Comparative Analysis of CBRP, DSR, AODV Routing Protocol in MANET

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Abstract. ***An ad-hoc network is self-organizing and adaptive. Networks are formed on-the-fly, devices can leave and join the network during its lifetime, devices can be mobile within the network, the network as a whole may be mobile and the network can be deformed on-the-fly. Devices in mobile ad-hoc networks should be able to detect the presence of other devices and perform the necessary set-up to facilitate communications and the sharing of data and services. This paper focuses on the three popular routing algorithms Ad-Hoc on Demand Distance Vector (AODV), Dynamic Source Routing (DSR) both being reactive routing protocols and Cluster Based Routing Protocol (CBRP), a proactive routing protocol. The performance analysis is done with the help of packet delivery ratio(PDR), average end-to-end delay and routing overhead through simulation using GLOMOSIM simulator.***

Keywords: MANETs, Routing Protocol, CBRP, AODV, DSR.

1. INTRODUCTION

A Mobile ad-hoc network (MANETs) is a system **of** wireless mobile nodes dynamically self-organizing in arbitrary and temporary network topologies. Mobile ad-hoc networks can turn the dream of getting connected "anywhere and at any time" into reality. Typical application examples include a disaster recovery or a military operation. Not bound to specific situations, these networks may equally show better performance in other places[1]. In MANET, all the nodes are mobile nodes and the topology will be changed rapidly. The structure of the MANET is shown in Fig. 1.

A MANETS is expected to be of large size than the radio range of wireless antenna, because of this reason it could be necessary to route the traffic through a multihop. Routing protocols in MANETs can be classified as Proactive (Table driven), Reactive (On demand) and Hybrid. The primary goal of an ad-hoc network routing protocol is to provide correct and efficient route establishment between pair of nodes so that the messages may be delivered on time[2].

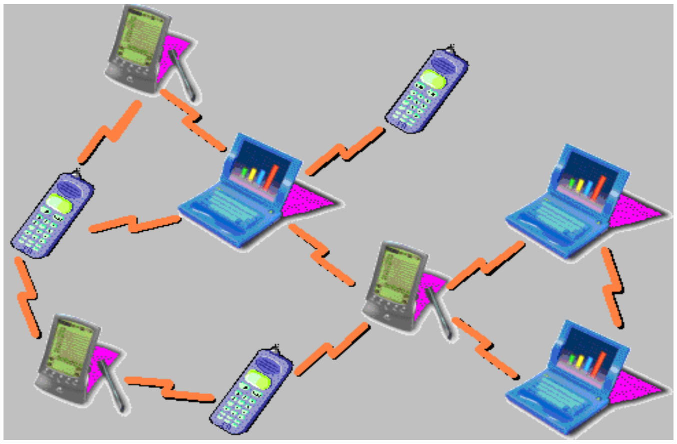


Fig. 1. Structure of MANET.

In table-driven protocol, each node maintains a routing table, containing routing information on reaching every other node in the network. All the nodes update these tables so as to maintain a consistent and up-to-date view of the network. Proactive routing protocol use periodic broadcast to establish routes and maintain them. The advantage is that routes to any destination are always available without the overhead of a route discovery.

In on-demand routing, all up-to-date routes are not maintained at every node, instead the routes are created when required. When a source wants to send a destination, it invokes a route discovery mechanism to find the path to the destination. The route remains valid till the destination is unreachable or until the route is no longer needed.

Hybrid protocols combine the benefit of both approaches. Hybrid protocols are scalable to network size.

The remainder of the paper is organized as follows. Section 2 shows issues and difficulties in MANET, also briefly reviews the three on-demand routing protocols: AODV, CBRP and DSR and analyze the differences between these protocols that may affect their performance in Section 3. Section 4 presents the simulation experiments carried out to study and compare the performance of the three routing protocols, followed by the conclusions in Section 5.

2. ISSUES AND DIFFICULTIES IN MANETS

MANETs differ from the traditional wired Internet infrastructures. The differences introduce difficulties for achieving Quality of Service in such networks. Some of the problems as listed below:

A. *Dynamic topologies*: Nodes are free to move arbitrarily; thus, the network topology - which is typically multi-hop - may change randomly and rapidly at unpredictable times, and may consist of both bidirectional and unidirectional links.

