Node Wise Optimization Strategy Proposal and Analyses of Routing Protocols for MANET using NCTUns 6.0

Mukta Gahlawat,
CSE Dept, MSIT
Delhi, India

Dal Singh

Poonam Bansal
CSE Dept, MSIT,
Delhi,India

Darshna
DCRUSTM,
Murthal,India

ABSTRACT
Mobile Ad-hoc networks (MANETs) are defined as category of wireless network that utilize multi-hop radio relaying. These are capable of operating without support of any fixed infrastructure or centralized management. In MANETs network organization is carried out by the nodes themselves. Every node is capable to work as a sender, destination or as a forwarding node. Absence of base station or central coordinator makes routing a complex task as compared to cellular network. Path setup for a call between two nodes is completed through intermediate mobile nodes. It is a not easy problem for searching and maintaining an effective route for transporting some data information. Many researcher have done analyses of some existing routing protocols for MANETs like AODV, DSDV, DSR. But in this paper we will do node wise analysis for chosen network. We have taken various performance metrics like dropped packets, packets collided, number of incoming and outgoing packets and throughput on each and every node. On the basis of result for each node, we have tried to propose an optimization strategy using soft computing concepts for better performance of network. We have used network simulator NCTUns 6.0 to study the relative performance of the routing protocols according to different metrics for each node**.**

Keywords
MANETs, AODV, DSDV, DSR, NCTUns

1. INTRODUCTION
Mobile ad hoc network is a new broadband wireless network architecture which can be deployed easily in almost any environment. These are short-lived networks and form autonomous systems of mobile nodes in the absence of any centralized support, which is able to provide services at places where it is not possible otherwise. It is possible that two nodes communicate even when they are outside each other's transmission ranges because intermediate can function as routers, because of this reason they are called multi-hop wireless networks. These are formed by the devices that are able to communicate with each other using a wireless physical medium without having to resort to a pre existing infrastructure. Presence of infrastructure less network poses several types of challenges for this type of networking. Among these challenges the one important is routing. Routing, we mean process of exchanging information from one station to the other stations of the network. According to the way of how routing is setup, the routing protocols in MANETs can be divided into various routing protocols. There are various classification methods for mobile ad hoc network routing approaches. The classification methods are not completely orthogonal. According to different classification methods, a routing protocol can be categorized into different groups.

A. Classification Criteria

On Basis of Route Creation:

(a) Proactive protocol: This type of protocols attempt to find and maintain consistent, up-to-date routes between all source-destination pairs regardless of the use or need of such routes and we need periodic control messages to maintain routes up to date for each nodes e.g DSDV[3].

(b) Reactive protocol: Routes are created only when a source node request them. Data forwarding is accomplished according to two main techniques: Source routing and Hop by- hop routing e.g DSR[2],AODV[1].

On Basis of Topology:

(a) Destination based rouing protocol: In a destination based routing protocol, when forwarding a packet to the destination, a node only need to know the next hop along the routing path e.g AODV, DSDV. (b)Topology based routing protocol: In a topology based routing protocol for mobile ad hoc networks,nodes collect network topology information for making routing decisions. e.g DSR. On Basis of functional differences between mobile Nodes: (a) Uniform routing protocol: In a uniform routing protocol for mobile ad hoc networks, all mobile nodes have same importance and functionality.e.g DSR, AODV and DSDV routing protocol. (b)Non Uniform routing protocol: In a non-uniform routing protocol for mobile ad hoc networks, some nodes carry out distinct management and/or routing functions. Distributed algorithms are exploited to select those special nodes. Sometimes non uniform routing approaches are related to hierarchical network structures to facilitate node organization and management.

We have used Simulator NCTUns 6.0 [5][6] from Simreal Technologies. Latest version of Simulator was launched in January 2010. Many researchers had done the performance analysis of Ad Hoc Routing protocols over the years using different simulators so far based on varying number of nodes or any fixed number of in the Ad Hoc Network. We have done node wise analysis of entire network using different protocols namely AODV,DSR,DSDV. We have not seen the node wise analysis using NCTUns so far. The remaining paper is organized as follows: Section 2 provides the related work done in this area. Section 3 provides an overview of the three Ad Hoc Routing Protocols namely AODV, DSR and

DSDV. Section 4 describes the simulation environment and discusses the simulation results. Section 5 concludes the paper.

