum_{k \neq i, j} E_k A(p_k - p_j)) \geq \alpha \quad (2)$$

From equations (1) and (2), we can construct an oriented graph that sums up the available links in the MANET. In organized connected components, we need to establish a symmetric relation. In this paper, we prefer to disregard unidirectional links, which are difficult to utilize in wireless networks [10]. In other words, we state that two nodes are directly connected if the equations (1) and (2) hold.

3.2 Scheme

A hybrid multipath is taken for routing from a given source and destination. In the hybrid path, the path shares a common link and node.

Step 1: DSR is applied for a given topology of a MANET is taken and a single path with least interference.

Step 2: The next path with least interference is found by using the DSR procedure again by avoiding some links and nodes with the given source and destination present in the path found in Step 1.

Step 3: The DSR procedure is repeated several times with given value of k , where $k=1$ to n by avoiding some nodes and links between the given source and destination present in the paths found in the previous steps to find k -least interference path.

Step 4: If there are additional minimum interference paths then the route which contains higher route expiry time is opted for routing.

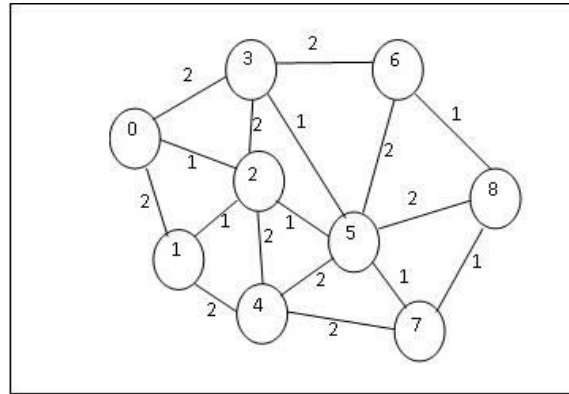


Fig 1: MANET with interference intensity values

We describe an example for a minimum path computation considering the example of the MANET in Fig 2, as a weighted graph with nodes as vertices and interference intensity values as links. The intensity interference values of MANET in Fig 1 are calculated by interference measurement method by equation (1) and (2) and approximated to 0, 1 and 2 integer values.

When DSR algorithm is used at the first time for Fig 2 weighted graph which contains link expiry times inside the bracket with $S=0$ as source and $D=7$ as destination, we get the resultant interference path 0-1-7 that contains the route interference value 3. Applying the DSR procedure again, we get the next interference route 0-1-4-7 with the route interference value 6.

We carry on applying the DSR algorithm to find the third path 0-2-5-7 with the interference value 3. There are two minimum interference paths 0-1-7 and 0-2-5-7 with interference value 3. Now we consider the link expiry times of path 0-1-7. The minimum link expiry time of path 0-1-7 is 05. For path 0-2-5-7 the minimum link expiry time of path is 06. Comparing the minimum link expiry times of the paths, the path that has greater minimum link expiry times is selected. Here the path 0-2-5-7 has greater minimum link expiry time than 0-1-7, so 0-2-5-7 is selected for routing.

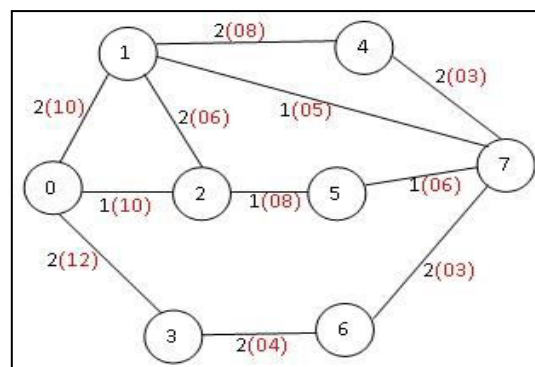


Fig 2: MANET for calculation of interference path.

4 Simulation and Observation

4.1 Simulation Environment

Both DSR and IAHM-DSR protocols are implemented using the Java program. These are structured in compliance with MANET protocols specified for radio/wireless models. The simulation parameters are shown in Table 1.

Table 1. Simulation Parameters.

Parameter	Parameter Value
Simulation Iterations	5
Simulation terrain (m x m)	Varies from 250m x 250m to 1000m x 1000m
Number of Nodes	100 to 500
Mobility Model	Random way point model
Propagation Model	Free Space Model
Channel Bandwidth	4Mbps
Transmission Range	Varies from 250m to 500m
Packet Size	512byte
Transport Protocol	UDP

4.2 Simulation Results

The performance parameter metrics for simulation are packet delivery ratio, Source Destination Pairs (SD Pairs), throughput and number of nodes (n).

