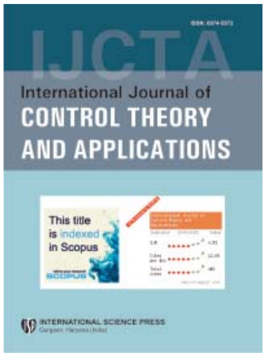

International Journal of Control Theory and Applications

ISSN : 0974–5572

Volume 10 • Number 25 • 2017

Hybrid Multipath Dynamic Source Routing Protocol for MANET

Nagaraj M. Lutimath[a] Arun Kumar D.R[a] and Chethan C[b]

[a]Department of Computer Science and Engineering, SVCE Vidyanagar, Kempegowda International Airport Road, Bengaluru-57, Karnataka, India

E-mail: nagarajlutimath@gmail.com, arunkumardr1987@gmail.com

[b]Department of Information Science and Engineering, SVCE Vidyanagar, Kempegowda International Airport Road, Bengaluru-57, Karnataka, India

E-mail: chethanc123@gmail.com

Abstract: In a Mobile Ad Hoc Network (MANET) routing plays vital role. Developing an efficient routing protocol considering battery life, mobility, quality of service features of MANET is challenging. Interference is a significant characteristic of network. Reducing the interference and transmission of data from a given source to destination is necessary to improve packet delivery. We have proposed hybrid multipath routing protocol (HM-DSR) based on DSR that considers the interference of the network and finds a minimum interference path. Simulation is done using Java program to analyze the performance and comparison. Results show that HM-DSR performs better in terms of packet delivery ratio and throughput than the classical DSR protocol.

Keywords: *DSR, Interference, Reactive Protocol.*

1. INTRODUCTION

An infrastructure-less network of mobile nodes is said to be Mobile ad hoc network (MANET). The nodes move in a random fashion. Due the dynamic mobility of the nodes and sparse resources designing of the protocols becomes demanding. Interference is a disturbance caused between the sender and receiver nodes propagation signals. This happens when a node moves out between any two nodes transmission sensing range. When data is transmitted, a channel is accessed by a node. The nodes within this node's carrier sensing range get affected. Interference causes a substantial decrease in data transfer and throughput. A multi node or link path can be used but the efficiency of multipath node or link disjoint path is reduced which is nearly equal to sharing the traffic load in a single route. As the traffic load increases in a single path , the packet delivery ratio and throughput of multi-path decreases resulting in a hidden terminal problem [1], even though there is a existence shared channel problem. Many efforts by designing multipath routing protocols to share the traffic load on multiple node-disjoint paths were made. The developed protocols have varied in load balancing, power saving or increasing the packet delivery ratio and throughput such as LS-AOMDV [2] and NDM_AODV [3].TORA [1] is a link reversal protocol which is highly suitable for topological change. These multipath protocols are developed have handled the problem of scalability and security [4][5][6]. In MANETs signal propagation disturbances occur between the sender. This causes interference between the sender and receiver. The multiple node-disjoint paths between the sender and receiver change the complete performance of MANETs by many factors. They are data loss, conflict, retransmission, channel share etc. Thus interference is most essential factor that should to be taken for developing a multiple path disjoint scheme. With explicit definition of interference [7][8], geographical position of nodes and link state information many protocols were designed to minimize routing overhead. Using link disjoint multipath with interference [9] work was done to address the challenges of routing to progress the throughput and raise packet delivery ratio. In this paper we have designed a hybrid multipath scheme. The paper is organized as follows. Section II introduces the problem statement. Section III describes the proposed work. In section IV simulation and results are depicted by comparing and analysing HM-DSR and DSR. In Section V conclusion of the paper is given in brief.

2. PROBLEM DEFINITION

Reduction of the interference caused during data transfer increases the packet delivery and throughput. Further decrease in the end to end delay enhances the developed protocol. An efficient multipath hybrid protocol based on existing DSR solves the problem by considering a minimum interference path to route the packets from a given source to destination.

