Zone based Multi-Agent with Multi-hopRouting in MANET

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ABSTRACT: *Mobile Ad hoc Network (MANET) comprises of thousands of mobile nodes spread across the network. These nodes are highly mobile which possess some inherent characteristics like node reliability, resource heterogeneity, etc. In this paper, we proposed a Multi-Agent Based Multi-hop Routing (MAMR) protocol for MANETs. Our proposed MAMR protocol comprises of multiple agents including static and dynamic mobile agents. The operation of our proposed scheme is as follows: (i) At first, the zone leaders are discovered; (ii) These zone leaders are connected with communication nodes, (iii) Back bones are built by employing communication and zone leaders to achieve multicast routing, (iv) Zone members of multicast are connected to the backbones, (v) In case if the nodes are highly mobile, backbone and zone managements are initiated. In MAMR protocol there are five kinds of agent nodes are used in which Path agent, Network control agent and Multicast control agent are static; Network launch agent and Multicast control agents are mobile. The performance of the proposed system is evaluated under several network conditions in which packet delivery ratio, delay and throughput are measured. The proposed protocol is compared with Multicast Routing Protocol Based on Zone Routing (MZRP), On-Demand Multicast Routing Protocol (ODMRP). Through the obtained simulation results it is clearly shows that MAMR protocol performs better than MZRP and ODMRP. This also offers better flexibility and versatile multicast services.*

Keywords: Mobile Ad hoc Network (MANET), Multi-Agent Based Multi-hop Routing (MAMR) Protocol, Backbones, Multicast Routing, MZRP and ODMRP

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1. Introduction

Autonomous system of network routers and associated host connection by the wireless paths is called as Mobile Ad hoc Networks (MANET) which does not possess base stations. Instead, the purpose of routing is admitted in each and every mobile node and multiple hops may be essential to allow one mobile node to communicate with any other mobile node throughout the network due to the limited range of transmission [1, 2].Group communications such as collaborative works and video conferencing require multicast routing and it has so many advantages since it uses within the network [3]. A main advantage of multicast routing is it reduces the cost of communication by sending the same information to multiple recipients. It also reduces the consumption of bandwidth, packet delivery delay and processing time of source and router. Thus, the multicast routing has gained research focus and there are several multicast routing protocols have been presented in MANET [4, 5].

Multicast is a primary technique for zone oriented communications in mobile networks. Multicast Routing Protocol Based on Zone Routing (MZRP) [6], On-Demand Multicast Routing Protocol (ODMRP) [7], Multicast Ad hoc On-Demand Distance Vector (MAODV) [8], Preferred Link-Based Multicast (PLBM) Protocol [9], Weight-Based Multicast Protocol (WBM) [10] and On-Demand Overlay Multicast Protocol (ODOMP) [11] are some of the multicast routing protocols used in MANET. Among these multicast protocols, ODMRP and MZRP are well known multicast routing protocols which are taken to compare the performance of the proposed protocol.

The MAMR protocol is proposed to overcome the drawbacks present in existing multicasting protocols such as: less reliable and robust during frequent topology changes, poor scalability and reduced Quality of Service (QoS).The contributions of our proposed work are as follows:

♣ Multicast paths are discovered by the multi-agent mechanism.

♣ To achieve reliable multicast routing, backbones are created by the multi-agents.

♣ Frequent topological changes are adapted by the agents.

♣ The proposed MAMR provides better packet delivery ratio as compared to MZRP and ODMRP.

2. Proposed Technique

In this paper, we proposed Multi-Agent Based Multi-hop Routing (MAMR) protocol for MANETs in which static and dynamic mobile nodes are used. This section describes the network arrangement and operation principle in a detailed manner.