B. *Bandwidth-constrained, variable capacity links*: Wireless links will continue to have significantly lower capacity than their hardwired counterparts. In addition, the realized throughput of wireless communications - after accounting for the effects of multiple access, fading, noise, and interference conditions, etc.- is often much less than a radio's maximum transmission rate. One effect of the relatively low to moderate link capacities is that congestion is typically the norm rather than the exception, i.e. aggregate application demand will likely approach or exceed network capacity frequently. As the mobile network is often simply an extension of the fixed network infrastructure, mobile ad hoc users will demand similar services. These demands will continue to increase as multimedia computing and collaborative networking applications rise.

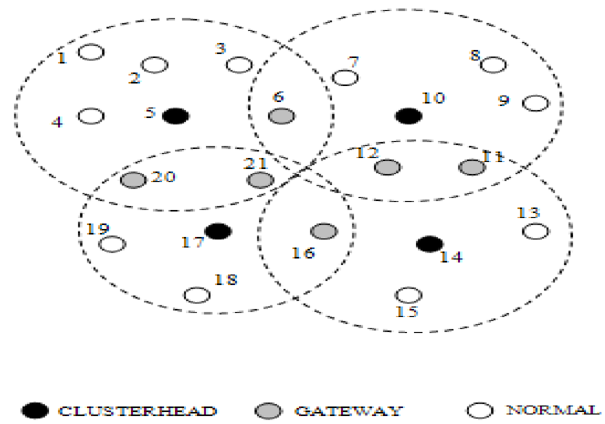
C. *Energy-constrained operation*: Some or all of the nodes in a MANET may rely on batteries or other exhaustible means for their energy. For these nodes, the most important system design criteria for optimization may be energy conservation.

3. ROUTING PROTOCOL

CLUSTER BASED ROUTING PROTOCOL

CBRP (Cluster Based Routing Protocol) is an on-demand routing protocol, where the nodes are divided into clusters. It uses clustering's structure for routing protocol. Clustering is a process that divides the network into interconnected substructures, called clusters. Each cluster has a cluster head as coordinator within the substructure. Each cluster head acts as a temporary base station within its zone or cluster and communicates with other cluster heads.

CBRP is a routing protocol designed to be used in mobile ad hoc networks. The protocol divides the nodes of the ad hoc network into a number of overlapping or disjoint 2-hop-diameter clusters in a distributed manner. Each cluster chooses a head to retain cluster membership information. there are four possible states for the node: NORMAL, ISOLATED, CLUSTERHEAD and GATEWAY. Initially all nodes are in the state of ISOLATED. Each node maintains the NEIGHBOR table wherein the information about the other neighbor nodes is stored cluster heads have another table (cluster heads NEIGHBOR) wherein the information about the other neighbor cluster heads is stored[4].



3.2. ADHOC ON-DEMAND DISTANCE VECTOR (AODV)

Adhoc On-Demand Distance Vector (AODV), which is used to provide secure and reliable data transmission over the MANETs [5]. AODV discovers a route through network-wide broadcasting. The source host starts a route discovery by broadcasting a route request to its neighbors. In the route request, there is a requested destination sequence number which is 1 greater than the destination sequence number currently known to the source. This number prevents old routing information being used **as** reply to the request, which is the essential reason for the routing loop problem in the traditional distance vector algorithm.

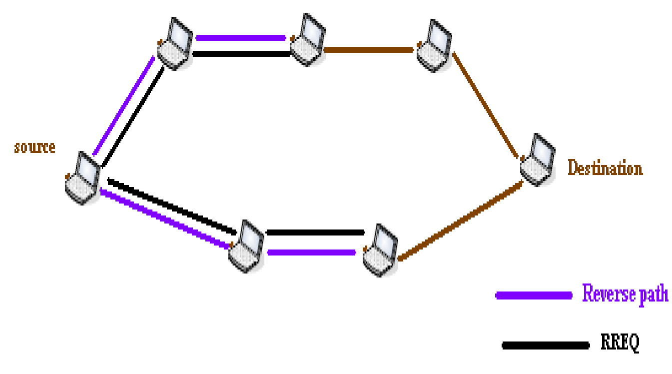


Fig. 2: Route Requests in AODV

When a node wants to send a packet to some destination node and does not have a valid route in its routing table for that destination, it initiates a route discovery process. Source node broadcasts a route request (RREQ) packet to its Neighbours, which then forwards the request to their neighbours and so on. Nodes generate a Route Request with destination address, Sequence number and Broadcast ID and sent it to his neighbour nodes. . Each node receiving the route request sends a route back (Forward Path) to the node as shown in the fig. 1.