2. RELATED WORK

Many researchers have done the qualitative and quantitative analysis of Ad Hoc Routing Protocols by means of different performance metrics like packet delivery ratio, throughput, packets collision etc. They have used different simulators for this purpose namely like Ns2[12], Opnet[13], NCTUns.

Ha Duyen Trung et al[8] analyzed the performance differentials using varying network load and mobility. Simulations demonstrate the performance benefits of their proposal LAMR over LAR and AODV in most movement scenarios. They found AOMDV uses higher bandwidth than LAMR due to more frequent flooding of control packets. They discussed the performance evaluation and comparison of four routing protocols. Samir R. Das , Charles E. Perkins et al. [7] evaluated two on-demand routing protocols namely AODV and DSR with three performance metrics : Packet delivery fraction, Average End-End Delay and Normalized routing load with varying pause times. They have used ns-2 simulator. Based on the observations, recommendations were made as to how the performance of either protocol can be improved. Himabindu Pucha etal[10] studied the performance impact of diverse traffic patterns on routing protocols in MANETs. They propose a new communication model that extends the previous communication model to include a more general traffic pattern that varies the number of connections per source node and study the performance impact of traffic patterns on various routing protocols via detailed simulations of an ad hoc network of 112 mobile nodes. Their simulation results show that many of the conclusions drawn in previous protocol comparison studies no longer hold under the new traffic patterns. N.H. Saeed et al[15] proposed IMAN (intelligent manet routing system) . It include protocol switching depending on best optimal solution among different available protocols. They have taken various parameters like delay, RDR, MANET-RDR, MANET Routing Load. Using Opnet 11.5 as a simulator , they have incorporated ANFIS concept and neuro fuzzy logic for making entire system an intelligent system.

3. AD-HOC ROUTING PROTOCOLS

3.1 Destination-Sequenced Distance Vector (DSDV) routing Protocol

The Destination-Sequenced Distance-Vector[3] is a proactive unicast mobile ad hoc network routing protocol. It is a table-driven algorithm based on the classical Bellman-Ford routing mechanism [11]. The improvements made to the Bellman-Ford algorithm include absence of loops in routing tables. A routing table for every mobile node in the network is maintained in which all of the possible destinations within the net work and the number of hops to each destination are stored. Sequence number assigned by destination node for each entry. The advantage of sequence numbers for nodes is to avoid formation of routing loops by distinguishing stale routes from fresh routes. The route updates of DSDV can be either event-driven or time-driven. Every node periodically transmits updates including its routing information to its immediate neighbours. While a significant change occurs from the last update, a node can transmit its changed routing table in an event-triggered style. Moreover, the DSDV has two ways when sending routing table updates. Full Dump: This type of update packet carries all available routing information . A "full dump" update could span in many packets. Incremental update: This type of update packet contains only those entries that with metric have been changed since the last update is sent. Additionally, the incremental update fits in one packet. New route broadcast contains following fields:

Address of the destination
Number of hops to reach the destination
Sequence number of the information received regarding the destination
New sequence number unique to the broadcast

Selection of new route is based on the route labeled with the most recent sequence number. In the event that two updates have the same sequence number, the route with the smaller metric is used.

3.2 Dynamic Source Routing (DSR) Protocol

The key distinguishing feature of DSR [2] is the use of source routing. The sender knows the complete hop -by-hop route to the destination. These routes are stored in a route cache. The source route are carried in the packet header of data packets. If a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, then it uses a route discovery process to dynamically determine such a route.DSR protocol makes very aggressive use of source routing and route caching. There are three types of packets viz RREQ, RREP, RERR. These are described as follows:

RREQ, RREP, RERR: Route discovery works by flooding the network with route request (RREQ) packets. Each node receiving an RREQ packets again broadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ packets builds up the path traversed across the network. The RREP packets routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. When any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed.

3.3 Ad-hoc On Demand Routing Protocol (AODV)

The AODV [1] routing protocol shares features of both DSDV [3] and DSR [2] algorithms. AODV shares DSR's on-demand characteristics in that it also discovers route as and when needed by initiating a route discovery process. It maintains one entry per destination in its routing tables unlike in DSR, which maintains multiple route entries for each destination in its route cache. The Ad Hoc On-Demand Distance-Vector Protocol (AODV) is a distance vector routing for mobile ad-hoc networks. AODV is an on-demand routing approach, i.e. there are no periodical exchanges of routing information. The protocol consists of two phases:
Route Discovery and Route Maintenance. AODV is a reactive routing protocol that minimizes the number of broadcasts by creating routes on demand. A route request packet (RREQ) to

find a path to the destination, is broadcasted by the source till it reaches an intermediate node that has recent route information about the destination or till it reaches the destination. When a node forwards a RREQ to its neighbours, it also records in its tables the node from which the first copy of the request came. This information is used to construct the reverse path for the route reply packet (RREP). As the RREP follows the reverse path of the RREQ so AODV uses only symmetric links. If one of the intermediate nodes moves then the moved node's neighbour sends a link failure notification to its upstream neighbours and so on till it reaches the source upon which the source can reinitiate route discovery if needed.