3. PROPOSED WORK

3.1. Poisson Signal To Noise Interference Model

We consider a multiple-hop ad-hoc network where nodes are distributed according to a Poisson point process of constant spatial intensity λ [10]. Depending on its location, number of neighbours, and battery level, each node i will adjust its emitting power E_i within a given range [0, E], where E is the maximal power of a node, which is finite. The power of the signal emitted by Node i and received by Node j is $E_i L(x_i - x_i)$, where x_i and x_j are the positions of Node i and j in the plane, respectively, and L(.) is the attenuation function in the wireless medium. We assume that Node i can transmit data to Node j if the signal received by j is strong enough, compared to the thermal noise. Formally, this condition is written as

$$E_i L(x_i - x_i)/(N_0 + \eta \sum_{k \neq i,j} E_k L(x_k - x_i)) \geq \alpha \quad (1)$$

Where N_0 is the power of the thermal background noise and α is the signal to noise ratio required for successful decoding. The coefficient η is the inverse of the processing gain of the system; it weights the effect of interferences depending on the orthogonality between codes used during simultaneous transmissions. It is equal to 1 in a narrowband system, and is smaller than 1 in a broadband system that uses CDMA. The physical model of Gupta and Kumar [11] assumes; other models [12] allow to be smaller than 1. Similarly, Node i can transmit data to Node j if and only if

$$E_i L(x_j - x_i)/(N_0 + \eta \sum_{k \neq i,j} E_k L(x_k - x_i)) \geq \alpha \quad (2)$$

From conditions (1) and (2), we can build an oriented graph that summarizes the available links between nodes. In order to define connected components (or clusters), we have to introduce a symmetric relation. In this paper, we choose to neglect unidirectional links, which are difficult to exploit in wireless networks [13]. In other words, we declare that Node and Node are directly connected if and only if both (1) and (2) are satisfied.

3.2. Scheme

We use hybrid multipath, where the path share a common link and node between a given source and destination.

Step 1: A given topology of a MANET is taken and a single path with least interference based on the DSR algorithm is found.

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

Step 3: The DSR algorithm is repeated for a number of times for a given value of *k*, where *k* = 1 to *n* by avoiding some nodes and links between the source and destination along the paths found in the previous steps to find *k*-minimum interference path.

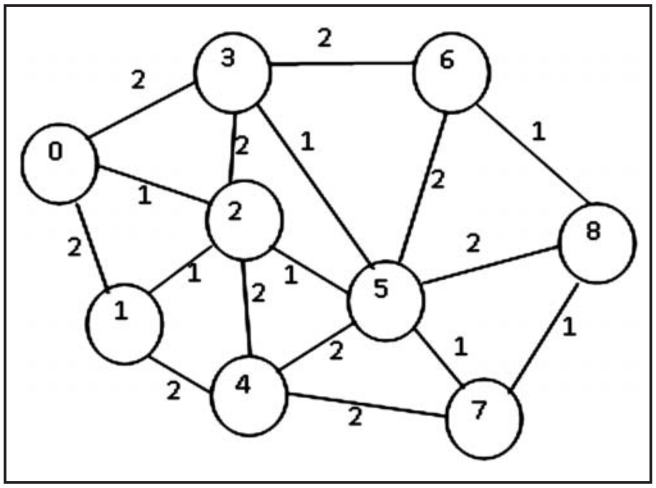

Figure 1: MANET with interference intensity values

We illustrate an example for a computation of minimum path taking the example of the MANET in Fig 2, considered 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 as given in [9] and approximated to 0, 1 and 2 integer values.

