ISSN:0975-9646

Makarand R. Shahade et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 3 (1) , 2012, 2969 - 2974

Simulation Result of Hybrid Routing Protocol for Mobile Ad hoc Network

Mr. Makarand R. Shahade
Asst. Prof., Department of I.T.
J.D. Institute of Engg. & Technology,
Yavatmal, INDIA

Prof. Dr. D. N. Choudhari
Professor, Department. of I.T.
J.D.Institute of Engg. & Tech.,
Yavatmal, INDIA

Abstract - **MaNet has emerged as one of the most focused and thrust research areas in the field of wireless networks and mobile computing. In ad hoc mobile networks, routes are mainly multi hop because of the limited radio propagation range and topology changes frequently and unpredictably since each network host moves randomly. Therefore, routing is an integral part of ad hoc communications. Many routing protocols are proposed for MaNet. The protocols are mainly classified in to three categories: Proactive, Reactive and Hybrid. Proactive routing protocols attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. Reactive routing protocols creates routes only when desired by the source node. Once a route has been established, it is maintained by a route maintenance procedure.**

In this paper, we propose Routing Protocol which combines the merits of proactive and reactive approach and overcome their demerits. We propose variation of this proposed Hybrid Routing Protocol (HRP), the propose protocol creates route only when desired by the source node as in case of reactive routing protocols. The propose protocols maintain routing table at each node as in case of proactive routing protocols. Hence called hybrid routing protocol.

The propose protocol takes advantage of broadcast nature of MaNet to discover route and store maximum information in the routing tables at each node. HRP-Broadcast Reply is compared with existing routing protocol AODV using simulation result. The results of Data packets sent and dropped in the Network shows significant reduction in routing overhead, end- to-end delay and increases packet delivery ratio over AODV.

Keywords - **Mobile ad hoc network, Hybrid Routing Protocol, Proactive Routing Protocols, Reactive Routing Protocols, AODV, Broadcast Reply (BR)**

I. INTRODUCTION

MaNet [1] has emerged as one of the most focused and thrust research areas in the field of wireless networks and mobile computing. Mobile ad hoc networks consist of hosts communicating one another with portable radios. These networks can be deployed impromptu without any wired base station or infrastructure support. In ad hoc mobile networks, routes are mainly multi hop because of the limited radio propagation range and topology changes frequently and unpredictably since each network host moves randomly. Therefore, routing is an integral part of ad hoc communications, and has received interests from many researchers. Many routing protocols are proposed for MaNet. The protocols are mainly classified into three types, Proactive, Reactive and Hybrid [2,4]. In Proactive [2, 5] i.e.

Table-driven routing protocols attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store routing information, and they respond to changes in network topology by propagating hello messages throughout the network in order to maintain a consistent network view.

Reactive routing protocol [6,8]creates routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. The Ad hoc On-demand Distance Vector (AODV) [6, 8, 9] protocol, one of the reactive routing protocol that has receive the most attention, however, does not utilize multiple paths. In AODV [2, 6], at Every instance, route discovery is done for fresh communication which consumes more bandwidth and causes more routing overhead. The data packets will be lost during path break which occurs due to node mobility. When the network traffic requires real time delivery (voice, for instance), dropping data packets at the intermediate nodes can be costly. Likewise, if the session is a best effort, TCP connection, packet drops may lead to slow start, timeout, and throughput degradation.

This paper Hybrid Routing Protocol which combines the features of proactive and reactive routing protocol approaches [2]. This paper propose Hybrid Routing Protocol (HRP), The propose protocol creates route only when desired by the source node as in case of reactive routing protocols. The propose protocols maintain routing table at each node as in case of proactive routing protocols. Hence called hybrid routing protocol. The proposed protocol takes advantage of broadcast nature of MaNet which is used to gain maximum routing information at the nodes in the network. HRP-BR with AODV, a highly used reactive routing protocol in Ad hoc network. The simulation Results of Data packets sent and dropped in the Network shows significant reduction in routing overhead, End-To-End delay as well as increase packet delivery ratio.

II. PROACTIVE ROUTING PROTOCOLS

In Proactive [3, 5, 19] i.e. Table-driven routing protocols attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store routing information, and they respond to changes in network topology by propagating hello messages [20] throughout the network in order to maintain a consistent network view.