Packet delivery ratio is given by the ratio of the number of packets received successfully to the number of packets sent from source to destination. Throughput is defined as the number of packets received by the destination node per unit time. Fig 3 shows the packet delivery results for 255m transmission range.

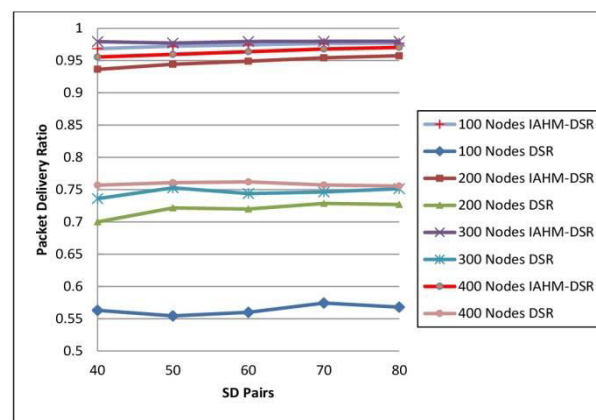


Fig 3: Packet delivery ratio vs. SD Pairs for 255 m transmission range

In the Fig 3 the packet delivery ratio for DSR is 0.5629 for 100 nodes with 40 SD Pairs.

IAHM-DSR it is 0.982 which is more than DSR. In the

nodes with 60 SD Pairs. IAHM-DSR it is 0.9490 which is 31.82 percent more than DSR. This is because a minimal interference path formed by interference multipath is taken for packet delivery in IAHM-DSR protocol. The packet delivery ratio in IAHM-DSR is 0.9595 for 50 SD pairs with 400 nodes but it is 0.7608 for 400 nodes and 50 SD pairs for DSR. It is 26.11 percent higher than DSR. Further in the graph we see that the packet delivery ratio in IAHM-DSR is 0.9792 for 40 SD Pairs and 300 nodes, it grows to 0.9798 for 80 SD Pairs. This is because interference for 40 SD Pairs is more than 80 SD Pairs for 300 nodes. Comparing IAHM-DSR with DSR with given SD Pair and nodes, we find that packet delivery ratio for IAHM-DSR is more than DSR. Fig 4 shows the packet delivery results for 455 m transmission range.

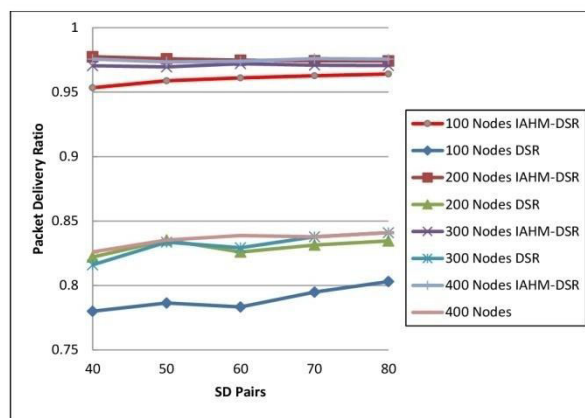


Fig 4 :Packet delivery ratio vs. SD Pairs for 455m transmission range.

Fig 4 shows the packet delivery results for 455 m transmission range In the Fig 4 the packet delivery ratio for IAHM-DSR is 0.9588 for 100 nodes with 50 SD Pairs. DSR it is 0.7864. IAHM-DSR packet delivery ratio is 21.92 percent more than DSR. In the similar way packet delivery ratio for DSR is 0.8159 for 300 nodes with 40 SD Pairs. In case of IAHM-DSR it is 0.9705 which is 18.9 percent higher than DSR This is because a minimal interference path formed by interference multipath is taken for packet delivery in IAHM-DSR protocol. The packet delivery ratio in IAHM-DSR is 0.9709 for 70 SD Pairs with 300 nodes but it has grown to 0.9760 for 400 nodes and 70 SD pairs. The cause behind this is that that SD Pairs for 300 nodes exhibit more interference than and 400 nodes. Further in the graph we see that the packet delivery ratio in IAHM-DSR is 0.9588 for 50 SD Pairs and 100 nodes it raises to 0.9610 for 60 SD Pairs. This is because interference produced by 50 SD pairs is more than 60 SD Pairs. The 50 SD Pairs and 60 SD Pairs are not same. Further comparing IAHM-DSR with DSR with given SD Pairs and nodes, We find that packet delivery ratio for IAHM-DSR is higher than DSR. Fig 5 shows the throughput