4. SIMULATION ENVIRONMENT AND RESULTS

NCTUns is open source, high quality, and supports many types of networks. The NCTUns is a high-fidelity and extensible network simulator and emulator capable of simulating various protocols used in both wired and wireless IP networks. Its core technology is based on the novel kernel re-entering methodology invented by Prof. S.Y. Wang[5][6] when he was pursuing his Ph.D. degree at Harvard University. Due to this novel methodology,NCTUns provides many unique advantages that cannot be easily achieved by traditional network simulators such as ns-2 and OPNET. After obtaining his Ph.D. degree from Harvard University in September 1999, Prof. S.Y. Wang returned to Taiwan and became an assistant professor in the Department of Computer Science and Information Engineering, National Chiao Tung University (NCTU), Taiwan, where he founded his "Network and System Laboratory."

4.1 Simulation Environment

The various parameters which are set for doing simulation are described in table1. We have taken three performance metrics namely dropped packets, number of incoming – outgoing packets and throughput of incoming and outgoing packets.

Name of parameter	***Value***
SIMULATOR USED	NCTUns 6.0
NUMBER OF NODES	4
MAC LAYER	802.11
MOBLITY MODEL	RANDOM WAY POINT
MOVING SPEED	10 M/SEC
SIMULATION TIME	20 SECONDS
SOURCE NODE	NODE1
DESTINATION NODE	NODE4
SOURCE IP ADDRESS	1.0.1.1
DESTINATION IP ADDRESS	1.0.1.4
NODE SPACING	200 M
TOP LEFT POSITION OF X , Y	80,80
ROUTING PROTOCOL USED	AODV, DSR, DSDV