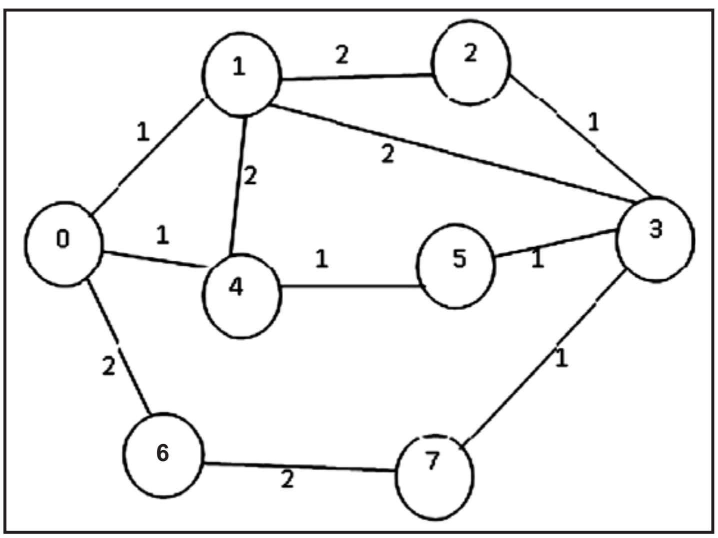

Figure 2: MANET for calculation of interference path

When DSR algorithm is used at the first time, Fig 2 weighted graph with source S = 0 and destination D = 3 we get the minimum interference path 0-1-3 that has the path interference value of 3.Using the DSR algorithm once more, we get the second minimum interference path 0-1-2-3 with the path interference value of 4. We continue to apply the DSR algorithm and find the third path 0-4-5-3 with the interference value of 3. The minimum path of these is 0-1-3 with interference value of 3. The path 0-1-3 is selected as it has minimum interference 3. This is used for routing the information.

4. SIMULATION AND RESULTS

4.1. Simulation Environment

Both the interference aware protocols, DSR and IALMDSR are implemented using the Java program. The protocols are designed in compliance with MANET protocols specified for radio/wireless models.

Table 1
Simulation Parameters

S.No	*Parameter*	*Parameter Value*
1.	Simulation Iterations	5
2.	Simulation terrain (m x m)	Varies from 250m x 250m to 1200m x 1200m
3.	Seed Values	1to 15
4.	Number of Nodes	100 to 500
5.	Mobility Model	Random Waypoint Model
6.	Propagation Model	Free Space Model
7.	Channel Bandwidth	4Mbps
8.	Transmission Range	Varies from 250m to 250m
9.	Packet Size	512byte
10.	Transport Protocol	UDP

4.2. Simulation

The simulation parameter metrics used for simulation are Packet Delivery Ratio (PDR), Source Destination Pairs (SD Pairs), Throughput and number of nodes (*n*).

Packet Delivery Ratio is defined as 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 second.

Fig 3 shows the packet delivery results for 250m transmission range.