When the RREQ is received by a node that is either the destination node or an intermediate node with a fresh enough route to the destination, it replies by unicasting the route reply (RREP) towards the source node. As the RREP is routed back along the reverse path, intermediate nodes along this path set up forward path entries to the destination in its route table and when the RREP reaches the source node, a route from source to the destination established. Fig. 2 indicates the path of the RREP from the destination node to the source node.

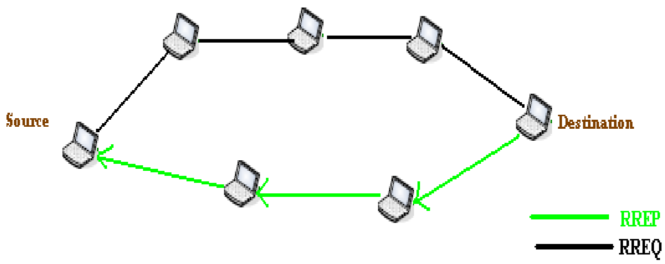


Fig. 2. RREP in AODV

3.3 DSR

The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing 20 network infrastructure or administration. Dynamic Source Routing, DSR[6], is a reactive routing protocol that uses source routing to send packets. It uses source routing which means that the source must know the complete hop sequence to the destination. Each node maintains a route cache, where all routes it knows are stored. The route discovery process is initiated only if the desired route cannot be found in the route cache. To limit the number of route requests propagated, a node processes the route request message only if it has not already received the message and its address is not present in the route record of the message.

4. SIMULATION

The simulations were performed using GLOMOSim [], popular in the adhoc networking community. CBR is the traffic sources. The source-destination pairs are spread randomly over the network.

Random waypoint model is one of the mobility model which is used for the scenario in a terrain dimension area of 1000m x 1000m with 50 nodes. During, the simulation, each node starts with journey from a random spot to a random chosen destination. Table 1 shows the simulation parameters used in the evaluation.

Table 1 : Simulation parameters for scenario

Parameter	Value
No. of Nodes	10,20,40
Area	1000m*1000m
Simulation time	960sec
Phy and MAC Model	802.11
Node Placement	Random
Mobility	Random Way point(0-25msec)
Transmission Power	15.0 dBm
Bandwidth(B/S)	2000000
Radio Frequency	2.4e9 Hz
Routing Protocol	AODV, DSR,CBRP

To evaluate QoS parameters performance for IEEE 802.11 using different reactive routing, use the following QoS performance metrics.

Packet delivery ratio(PDR): It is the ratio of the number of data packets successfully delivered to destination nodes to the total number of data packets sent by source nodes. Mathematically, it can be expressed as:

$$PDR = \frac{1}{c}\sum_{f=1}^{c}\frac{R_f}{N_f}$$

Where PDR is the fraction of successfully delivered packets, C is the total number of flow or connections, f is the unique flow id serving as index, R_f is the count of packets received from flow f and N_f is the count of packets transmitted to f.

Average End-to-End delay: It indicates the length of time taken for a packet to travel from the CBR (Constant Bit Rate) source to the destination. It represents the average data delay an application experiences during transmission of data.

$$AD = \frac{1}{N}\sum_{i=1}^{s}(r_i - s_i)$$

Where N is the number of successfully received packets, I is unique packet identifier, r_i is time at which a packet with unique id I is received, s_i is time at which a packet with unique id I is sent and D measured in ms. It should be less for high performance.

Normalized routing overhead: the number of control packets “transmitted” per data packet “delivered” at the destination.

5. SIMULATION RESULTS & OBSERVATIONS

The simulation results are shown in the following section in the form of line graphs. Graphs show comparison between the three protocols by varying different number of sources on the basis of the above-mentioned metrics as a function of pause time.

A. Packet Delivery Ratio(PDR) or Throughput

Fig. 4.1-4.3, shows a comparison a comparison between the routing protocols on the basis of packet delivery ratio as a function of pause time and using different number of traffic sources. Throughput describes the loss rate as seen by the transport layer. It reflects the completeness and accuracy of the routing protocol. According to the graphs, it is clear that throughput decrease with increase in mobility. As the packet drop at such a high load traffic is much high.