Table 1: Simulation Parameters

4.2 NODE WISE SIMULATION RESULT OF AODV, DSR, DSDV

4.2.1 Number of incoming outgoing packets at various nodes

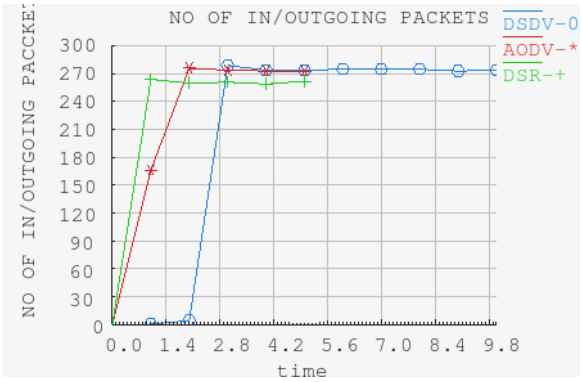

Figure 1 : Number of incoming-outgoing packets at node 1

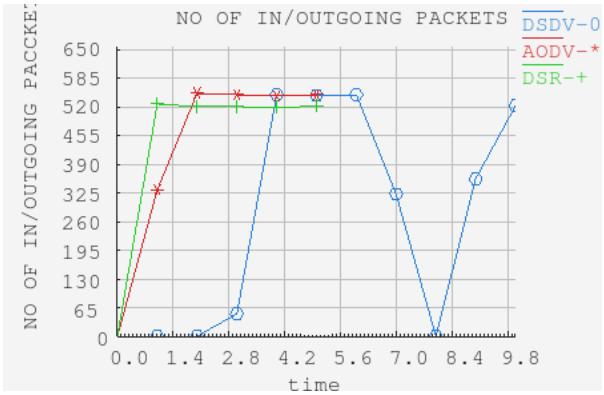

Figure 2: Number of incoming-outgoing packets at node 2

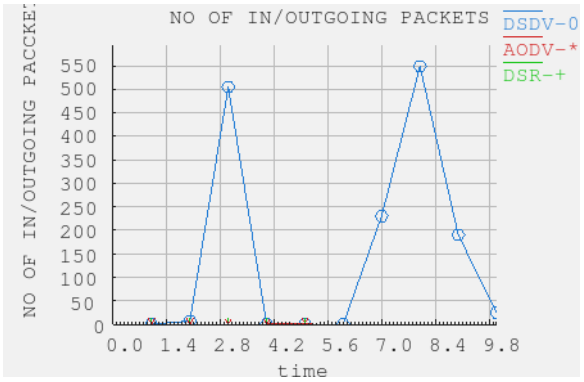

Figure 3 : Number of incoming-outgoing packets at node 3

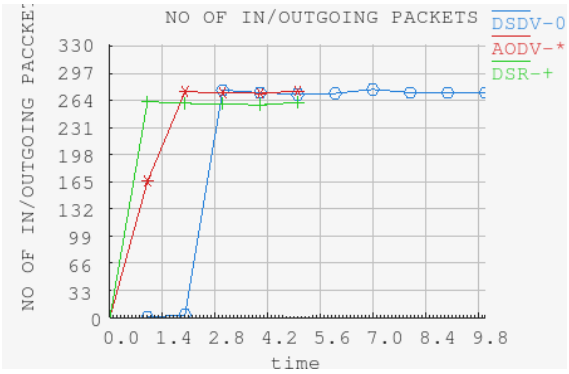

Figure 4 : Number of incoming-outgoing packets at node 4

4.2.2 Number of packets dropped at various nodes

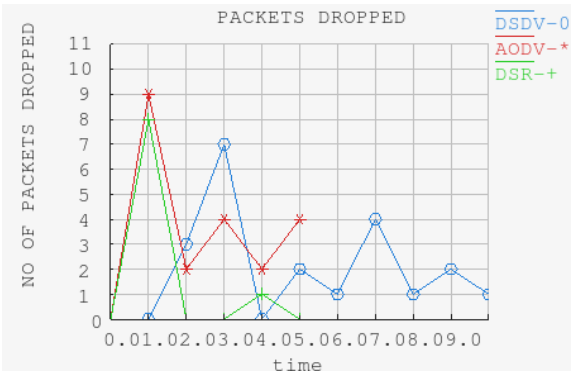

Figure 5: Number of packets dropped at node 1.

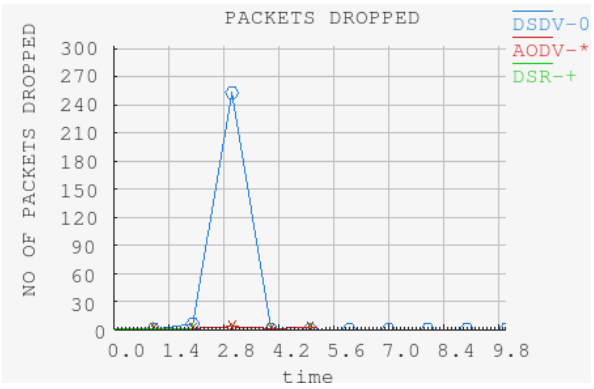

Figure 6: Number of packets dropped at node 2.

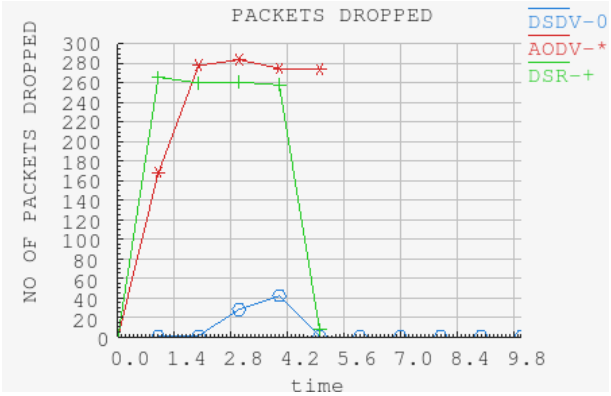

Figure 7: Number of packets dropped at node 3.

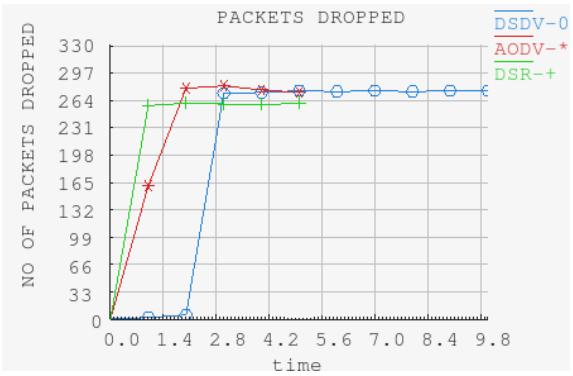

Figure 8: Number of packets dropped at node 4.