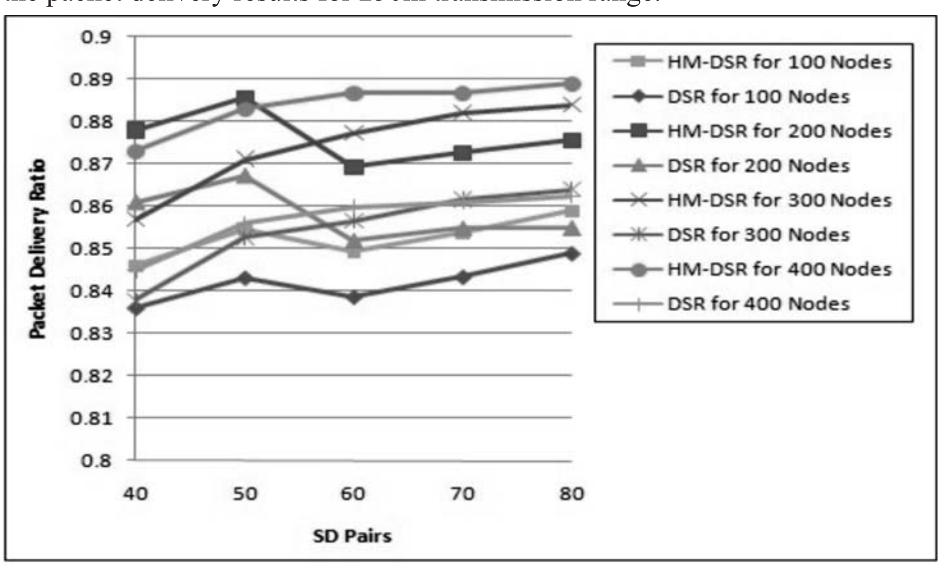

Figure 3: PDR vs. SD Pairs for 250m transmission range

In the Fig 3 the Packet Delivery Ratio for DSR is 0.8532 for 100 nodes with 50 SD Pairs. HM-DSR it is 0.8544 which is higher than DSR.. Similarly packet delivery ratio for DSR is 0.8671for 200 nodes with 50 SD Pairs. HM-DSR it is 0.8856 which is 3.1 percent higher than DSR. This is because a minimal interference path formed by intereference multipath is taken for packet delivery in HM-DSR protocol. The packet delivery ratio in HM-DSR is 0.873 for 40 SD pairs with 400 nodes but it is 0.845 for 400 nodes and 40 SD pairs for DSR. It is 3.3 percent higher than DSR.Further in the graph we observe that the packet delivery ratio in HM-DSR is 0.8712 for 50 SD Pairs and 300 nodes , it rises to 0.883 for 80 SD Pairs. This is because intereference for 50 SD Pairs is more than 80 SD Pairs for 300 nodes.Comparing HM-DSR with DSR with given SD Pair and nodes. We find that packet delivery ratio for HM-DSR is more than DSR. Fig 4 shows the packet delivery results for 450m transmision range.