A. Destination-Sequenced-Distance-Vector Routing

Destination- Sequenced-Distance-Vector Routing [5] is the table driven routing based on classical Bellman-ford routing mechanism. Every mobile node in the network maintains routing table in which all of the possible destinations within the network and the number of hops to each destination are recorded.

B. Cluster Head Gateway Switch Routing

Cluster head gateway switch routing [21] uses hierarchical network topology. The nodes are organized into small clusters. Each cluster is having cluster-head which coordinate the communication among members of each cluster head. Cluster-head also handles issues like channel access ,bandwidth allocation in the network.

C. Wireless Routing Protocol

Wireless Routing Protocol is one of the table driven routing protocol [22]. Each node is responsible for maintaining four tables i.e. Distance table(DT), Routing table(RT), Link cost table(LCT) and Message Transmission List table(MRL).

The comparison of proactive routing protocol [19] is summarized in Table I.

Table I : Comparison of Proactive Routing Protocol

Parameter	DSDV	CGSR	WRP
Time Complexity (Link Addition/Failure)	O(d)	O(d)	O(h)
Communication complexity (Link Addition/Failure)	O(x=N)	O(x=N)	O(x=N)
Routing Philosophy	Flat	Hierarchical	Flat
Loop Free	Yes	Yes	Yes but not instantaneous
Multicast Capability	No	No	No
Number of Required Tables	Two	Two	Four
Frequency of Update Transmission	Periodically & as Needed	Periodically	Periodically & as Needed
Updates Transmission to	Neighbor	Neighbor and Cluster Head	Neighbor
Utilizes Sequence Numbers	Yes	Yes	Yes but not instantaneous
Utilizes "Hello" messages	Yes	No	Yes but not instantaneous
Routing Metric	Shortest Path	Shortest Path	Shortest Path

Abbreviations:
N=No. of nodes in the network h=Height of Routing Tree
d=Network Diameter x=No. of nodes affected by topological change

III. REACTIVE ROUTING PROTOCOLS

Another approach used for routing is reactive approach [6,7]. This type of routing creates routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired.

A. Ad hoc On-Demand Distance Vector (AODV)

The Ad hoc On-demand Distance Vector (AODV) [6, 8, 9] protocol, one of the on-demand routing algorithms that has receive the most attention, however, does not utilize multiple paths. It joins the mechanisms of DSDV and DSR. The periodic beacons, hop-by-hop routing and the sequence numbers of DSDV and the pure on-demand mechanism of Route Discovery and Route Maintenance of DSR are combined. In AODV [6], at Every instance, route discovery is done for fresh communication which consumes more bandwidth and causes more routing over-head. The source prepares RREQ packet which is broadcast to it's neighboring nodes. If neighboring node will keep backward path towards source. As soon as destination receives the RREQ packet, it sends RREP packet on received path.
This RREP packet is unicast to the next node on RREP path. The intermediate node on receiving the RREP packet make reversal of path set by the RREQ packet. As soon as RREP packet is received by the source, it starts data transmission on the forward path set by RREP packet.

Sometimes while data transmission is going on, if path break occurs due to mobility of node out of coverage area of nodes on the active path, data packets will be lost. When the network traffic requires real time delivery (voice, for instance), dropping data packets at the intermediate nodes can be costly. Likewise, if the session is a best effort, TCP connection, packet drops may lead to slow start, timeout, and throughput degradation.

B. Dynamic Source Routing (DSR)

Dynamic Source Routing, DSR [2,14,16], is a reactive routing protocol that uses source routing to send packets. It is reactive protocol like AODV which means that it only requests a route when it needs one and does not require that the nodes maintain routes to destinations that are not communicating. 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.

The comparison of reactive routing protocol [19] is given in Table II.

Table II: Comparison of Reactive Routing Protocol

Parameter	AODV	DSR
Routing Metric	Freshest & Shortest Path	Shortest Path
Route Maintained in	Route Table	Route Cache
Route Reconfiguration Methodology	Erase Route; Notify Short	Erase Route; Notify Short
Loop Free	Yes	Yes
Multicast Capability	Yes	No
Routing Philosophy	Flat	Flat
Communication Complexity	O(2N)	O(2N)
Time Complexity	O(2d)	O(2d)
Beaconing Requirement	No	No

Abbreviations:

N=No. of nodes in the network h=Height of Routing Tree

d=Network Diameter x=No. of nodes affected by topological change

IV. HYBRID ROUTING PROTOCOLS

Hybrid Routing Protocols combines the merits of proactive and reactive routing protocols by overcoming their demerits. In this section we put some light on existing hybrid routing protocol.