4.2.3 Throughput of incoming outgoing packets at various nodes

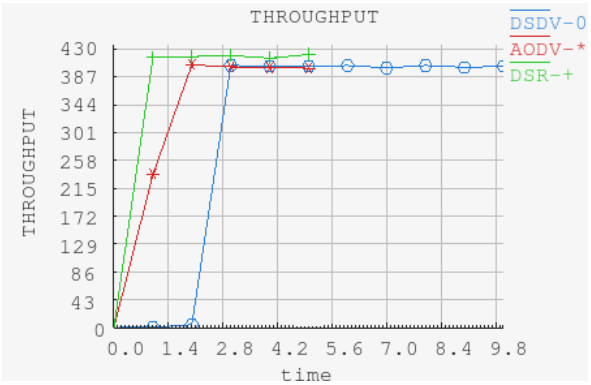

Figure 9 : Throughput of incoming and outgoing packets for node 1

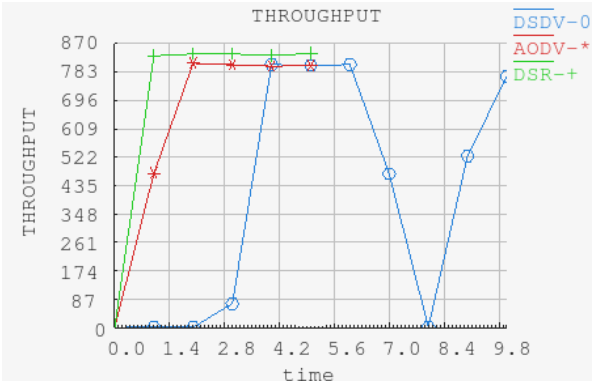

Figure 10: Throughput of incoming and outgoing packets for node 2

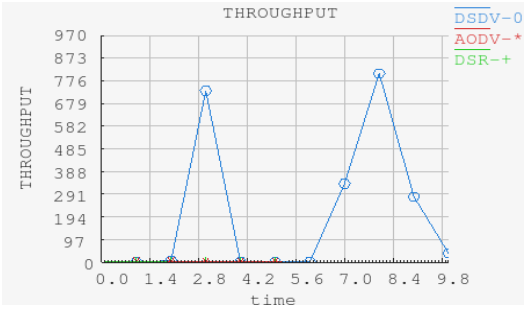

Figure 11 : Throughput of incoming and outgoing packets for node 3

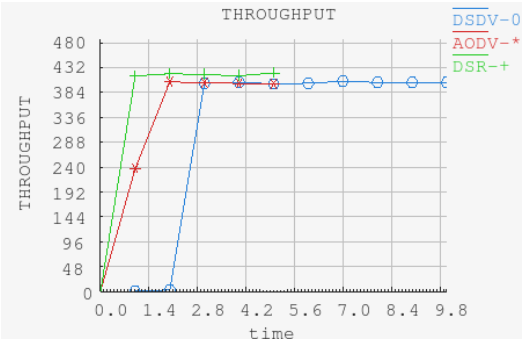

Figure 12: Throughput of incoming and outgoing packets for node 4

4.3 Node Wise Analysis Of Graphs

Number of incoming and outgoing packets: Number of incoming and outgoing packets at node 1(Figure 1), node 3(Figure3) and node 4 (Figure 4) are almost same using reactive protocol (AODV,DSR) but slight delay is seen for proactive protocol (DSDV). Almost negligible number of packets are observed at node 2(Figure 2), reason being the path taken from source to destination does not involve node 2.

Number of packets dropped: Number of packets dropped at node 1 (Figure 5) using all the protocols are less than 10, but at node 3 (Figure 7), node 4 (Figure 8) this is increased to 250. At node 3 the packets dropped using DSDV is very less as compare to AODV, DSR.

Throughput of incoming and outgoing packets: At node 1 (Figure 9), node 2 (Figure 10), node 4 (Figure 12) DSR has slightly more throughput than AODV and DSDV. But at node 3 (Figure 11) as there are negligible number of incoming and outgoing packets so throughput is also negligible.