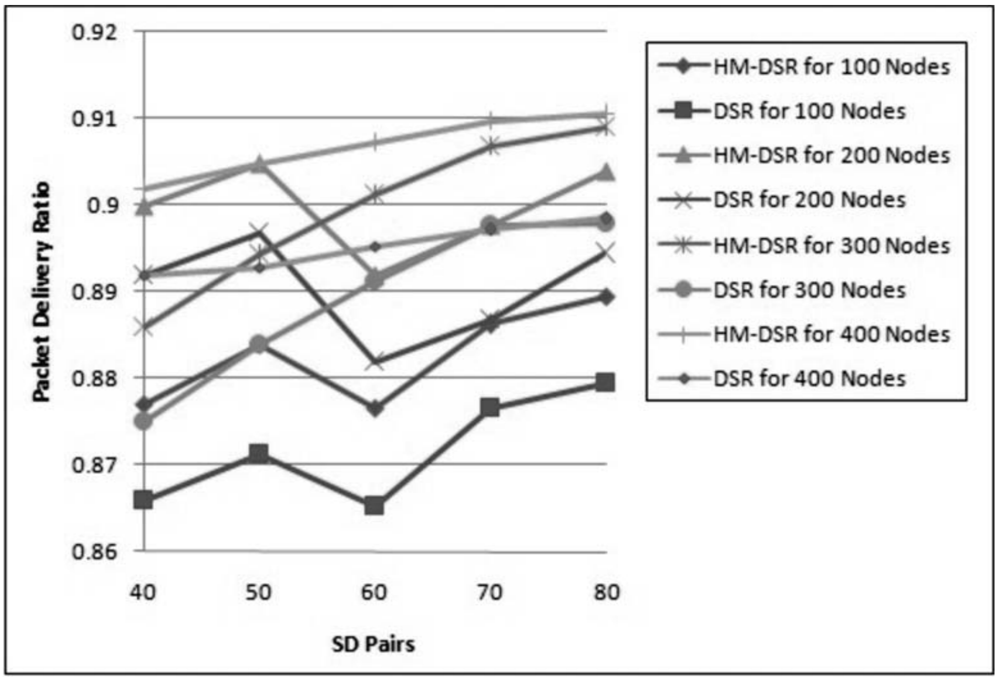

Figure 4: Packet Delivery Ratio vs. SD Pairs for 450m transmission range

In the Fig 4 the Packet Delivery Ratio for HM-DSR is 0.9048 for 200 nodes with 50 SD Pairs. DSR it is 0.8968. HM-DSR packet delivery ratio is 0.9 percent higher than DSR.. Similarly packet delivery ratio for DSR is 0.8839 for 300 nodes with 50 SD Pairs. In case of HM-DSR it is 0.8944 which is 1.2 percent higher than DSR. This is because a minimal interference path formed by intereference multipath is taken for packet delivery in HM-DSR protocol. The packet delivery ratio in HM-DSR is 0.9013 for 60 SD pairs with 300 nodes but it has increased to 0.90733 for 400 nodes and 60 SD pairs. The reason behind this is that that SD Pairs for 300 nodes exibit more interference than and 400 nodes.Further in the graph we observe that the packet delivery ratio in HM-DSR is 0.8862 for 70 SD Pairs and 100 nodes , it rises to 0.8894 for 80 SD Pairs. This is because interference produced by 70 SD pairs is more than 80 SD Pairs. The 70 SD Pairs and 80 SD Pairs are not same. Further comparing HM-DSR with DSR with given SD Pair and nodes. We find that packet delivery ratio for HM-DSR is more than DSR Fig 5 shows the Throughput results for 250m transmision range

In the Fig 5 the Throughput for DSR is 469.99KB/s for 200 nodes with 60 SD Pairs. HM-DSR it is 569.33KB/s which is 17.44 percent higher than DSR Similarly Throughput for DSR is 473KB/s for 300 nodes with 50 SD Pairs. In case of HM-DSR it is 571.19KB/s which is 20.7 percent higher than DSR. This is because a minimal interference path formed by intereference multipath is taken for packet delivery in HM-DSR protocol.

The Throughput in HM-DSR is 569.33KB/s for 60 SD pairs with 200 nodes but it is 586.66KB/s for 400 nodes and 60 SD pairs. The reason behind this is that that SD Pairs for 200 nodes exibit more interference than 400 nodes. There are some broken paths in case of 200 nodes with 60 SD Pairs. Further in the graph we observe that the Throughput in HM-DSR is 545.99KB/s for 40 SD Pairs and 100 nodes , it rises to 554.39KB/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 HM-DSR with DSR with given SD Pair and nodes. We find that Throughput for HM-DSR is more than DSR Fig 6 shows the Throughput results for 450m transmision range.