A. Zone Routing Protocol(ZRP)

Zone routing protocol is a hybrid routing protocol which effectively combines the best features of proactive and reactive routing protocol [2, 17]. The key concept is to use a proactive routing scheme within a limited zone in the r-hop neighborhood of every node, and use reactive routing scheme for nodes beyond this zone. An Intra-zone routing protocol(IARP) is used in the zone where particular node employs proactive routing whereas inter-zone routing protocol(IERP) is used outside the zone. The routing zone of a given nodes is a subset of the network, within which all nodes are reachable within less than or equal to the zone radius hops. The IERP is responsible for finding paths to the nodes which are not within the routing zone. When a node S want to send data to node D, it checks whether node D is within its zone. If yes packet is delivered directly using IARP. If not then it broadcasts (uses unicast to deliver the packet directly to border nodes) the RREQ packet to its peripherals nodes. If any peripheral nodes find D in its zone, it sends RREP packet; otherwise the node re broadcasts the RREQ packet to the peripherals nodes. This procedure is repeated until node D is located.

V. HYBRID ROUTING PROTOCOL WITH BROADCAST REPLY

In this paper, we proposed hybrid routing protocol with broadcast reply scheme (HRP-BR). The proposed protocol takes the advantages of both proactive and reactive routing protocol hence called Hybrid Routing Protocol(HRP).

Table III: Structure of Routing Table

Dest	Next hop	Hop count

- Dest : Source address on received packet.
- Next Hop : Next hop address on the path towards source node.
- Hop Count : Hop distance to reach to source node.

A. Analytic Study of HRP-BR

Hybrid Routing Protocol with broadcast reply scheme, HRP-BR combines the features of proactive and reactive routing protocols, overcoming their demerits. The propos protocol maintains routing table as that of table driven (proactive) routing protocol scheme. Initially, all the nodes in the network will have empty routing table. The structure of routing table is as shown in Table IV. Updating in routing table takes place in on demand manner (reactive). The proposed routing

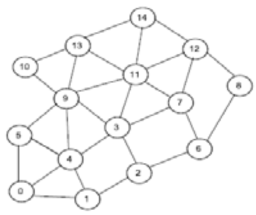

Figure 1: Network Topology

Table IV: Structure of Routing Table

Dest	Next hop	Hop count

protocol, HRP-UR operates in two different phases: Route Discovery and Route Maintenance.

1) Route Discovery in HRP-BR

A source, on receiving a data packet first checks, whether route to the destination exists in it's routing table. If route exists then it sends data packets to the destination. If no route exists then source node first stores the data packet in queue, prepares route request packet(RREQ) and broadcast it. The source generate broadcast id. Broadcast id is the unique id which will identify the unique communication over the network. The hop count field is set to one. After sending RREQ packet, the source waits for a route reply packet (RREP). If it did not receive within a certain time called *request timeout* , it broadcast another RREQ packet. If the maximum number of retries has been reached, all data packets for this destination are dropped since destination is unreachable. Destination on receiving the RREQ packet, sends RREP packet to the source on the same path RREQ packet has followed.

In the propose HRP-BR scheme. RREP packet is broadcast to all neighbors which are in the coverage area of the replying node. The RREP packet is broadcast to all neighbor nodes along with *intended* node. On receiving RREP packet, neighboring node makes an entry in the routing table about complete path which has received in RREP. If neighboring node is not the *intended* node, it drops RREP packet. If it is *intended* node, it adds own id in the received path and rebroadcast RREP. This process of extracting useful information from RREP packet and updates of RREP packet is carried out until RREP packet is not received by the destination which is source of RREQ packet. Figure 5.2 shows the process of RREP packet transmission.

Consider the example of network given in Figure 1. The process of route discovery is shown in Figure 2. Source node(say *0*) having Constant Bit Rate (CBR) traffic, want to communicate with destination node (say *14*). Let us assume this CBR traffic as CBR0 which starts at time *1.0* and ends at time *3.0*. Initially no route is available at any of the node in the network, so routing tables at all the nodes are empty. Source node 0 search destination node 14 in its own routing table. Route is absent, so node 0 prepares RREQ packet and fill up the necessary information and broadcast it. This RREQ packet is received by immediate neighbors i.e. node 5,1 and 4 . On receiving RREQ, they first store route information for source node 0 in there own routing table. So node 5,1 and 4 will enter route to node 0 in there routing table along with corresponding hop count which is 1.