2.1. Network Arrangement

Let us consider MANET is a collection of thousands of mobile nodes which are spread over the geographical location of network in a random manner as demonstrated in figure 1. With the help of communication node and zone leaders the network backbones

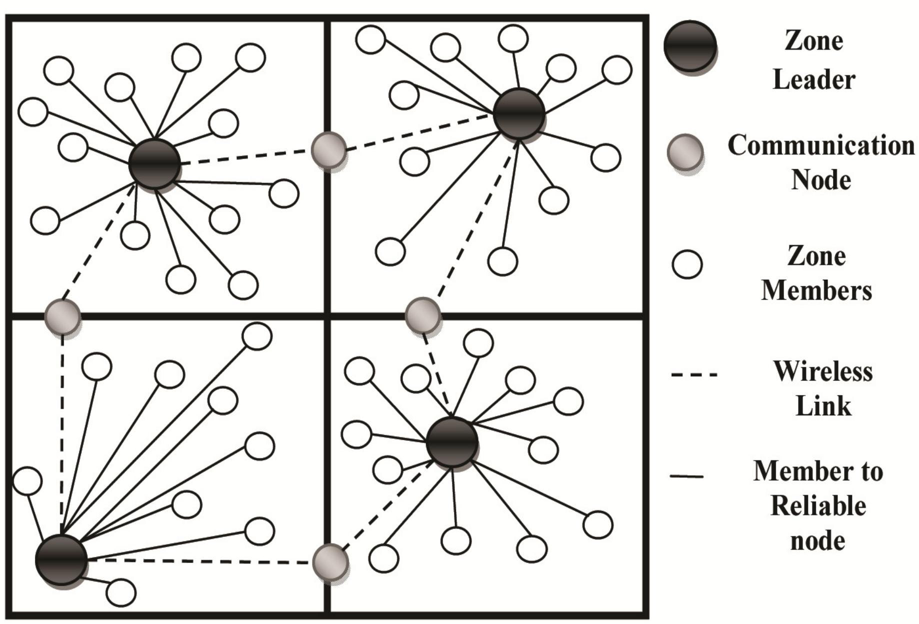

Figure 1. Network arrangement of MAMR protocol

are formed. Communication node of zone leaders can be done with some communication nodes. Each zone leader is connected with its corresponding zone members. The multicast operations are supported by the zone leaders whereas the communication nodes just act as forwarders i.e., it forwards the packets among the zone leaders. The zone members are described as child nodes to zone leader. Mobility has provided to zone members, reliable and communication nodes. The multicast paths will be frequently reconstructed in case of high mobility by applying different pairs of zone leaders and communication nodes. All the participating nodes in the network are established at the mobile agent platform so that it can support the entire network features.

2.2. Node Definitions

There are three types of nodes such as zone members, zone leader and communication nodes are used in our proposed protocol.

2.2.1 Zone Members

The whole network is divided into multiple zones and the zone membership is based on the location i.e., according to the geographical location of nodes the zones are formed. Each zone must contain a zone leader, zone members and a communication node. The communication nodes are placed at the end of any two zone coverage. These communication nodes act as forwarders and through this the intra communication (i.e., zone top zone communication) is achieved. The zone members are also denoted as children of zone leader.

2.2.2 Zone Leader

Each zone in the network must contain a zone leader which acts as a parent to its zone members. These zone leaders are elected based on their reliability factors. If a node possess highest reliability factor means it is elected as the zone leaderof the zone. All the responsibilities of the zone including connection providence of its zone members are given to the zone leader. If a node wants to join a zone means it should be authorized by the reliable bode of that zone. These zone leaders maintain responsibility table to provide alternate link when the current link breaks.

2.2.3 Communication Node

All the nodes in the network are mobile. If a zone leader moves out of the zone coverage where it serves, then all its connections to other zone leaders are broken. In order to provide such interconnections the communication nodes are formed. These nodes can provide new connections as well as lost connections among the zone leaders. Packet forwarding and connection management are some of the basic functions of communication nodes. It also maintains a connection table to identify the lost connections.