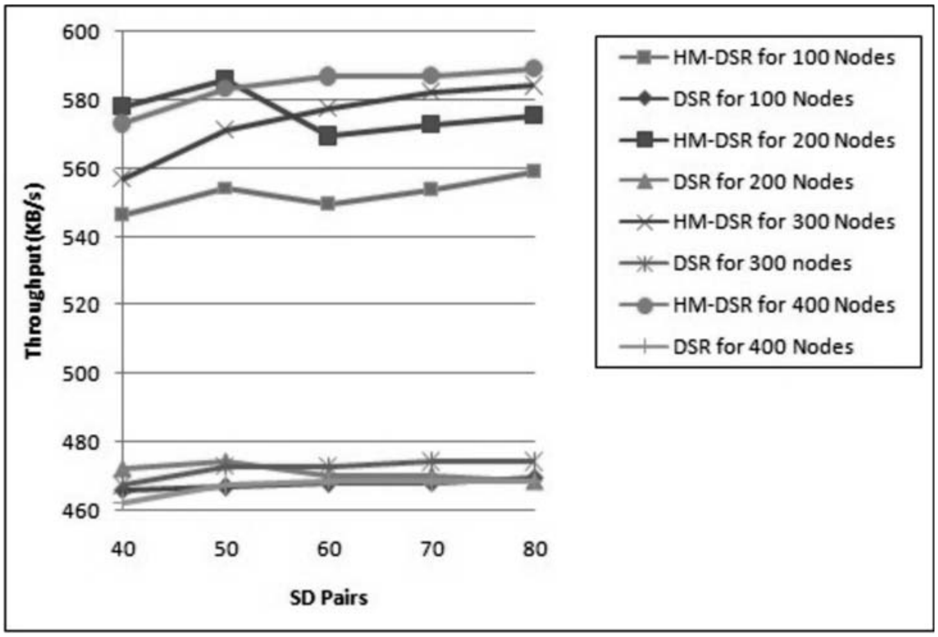

Figure 5: Throughput vs. SD Pairs for 250m transmission range

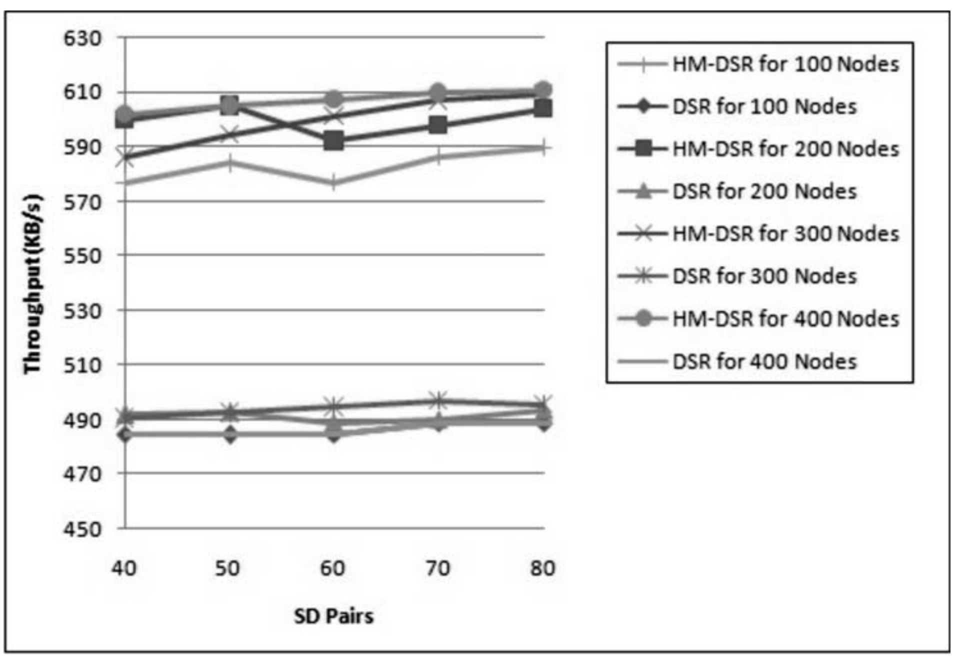

Figure 6: Throughput vs. SD Pairs for 450m transmission range

In the Fig 6 the Throughput for DSR is 492.49KB/s for 300 nodes with 50 SD Pairs. HM-DSR it is 594.39KB/s which is 20.69 percent higher than DSR. Similarly Throughput for DSR is 484.49KB/s for 100 nodes with 50 SD Pairs. In case of HM-DSR it is 583.99KB/s which is 20.53 percent higher than DSR. This is because a minimal interference path formed by intereference multipath is taken for packet delivery in HM-DSR protocol. The Throughput in HM-DSR is 585.99KB/s for 40 SD pairs with 300 nodes but it is 601.99KB/s for 400 nodes and 40 SD pairs. The reason behind this is that that SD Pairs for 300 nodes exibit more interference than and 400 nodes. There are some broken paths in case of 300 nodes with 40 SD Pairs. Further in the graph we observe that the Throughput in HM-DSR is 597.7KB/s for 70 SD Pairs and 200 nodes , it rises to 603.99KB/s for 80 SD Pairs. This is because interference produced by 70 SD pairs is more than 80 SD Pairs. The 70 SD Pairs and 80 SD Pairs are not same. Further comparing HM-DSR with DSR with given SD Pair and nodes. We find that Throughput for HM-DSR is more than DSR. From the observations from the results of Fig 3,Fig 4, Fig 5, and Fig 6 we conclude that Packet Delivery Ratio and Throughput of HM-DSR is more than DSR.