5. CONCLUSION

After doing analysis we want to conclude that path selected from source node to destination node plays an important role for finding various performance metrics. As proactive protocols like DSDV attempt to find and maintain consistent, up-to-date routes between all source-destination pairs regardless of the use or need of such routes so although the node 2 is not under the selected path but DSDV still contains information about this node . But reactive protocol DSR,AODV contains routes only when the demand came . As node 2 was not present in selected path so very less amount of packets are coming to this node. If user give no priority then AODV gives better performance at the nodes where the mobility of nodes is medium DSR gives good throughput for small number of nodes. This result is the first step in node wise optimization for MANET routing protocols that are capable of performing best in specific scenario. Now our next step will be towards the optimization of various performance metrics at each node which in turn will increase overall performance of network. As we have seen from simulation result that not a single protocol has the best performance at every node but every protocol gives their best throughput depending on number of packets coming at each node. Our proposed idea for optimization of performance will include intelligent routing system, which will make use of artificial neural network for training the node and genetic algorithms for selection of "best fitted protocol" for given scenario. N.H. Saeed et al[15] at Wireless Network Computing Group (WNCG), School of Engineering and Design, Brunel University, West London, Uxbridge, UK have proposed IMAN (intelligent manet routing system) . It include protocol switching depending on best optimal solution among different available protocols. We will try to carry forward their work for optimization at each node. As shown in above result the number of incoming packets at node 2 is negligible in AODV, DSR so we can shift the traffic to node 2 at the time of congestion or node 3 failure. For this we need to train the network using ANN. Then the optimization of node performance will be done using genetic algorithm. We are working on this proposed idea. In future we hope to come with the results of proposed strategy.

6. References

[1] C.E. Perkins and E.M. Royer, "Ad-Hoc on-Demand Distance Vector Routing," Proc. Workshop Mobile Computing Systems and Applications (WMCSA '99),Feb. 1999, pages 90-100.

[2] David B. Johnson and David A. Maltz. "Dynamic source routing in ad hoc wireless networks", Mobile Computing, Kluwer Academic Publishers, edited by Tomasz Imielinski and Hank Korth, chapter 5, \\pages 153–181, 1996.

[3] C. E. Perkins and P. Bhagwat "Highly dynamic destination sequenced distance-vector routing (DSDV) for mobile computers", Proceedings of the ACM SIGCOMM '94 Conference, August 1994, pages 234–244.

[4] Technical Report (Nr. 2003-08) A Survey of Mobile Ad Hoc network Routing Protocols Changling Liu, Jörg Kaiser.

[5] Shie-Yuan Wang, Chih-Che Lin "NCTUns 6.0:A simulator for advanced wireless vehicularnetwork research", proceedings of Vehicular Technology Conference (VTC 2010-Spring), 2010 IEEE 71st, 2010 , page(s): 1 – 2.

[6] NCTUns 6.0 http://nsl10.csie.nctu.edu.tw/

[7] S.R. Das, C.E. Perkins, and E.E. Royer, "Performance Comparison of Two On-Demand Routing Protocols for Ad Hoc Networks," Proc. INFOCOM, 2000, pp. 3-12.

[8] Ha Duyen Trung , Watit Benjapolakul, Phan Minh Duc, "Performance evaluation and comparison of different ad hoc routing protocols", Elsevier B.V. Computer Communications 30 (2007),page 2478–2496.

[9] Lei Guo a,b, Yuhuai Peng a, Xingwei Wang a, Dingde Jiang a, Yinpeng Yu, "Performance evaluation for on-demand routing protocols based on OPNET modules in wireless mesh networks" , press article, Elsevier.

[10] Himabindu Pucha, Saumitra M. Das, Y. Charlie Hu, "The performance impact of traffic patterns on routing protocols in mobile ad hoc networks" , Computer Networks , Elsevier (2007)page 3595–3616.

[11] L. R. Ford Jr. and D. R. Fulkerson, Flows in Networks, Princeton Univ.Press, 1962.

[12] Technical Report (Nr. 2003-08) A Survey of Mobile Ad Hoc network Routing Protocols Changling Liu, Jörg Kaiser.

[13] Network Simulator 2, http://www.isi.edu/nsnam/ns/.

[14] OPNET Simulator, http://www.opnet.com.

[15] N.H. Saeed, M.F. Abbod, H.S. Al-Raweshidy, "IMAN : An Intelligent MANET Routing System", 17th International conference of telecommunication ,IEEE 2009, page 401-404.