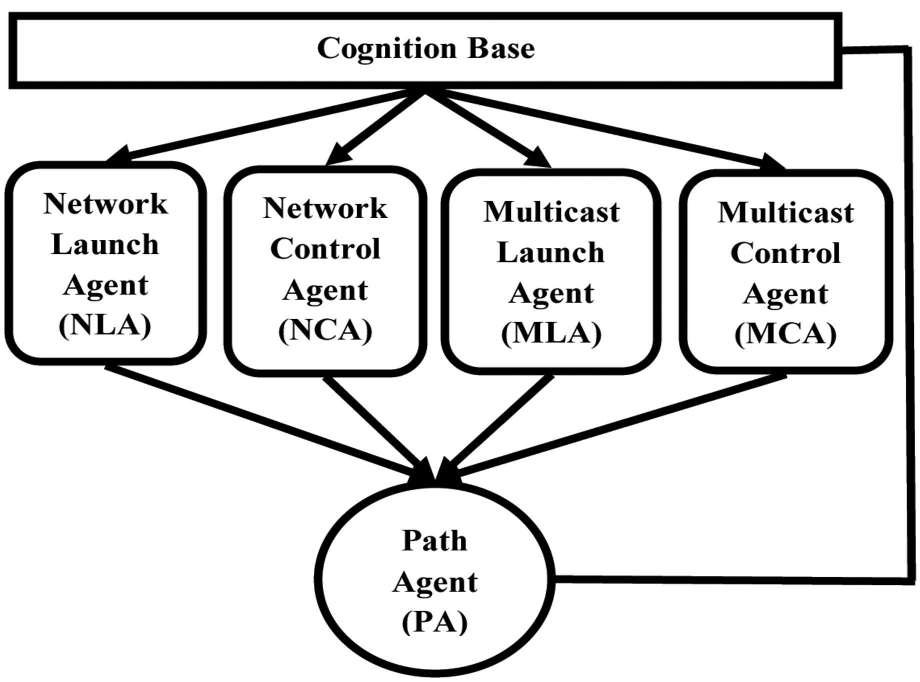

Figure 2. Routing model using agents

2.3. Agent Definition

There are five agent nodes are used in our proposed technique which are explained in this section. A common cognition base is placed in the network that contains the information of all five agents. Moreover, these agents are interacted through this cognition base which contains some of the network information such as node type, zone ID, forwarding and responsibility tables, list of connection nodes with its connectivity status and zone member status.

2.3.1 Path Agent (PA)

Path agents are static nodes which plays a main role in the network i.e. other four agents are created with the help of this PA. It also synchronizes the agent node actions and cognition base. The reliability factor of all nodes is computed by the PA which are then advertises to all of its nearby nodes or neighbor nodes in a periodical manner. Path agents discover their child nodes through which it makes communication with other agents and it also updates the responsibility table present in the cognition base.

2.3.2 Network Launch Agent (NLA)

Network Launch Agents are mobile nodes which collect the packets of reliability advertisement from their neighbor nodes. After analyzing these reliability advertisements, if a NLA possess highest measure of reliability factor among the analyzed advertisement packetsthenit announces itself as a zone leader. Path agent generate network launch agent periodically in which the period depends on the node mobility.

2.3.3 Network Control Agent (NCA)

Network Control Agents are static nodes which provide the control on connection management in order to avoid mobility issues.

2.3.4 Multicast Launch Agent (MLA)

These are mobile nodes that are responsible for the creation of multicast network zones. Each member of a zone receives a multicast key distributed by MLA. It sends an invite message to every zone leader for its membership to a zone. At first a fundamental survey which comprises all the essential information of zone members is conducted for zone membership. Then a multicast tree is formed by the MLA using zone leaders, zone members and communication nodes. A zone ID is given to each participating multicast member of the tree.

2.3.5 Multicast Control Agent (MCA)

Multicast Control Agent is a static node and it controls the maintenance of multicast tree. This MCA is present in all the multicast zones to reconstruct the broken links among the nodes in the zone especially between member and zone leader. Tokens are generated by the MCA present in multicast zone which are transmitted periodically within the zone. Each zone member receives these tokens and adds a token with a data packet. A child node assures its connection with the network by receiving a connectivity token periodically. This child node stimulates recovery process if it does not receive the token. In this recovery process, a connection is established by the MCA with its zone leader or any token receiving nodes with the help of cry calls.