Table V: Routing Table at Node 5

Dest	Next hop	Hop count
0	0	1

Table VI : Routing Table at Node 4

Dest	Next hop	Hop count
0	0	1

Table VII : Routing Table at Node 1

Dest	Next hop	Hop count
0	0	1

After making an entry for node *0* , node *5*,*1* and *4* search their routing table for destination node *14*. If any of them will find the entry in their own routing table, it creates RREP packet and sends back to the source node *0*. If not then increase the hop count received in RREQ packet by 1 and rebroadcast it. This process is repeated till destination node *14* is reached or TTL field of RREQ packet becomes 0.

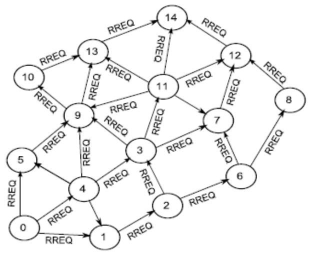

Figure 2: RREQ Transmission in the Network

In the Figure 3, node *14* is sending a RREP packet is response to RREQ from node *0*. Routing table at node *14* after processing RREQ packet from node *0* is shown in Table V

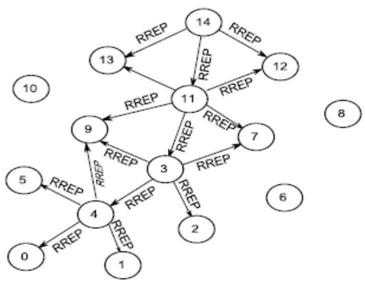

Figure 3: RREP Transmission in the Network

Table V: Routing Table at Node 14

Dest	Next hop	Hop count
0	11	4

At node *14* the next hop towards node *0* is node *11* shown in Table 4.1 with node *11* as *intended node*. It prepares RREP packet and broadcast with node *11* as the intended node. Neighboring node *11,12,13* will receives the RREP packet.

The nodes which are not intended node will drop the RREP packet after updating there routing table as shown in Table VI and VII

Table VI: Routing Table at Node 13

Dest	Next hop	Hop count
0	11	4
14	14	1

11	11	1
2	9	3

After receiving RREQ by *intended* node *11*, it searches node *0* in own routing table and finds next node towards source node *0* which is node *3* called new *intended* node as shown in Table 5.5. It then add it's own address in the received RREP packet. So modified reply path in RREP packet is *14-11*. Then it searches
node *0* in its own routing table and finds next hop towards source node *0*, which

Table VII: Routing Table at Node 12

Dest	Next hop	Hop count
0	11	4
14	14	1
11	11	1
2	7	2

Table VIII: Routing Table at Node 11

Dest	Next hop	Hop count
0	3	3
14	14	1
3	3	1
2	7	2
9	9	1

is termed as new *intended* node. After modification of RREP packet, *intended* node *11* will broadcast modified RREP packet to all its neighboring nodes i.e. node *13*,*14*,*12*,*7*,*3* and *9*. Then new *intended* node *3* rebroadcast modified RREP packet to all neighbors. This process is repeated until RREP packet is reached to the destination node *0* which is source of RREQ packet. The process of RREP packet transmission is as shown in the Figure 3.

2) Simulation Result of HRP-BR

In this section, we evaluate the performance of HRP-BR. We select parameters to evaluate the performance

We consider 14 node network examples shown in Figure 1. We simulate the new propose routing protocol, HRP-BR using NS2. We considered 5 CBR data traffic running in the network as explained in Section V. Total simulation time for the following scenario is considered to be 12 seconds. The details of data traffic running in the network are as follows:

CBR 0: node *0* to node *14* starts at 1.0 ends at 3.0
CBR 1: node *9* to node *0* starts at 4.0 ends at 6.0
CBR 2: node *1* to node *11* starts at 5.0 ends at 7.0
CBR 3: node *5* to node *14* starts at 8.0 ends at 9.0
CBR 4: node *2* to node *13* starts at 10.0 ends at 12.0

a) Data packets sent and dropped in the Network

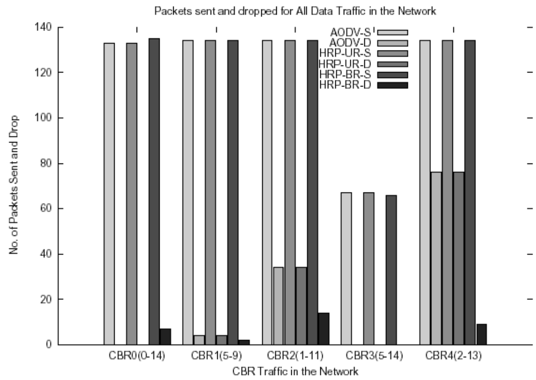

Figure 4: Data Packets Sent and Dropped in the Network

We plot the graph of number of packets sent and dropped versus CBR traffic in the network as shown in Figure 4. From the graph, the number of packet dropped in CBR0 between node *0* to node *14* is greater in HRP-BR than HRP-UR and AODV protocol. But it is decreasing for CBR1, CBR2 and CBR4 gradually as compared to HRP-UR and AODV. For CBR3 it is same in HRP-BR, HRP-UR and AODV. There exist four reasons for dropping packet

• packets will be dropped by interface queue (IFQ) when IFQ overflow occurs in the MAC layer
• packets will be dropped by Address Resolution Protocol (ARP), if ARP is already processing address converting request for other packets at MAC layer.
• packets will be dropped by MAC layer due to collision.
• packets will be dropped at network layer if MAC layer is not ready to accept packets.

b) End-to-End Delay Analysis

End-to-End delay is defined as the difference between time at which source node send data packets and the time at which destination node receives the same data packet. We compute the delay for CBR 0 traffic between node *0* to node *14*. Total number of packets transmitted from source node 0 to destination node 14 is 135. We plot the graph of End-to-End delay versus packet id as shown in Figure 5.11. From the graph, the End-to-End delay incorporated by HRP-BR is very low as compare to HRP-UR and AODV

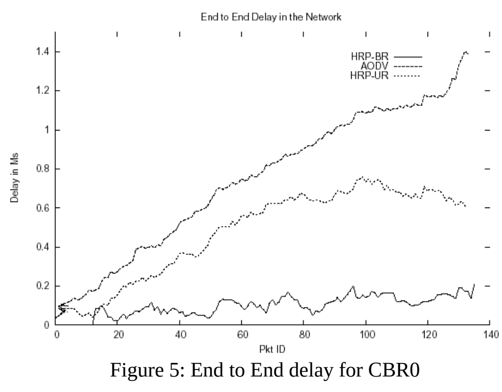

Figure 5: End to End delay for CBR0

protocol. Since we are broadcasting RREP, the source node able to receive it earlier than in AODV and HRP-UR.As the nodes are not using RTS/CTS/DATA/ACK pattern for sending RREP, it will help to start data transmission earlier in HRP-BR as compared to AODV and HRP-UR.

c) Packet Delivery Ratio

We plot the graph of CBR traffic versus packet delivery ratio as shown in Figure 6. From the graph, it can be seen that the packet delivery ratio is less initially when single data transmission is considered between node *0* to node *14* as compared to HRP-UR and AODV. But as the traffic increases, the packet delivery ratio increases in HRP-BR as compared to HRP-UR and AODV.

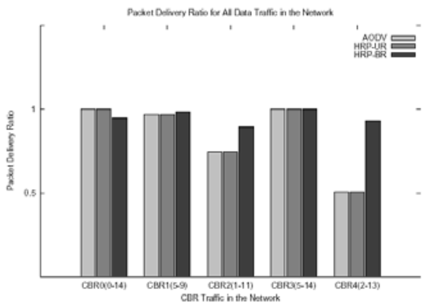

Figure 6: Packet Delivery Ratio for all CBR data traffic in the Network

VI. CONCLUSION

The Proactive and Reactive approach for routing in ad hoc network have their merits and demerits. The Proposed routing protocol will have an advantage of both proactive and reactive approach. Backup routing in proposed scheme will helpful in path break up to some extent. Here we want to conclude by saying that the analytic study of the new hybrid approach will result in less routing overhead than most of the routing algorithm such as AODV and DSDV. The simulation results of Data packets sent and dropped in the network is related with the efficient routing issue, which is most demanding and thrust area of ad hoc network. We have a hybrid routing protocol scheme with Broadcast reply.

REFERENCES

[1] Mobile Adhoc Network (MaNet). http://www.ietf.org/html.charters/manetcharter.html.