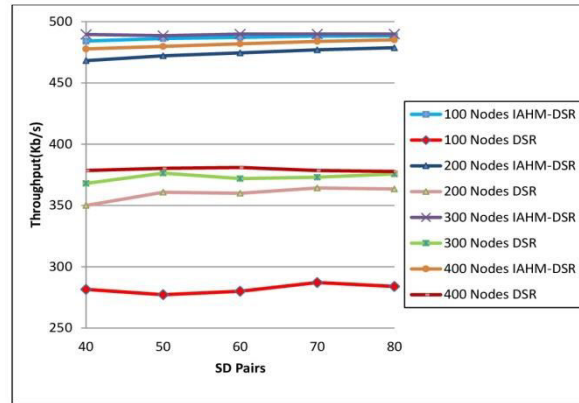


Fig 5 :Throughput vs. SD Pairs for 255 m transmission range

In the Fig 5 the throughput for DSR is 279.9KB/s for 100 nodes with 60 SD Pairs. IAHM-DSR it is 487.16KB/s which is 74.04 percent more than DSR. Similarly throughput for DSR is 360.8KB/s for 200 nodes with 50 SD Pairs. In case of IAHM-DSR it is 472.14KB/s which is 30.8 percent more than DSR. This is because a minimal interference path formed by interference multipath is taken for packet delivery in IAHM-DSR protocol. The throughput in IAHM-DSR is 376.39KB/s for 50 SD pairs with 300 nodes but it is 380.39KB/s for 400 nodes and 50 SD pairs. The cause behind this is that that SD Pairs for 300 nodes exhibit more interference than 400 nodes. There are some broken paths in case of 300 nodes with 60 SD Pairs. Further in the graph we observe that the throughput in IAHM-DSR is 484.16KB/s for 40 SD Pairs and 100 nodes, it rises to 486.14KB/s for 50 SD Pairs. This is because interference produced by 40 SD pairs is more than 50 SD Pairs. The 40 SD Pairs and 50 SD Pairs are not same. Further comparing IAHM-DSR with DSR with given SD Pair and nodes, we find that throughput for IAHM-DSR is higher than DSR.

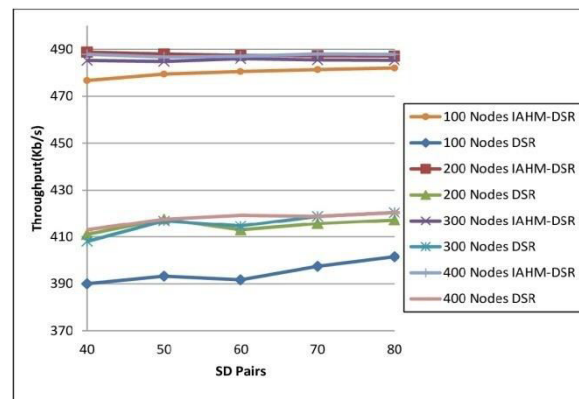


Fig 6 :Throughput vs. SD Pairs for 455 m transmission range

Fig 6 shows the throughput results for 455m transmission range. In the Fig 6 the throughput for DSR is 417.59KB/s for 300 nodes with 50 SD Pairs. IAHM-DSR it is 487.16KB/s for 300 nodes with 50 SD Pairs. This is because a minimal interference path formed by interference multipath is taken for packet delivery in IAHM-DSR protocol.

throughput for DSR is 391.66KB/s for 100 nodes with 60 SD Pairs. In case of IAHM-DSR it is 480.53KB/s which is 22.69 percent higher than DSR. This is because a minimal interference path formed by interference multipath is taken for packet delivery in IAHM-DSR protocol. The throughput in IAHM-DSR is 485.26KB/s for 40 SD pairs with 300 nodes but it is 487.84KB/s for 400 nodes and 40 SD pairs. The reason behind this is that SD Pairs for 300 nodes exhibit more interference than 400 nodes. There are some failure paths in case of 300 nodes with 40 SD Pairs. Further in the graph we observe that the throughput in IAHM-DSR is 486.70KB/s for 50 SD Pairs and 300 nodes, it rises to 488.01KB/s for 70 SD Pairs. This is because interference produced by 50 SD pairs is more than 70 SD Pairs. The 50 SD Pairs and 70 SD Pairs are not same. Further comparing IAHM-DSR with DSR with given SD Pair and nodes, we find that throughput for IAHM-DSR is more than DSR. From the observations of Fig 3, Fig 4, Fig 5, and Fig 6 we conclude that packet delivery ratio and throughput of IAHM-DSR is more than DSR.

5 Conclusion

In this paper, we have proposed an interference aware hybrid multipath routing protocol IAHM-DSR taking the link expiry times in the mobile ad-hoc network. An interference model based on Poisson distribution is assumed. IAHM-DSR uses minimal interference path for data delivery. With simulation we have shown that IAHM-DSR performs better than DSR in terms of packet delivery ratio and throughput. In future the protocol will be improved in terms of energy and network parameters.

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