Algorithm for Proposed Model

1. Radom node are Generated R_n

2. Zones splitting ($Z_1 + Z_2 + Z_3 + Z_4$)

3. Zone Members ($Z_{ia} + Z_{ib} + Z_{ic} + Z_{id}$)

4. Calculate threshold ($Z_n = T$)

5. For ($T = 0; T < N; T{+}{+}$)

6. If ($T = 1$) satisfy the threshold detect the Zoneleader)

7. Else

8. If ($T = 0$) that means act as group member node

9. Path formation ($Z_n + P_{th}$) Path Agent

10. For ($P_{th} = 0; P_{th} < N; P_{th}$++)

11. If ($P_{th} = 1$) Path full choose alternate path

12. Else

13. If ($P_{th} = 0$) Path free packet are travelling

14. End

15. End

3. Operation Principle

The operation principle of our proposed MAMR protocol is explained in this section. At first reliability factor is computed for all members of the zone in which each member with packets advertises its reliability factor to its nearby members using PA. Here all nodes are spread randomly over the network. These advertisement packets are received by the neighbors that compare the obtained reliability factor with its reliability factor to know who possess high reliability factor. The highest reliability factor containing node is chosen as the zone leader and notify to its PA. After choosing the reliability node in all zones, connections has to be established (i.e. interconnections of zone leaders) among these zone leader. Clones are created and flooded up to three hops throughout the network by NLA. By using three hops the agent movement is restricted.

The clone of NLA discovers a zone leader among these three hops through the flood. If it discovers a route, the traced route information is sent to parent NLA. If it cannot discover a route then it destroys itself after notifying parent NLA. Among the discovered routes, the parent NLA chooses a best route with better reliability and minimum number of hops. All the connection information is stored at the communication node as connection list. This connection information is collected by NLA by moving over the chosen route between any two zone leaders. It also generates packet forwarding tables and the packet forwarding is supported by reliable and communication nodes. PA presents in each zone leader is covers its child nodes and constructs a responsibility table. Thus the backbone is set for communication. The multicast zone creating node generates MLA which travels to each zone leader for inviting to join a zone. All packet forwarding nodes in a zone contains a zone ID and a key for multicasting provided by MLA. Finally child nodes initiate data transmission.

4. Simulation Results

The proposed system is simulated in Network Simulator-2 (NS-2) at several network scenarios. Here the simulation network arrangement and simulation parameters with results are explained in a detailed manner.

The proposed network model is comprised of 50 mobile nodes which are randomly spread over the network and are allowed to move freely throughout the network. The mobile node speed is varying from A to B meters per second. The entire network is split into four zones based on the geographical area of the network. Each zone has the area of $l \times b$ square meters. Each zone is comprised of zone members and zone leader. A communication node is placed at the end of any two zones.

Let us take, number of nodes = 50, network area = 1000×1000 meter^2, zone area = 250×250 meter^2 and node speed = 0 to 30 meters/second. The performance parameters are used as follows:

Delay: It is defined as the time duration between packets sent by a group member (sender) to the packet received by a group member (receiver).

Packet Delivery Ratio: It is the ratio between number of nodes transmitted by a group member to the number of node received by a group member.

Throughput: It is defined as the total number of packets delivered by all receivers over the total simulation time. Overall performance of the proposed and existing protocols is compared in throughput analysis.