The given graph shows that CBRP and DSR performs better in delivering packets which is 90% and 88% but AODV shows an average PDR equals to 80% . Between

DSR and CBRP, CBRP gives slightly better throughput for a larger network size and better scalability comes from its largely reduced flooding for route discovery.

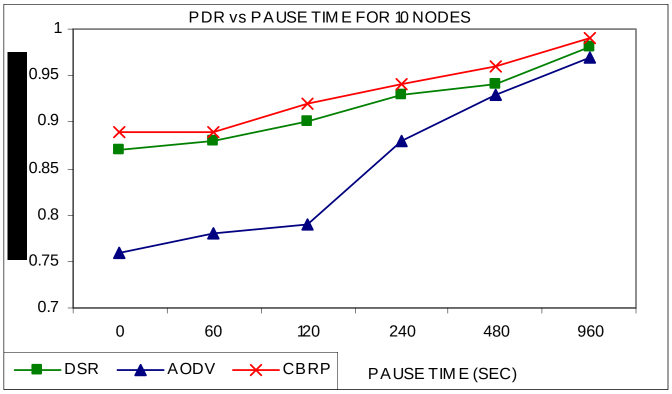


Fig. 4.1 PDR vs Pause Time for 10 nodes

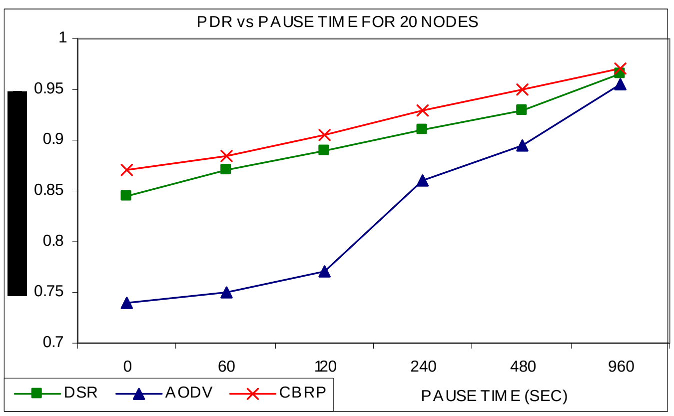


Fig. 4.2 PDR vs Pause Time for 20 nodes

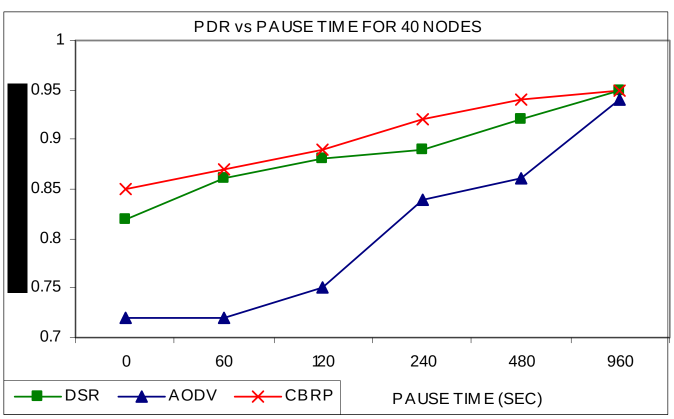


Fig. 4.3 PDR vs Pause Time for 40 nodes

*B. **Average End to End Delay***

Fig. 4.4 – 4.6, shows the graphs for end-to-end delay Vs pause time. From these graphs we see that the average packet delay increase for increase in number of nodes waiting in the interface queue while routing protocols try to find valid route to the destination. Besides the actual delivery of data packets, the delay time is also affected by route discovery, which is the first step to begin a communication session. The source routing protocols have a longer delay because their route discovery takes more time as every intermediate node tries to extract information before forwarding the reply. The same thing happens when a data packet is forwarded hop by hop. Hence, while source routing makes route discovery more profitable, it slows down the transmission of packets.

Out of the three routing protocols, AODV has the shortest average end-to-end delay (0.0077sec). CBRP and DSR have average end-to-end delay of 0.0227 and 0.035 sec resp. besides the actual delivery of data packets, the delay time is also affected by route discovery. CBRP is even more time consuming because of its two-phase route discovery. The task of maintaining cluster structure also takes a piece of host CPU's time.