[2] C. Siva Ram Murthy and B.S. Manoj. *Ad Hoc Wireless Networks Architectures and Protocol*, volume ISBN:81-297-0945-7. Pearson Education, first indian reprint,2005 edition, 2005.

[3] Santa Barbara Elizabeth M. Royer and Chai Keong Toh. A Review of Current Routing Protocols for Adhoc Mobile Wireless Networks. *IEEE Personal Communications*, pages 46-55, April 1999.

[4] Y. Zhang V. Kawadia and B. Gupta. System Services for Implementing Ad-hoc Routing: Architecture, Implementation & Experiments. In *First Inter-national Conference on Mobile System, Application and Services(Mobisys)*, pages 99{114. San Francisco ,CA., June 2003.

[5] C. P. P. Bhagwat. Highly Dynamic Destination Sequenced Distance Vector DSDV Routing for Mobile Computers. *Proceeding of ACM SIGCOM*, pages 234 - 244, September 1994.

[6] E. Royer C. Perkins and S. Das. Ad hoc On-demand Distance Vector (aodv) routing. (RFC 3561), July 2003.

[7] C. K. Toh. *Ad Hoc Mobile Wireless Networks-Protocols and Systems*, chapter 6, pages 79-94. Prentice Hall, 2002.

[8] Cenker Demir and Cristina Comanicia. An Auction Based AODV Protocol for Mobile Ad hoc Network with Selfish Nodes. *IEEE International Conference ICC'07*, pages 3351-3356, June 2007.

[9] Rendong Bai and M. Singhal. DOA: DSR over AODV protocol for mobile ad hoc network. *IEEE Transaction on Mobile Computing*, 5:1403-1416, Oct 2006.

[10] P. K. Pattanaik and R. Mall. Challenges in ad hoc networks. *Sidhanth Journal*, pages 153-160, 2007.

[11] M. Woo S. Singh and C. S. Raghvendra. Power Aware Routing in Mobile Ad-Hoc Networks. In *Proceedings of ACM/IEEE MOBICOM*, pages 181-190. Dallas, Texas, October 1998.

[12] K. Y. Wang R. Dube, C. D. Rais and S. K. Tripathi. Signal Stability Based Adoptive Routing SSA for Ad hoc Mobile Network. *IEEE Personal Communication*, 4:36-45, Feb 1997.

[13] J. H. Chang and L. Tassiulas. Energy Conserving Routing in Wireless Ad hoc Network. In *IEEE Conference on Computer Communications INFOCOM*, pages 22-31, Tel Aviv Israel, March 2000.

[14] 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 Ad hoc Networking*, pages 16-28, Feb 2001.

[15] David B. Johnson. Routing in Ad hoc Networks of Hmobile Hosts. *IEEE Workshop on Mobile Computing Systems and Applications*, pages 158-163, Dec 1994.

[16] D. B. Johnson and D. A. Maltz. Dynamic Source Routing in Ad hoc Wireless Network. *In the Book, Mobile Computing*, pages 153-181, 1996.

[17] E. Topalis S. Giannoulis, C. Antonopoulos and S. Koubias. Zrp Versus DSR and TORA: A Compressive Survey on ZRP Performance. *10th IEEE Conference ,ETFA 2005*, 1(ISBN:0-7803-9401-1), Sept 2005.

[18] L. Wang and S. Olariu. A Two Zone Hybrid Routing Protocol for Mobile Ad hoc Network. *IEEE Transaction on Parallel and Distributed Systems*, 12:1105-1116, Dec 2004.

[19] Ankur Khetrapal. Routing Techniques for Mobile Ad hoc Networks Classification and Qualitative/Quantitative Analysis. In *ICWN*, pages 251-257, 2006.

[20] Ian D. Chakeres and Elizabeth M. Belding-Royer. The Utility of Hello Messages for Determining Link Connectivity. In *Fifth International Symposium on Wireless Personal Multimedia Communication WPMC*, pages 504-508. Honolulu,Hawaii, October 2002.

[21] C.C. Chiang. Routing in Clustered Multihop, Mobile Wireless Networks with Fading Cchannel. In *In IEEE Proceeding, Sicon'97*, pages 197-211, April 1997.

[22] S. Murthy and J.J. Garcia-Luna-Aceves. An Efficient Routing Protocol for Wireless Networks. In *ACM Mobile Networks and Applications*, pages 183-197, October 1996.