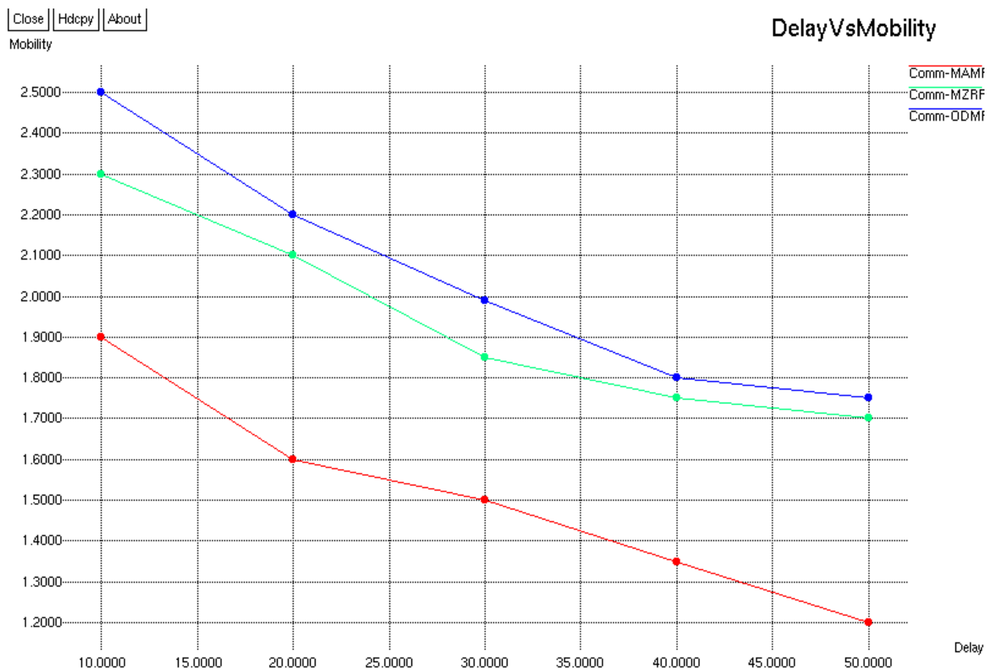

Figure 3. Delay vs. Mobility

In Figure 3, delay and mobility for the proposed MAMR protocol and existing MZRP and ODMRP protocols are compared. From the figure it is clearly shows the proposed protocol has better performance by reduced delay even in high mobility when compared to MZRP and ODMRP protocols.

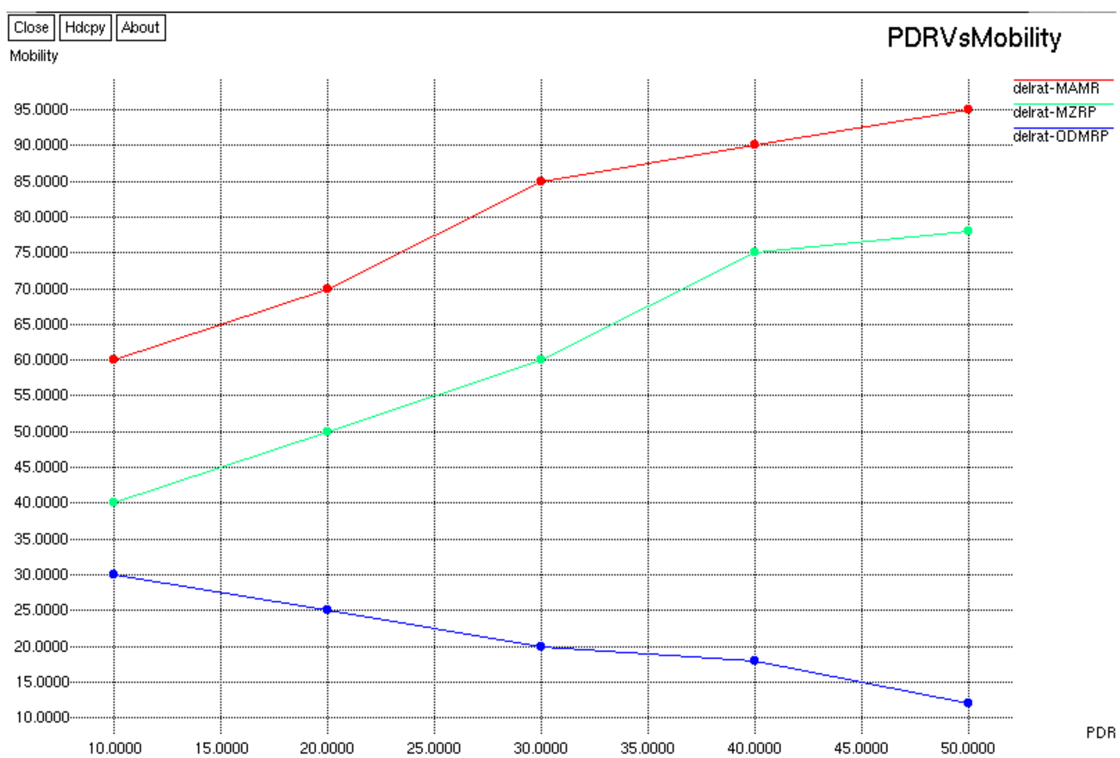

Figure 4. PDR vs. Mobility

Packet delivery ratio and mobility are compared in Figure 4. This comparison is made for the proposed MAMR protocol and existing MZRP and ODMRP protocols. It demonstrates that the PDR of MAMR protocol is higher than the MZRP and ODMRP protocols.