5. CONCLUSION

In this paper, we have proposed a hybrid multi-path routing protocol HM-DSR based on interference aware DSR for mobile ad-hoc network. HM-DSR uses minimal interference to increase the performance of data transmission between a source and a destination. With simulation we have shown that HM-DSR is better than DSR in terms of Packet Delivery Ratio and Throughput. In future to our protocol will be enhanced considering expiry times of the times.

REFERENCES

[1] A.Tsertou and D. Laurenson, "Revisiting the Hidden Terminal Problem in a CSMA/CA Wireless Network," *IEEE Transactions on Mobile Computing,* vol. 7, pp. 817 - 831, 2008.

[2] S. Ding and L. Liu, "A node-disjoint multipath routing protocol based on AODV," in *Distributed Computing and Applications to Business Engineering and Science (DCABES)*, Hong Kong, 2010.

[3] Perkins CE, Royer EM. Ad-Hoc on demand distance vector routing .In: IEEE Work-Shop on Mobile Computing Systems and Applications (WMCSA). New Orleans, 1999.

[4] K. Moaveni-Nejad and X. Li. "Low-interference topology control for wireless ad hoc networks. Ad Hoc& Sensor Wireless Networks": an International Journal, 2004. Paths in Ad Hoc Networks", IEEE ICC 2001, 2001, pp. 3201-3205.

[5] Kui Wu and Janelle Harms. "On-Demand Multipath Routing for Mobile Ad Hoc Networks". EPMCC 2001.1-6.

[6] Xinming Zhang, Qiong Liu, Dong Shi, Yongzhen Liu, Xiang Yu "An Average Link Interference-aware Routing Protocol for Mobile Ad hoc Networks ",,Conference on Wireless and Mobile Communications(ICWMC'07).

[7] S.-J. Lee and M. Gerla, "Split Multipath Routing with Maximally Disjoint Paths in Ad hoc Networks," in *IEEE International Conference on Communications(ICC)*, Helsinki, 2001

[8] Phu Hung Le, Guy Pujolle, Thi-Mai-Trang Nguyen "An Interference-aware multi-path routing protocol for Mobile Adhoc Network", Proc of International Conference on Networking, Sensing and Control Delft, the Netherlands, 11-13 April 2011

[9] Nagaraj M. Lutimath, Suresh L, Chandrakant Naikodi, "Interference-Aware Link Disjoint Dynamic Source Multipath Routing Protocol for Mobile Ad-hoc Networks", International Journal of Applied Engineering Research, ISSN 0973-4562 Vol .10 No. 86 (2015), pp. 15-19.

[10] Olivier Dousse, Franc¸ois Baccelli, Patrick Thiran, "Impact of Interferences on Connectivity in Ad Hoc Networks", IEEE/ACM Transactions on Networking, Vol. 13, No.2, April 2005.pp.425-436.

[11] P. Gupta and P. R. Kumar, "The capacity of wireless networks," IEEE Trans. Inform. Theory, vol. 46, no. 3, pp. 388–404, Mar. 2000.

[12] M. Grossglauser and D. Tse, "Mobility increases the capacity of ad hoc wireless networks," in Proc. IEEE INFOCOM, Anchorage, AK, Apr. 2001, pp. 1360–1369

[13] V. Ramasubramanian, R. Chandra, and D. Mosse, "Providing a bidirectional abstraction for unidirectional adhoc networks," in Proc. IEEE INFOCOM, New York, Jun. 2002, pp. 1258–1267.