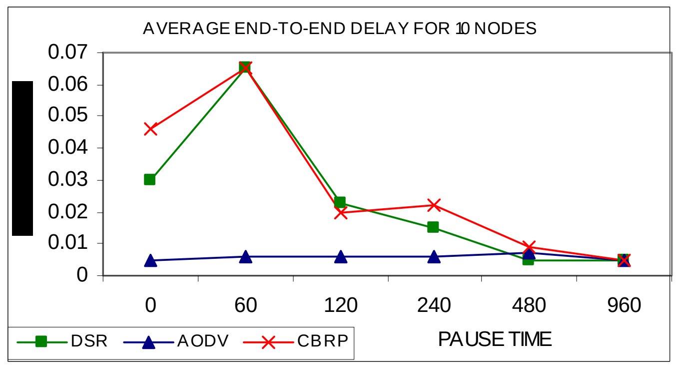


Fig. 4.4 Average End-to-End Delay vs Pause Time for 10 nodes

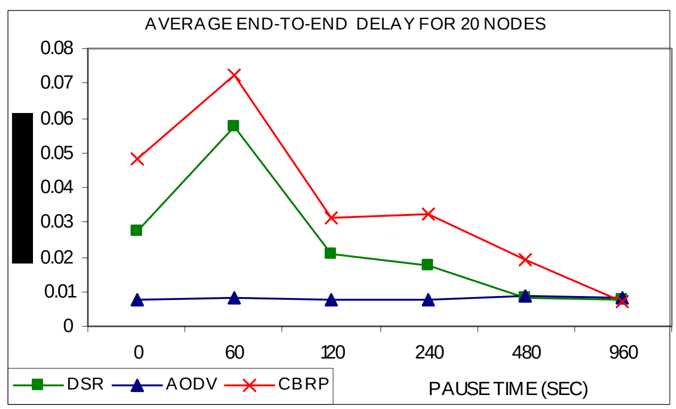


Fig. 4.5 Average End-to-End Delay vs Pause Time for 20 nodes

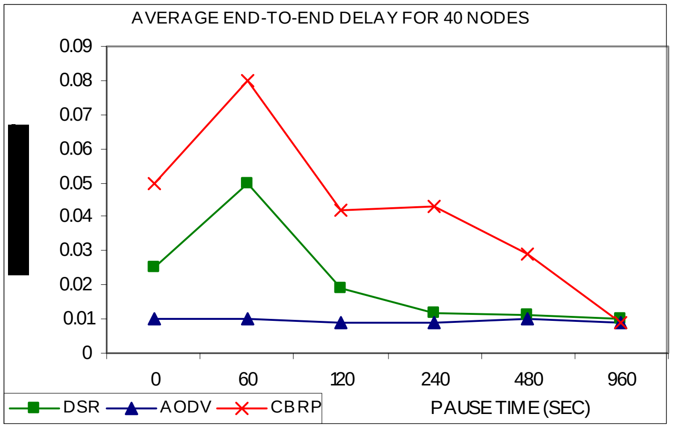


Fig. 4.6 Average End-to-End Delay vs Pause Time for 40 nodes

C. Routing Overhead.

Fig. 4.7-4.9 shows the performance of CBRP, AODV and DSR by evaluating Normalized packet overhead with varying pause time for 10, 20 and 40 number of nodes. Average packet overhead per packet received is 0.289, 1.67 and 2.75 for DSR, AODV and CBRP respectively. tn most cases, both the packet overhead and the byte overhead of CBRP and one-ninth of AODV's overhead. Due to smaller flooding range of CBRP, the number of ots route requests and replies is very less than that of DSR. But its hello messages outweigh this gain. The size of hello messages of CBRP can be larger than the size of the HELLO message of DSR. Hence, its byte overhead is more than DSR.

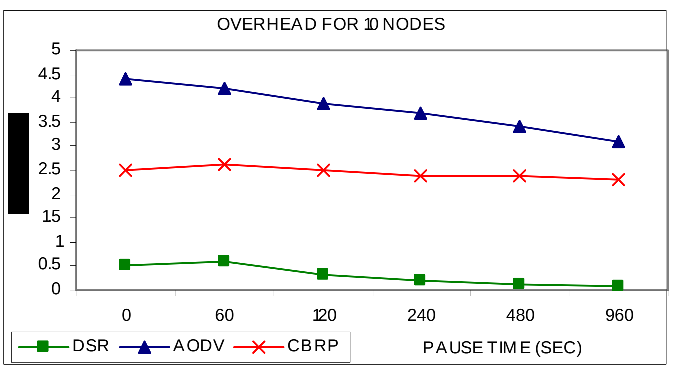
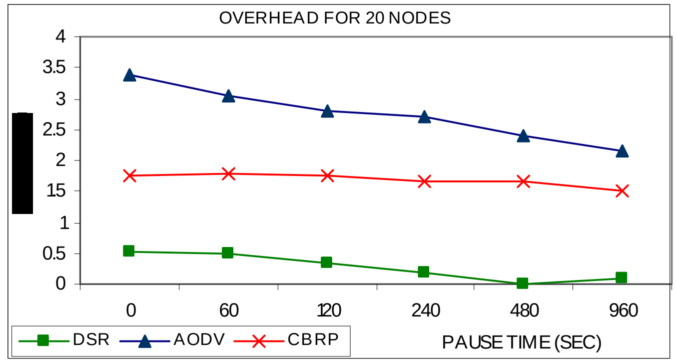
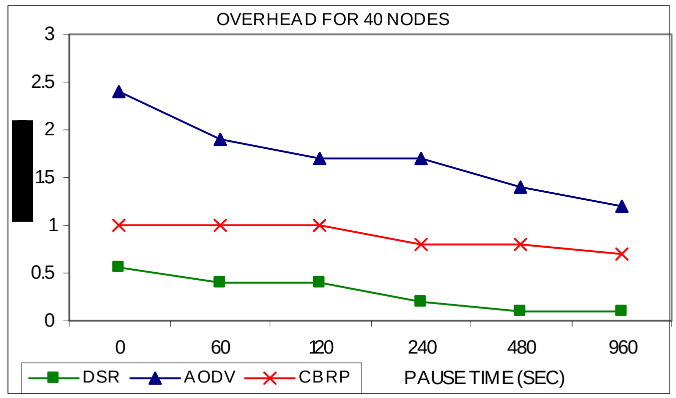


Fig. 4.7 Routing Overhead vs Pause Time for 10 nodes





5. CONCLUSION

This study was conducted to evaluate the performance between the three MANET routing protocols i.e. DSR, AODV and CBRP based on CBR traffic. These routing protocols were compared in terms of Packet delivery ratio, Average routing overhead and Average end-to-end delay when subjected to change in pause time and varying no. of nodes. Various algorithms developed by researchers cannot competing the requirement of mobile adhoc networks. Simulation results show that by comparing the performance between DSR, AODV and CBRP, we can conclude that a cluster structure bring scalability and routing efficiency for a MANET as the network traffic load or network size increases. A more stable cluster structure brings efficiency in route discovery and maintenance whereas a less overlapping cluster structure brings efficiency in routing overheads reduction.

References

[1] C. E. Perkins and E. M. Royer, "Ad-hoc on demand distance vector routing," in *Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA'99)*, vol. 3, New Orleans, LA, USA, February 1999, pp. 90–100.

[2] S. R. Das, C. E. Perkins, E. M. Royer, and M. K. Marina, "Performance comparison of two on-demand routing protocols for ad hoc networks," *IEEE Personal Communications Magazine, special issue on Mobile Ad Hoc Networks*, vol. 8, no. 1, pp. 16–29, February 2001.

[3] S. Ramanathan, M.E. Steenstrup, "**A** Survey of Routing Techniques for Mobile Communications Networks", *ACM MONET,* Vol.1 (1996), pp. 98-104.

[4] M**.** Jiang, J. Li, and Y.C. Tay. *"Cluster Based Routing Protocol (CBRP)"* , IETF MANET Working Group, Internet-Draft, 1999.

[5] C. E. Perkins, E. RM. Royer, and Samir R. Das. "*Ad Hoc On-Demand Distance Vector (AODV) Routing*", IETF MANET Working Group, Internet-Draft, March 2000**.**

[6] D. B. Johnson and D. A. Maltz. "*Dynamic Source Routing in Ad Hoc Wireless Networks*"**,** Mobile Computing, Chapter **5,** pages 153-181, Kluwer Academic Publishers, 1996.