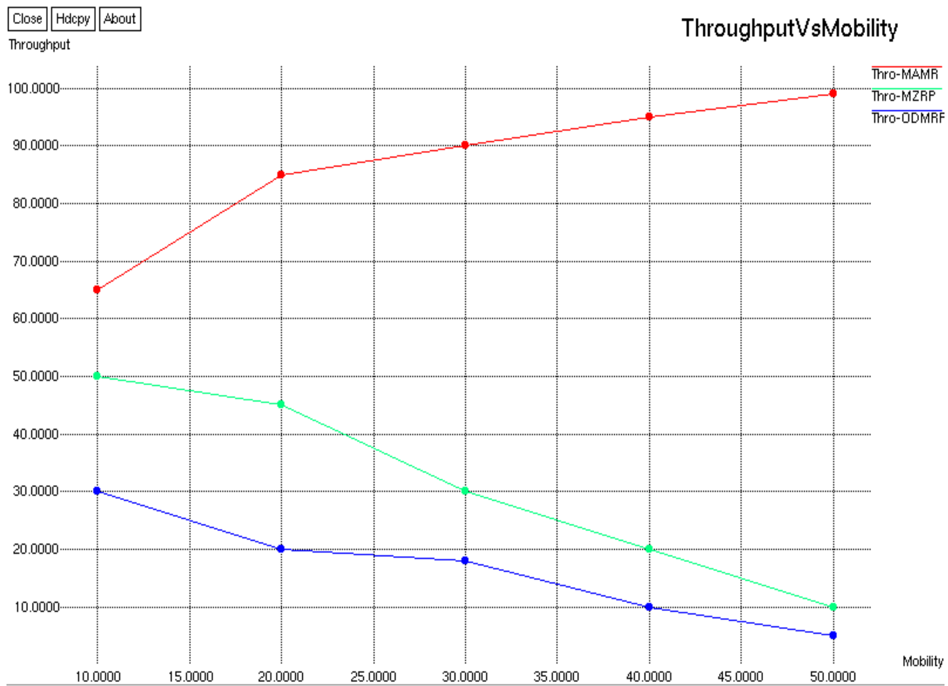

Figure 5. Throughput vs. Mobility

In Figure 5, the network throughput and mobility is compared for proposed and existing protocols. It is necessary to compare the throughput of all protocols since it provides overall performance. Here the throughput of our proposed MAMR protocol is much better than the existing MZRP and ODMRP protocols.

5. Conclusion

Thus, we proposed Multi-Agent Based Multi-hop Routing (MAMR) protocol for mobile ad hoc network in order to improve the network performance by increased packet delivery ratio, reduced delay and network reliability. Our proposed routing technique MAMR is completely based on the packet forwarding through intermediate and zone leader. The date packets are effectively routed among group members even in case of high mobility that is our proposed protocol possess better packet delivery ratio when compared to MZRP and ODMRP. It also possesses better flexibility since backbone is reconstructed by the agents after sensing mobility.In simulation there are some simulation parameters such as delay, packet delivery ratio and throughput are measured against node mobility which shows better performance in our proposed MAMR protocol.

References

[1] Sukumar, T. (2010). Energy Efficient Multicast Routing Protocol for MANET IJAET/1 (1)/April-June-2010.

[2] Sureshkumar. N., Vijayalakshmi.G., Natraj, N. A., Senthil. T., Prabu, P. (2012). Energy Efficient Routing Protocol for MANET International Journal of Computer Science Issues, 9 (2), 1, March .

[3] Dr. Annapurna P Patil., VarshaChandan, B., Aparna, S., Greeshma, R., Akshatha, H P. (2014). An Improved Energy Efficient AODV Routing Protocol for MANETs, *IEEE*.

[4] Shiva Prakash., JP Saini. (2010). A review of Energy Efficient Routing Protocols for Mobile Ad Hoc Wireless Networks , *International Journal of Computer Information Systems*, 1 (4), 2010.

[5] Vemana Chary. D., Padmanabham, P., PrabhakaraRao, B. (2012). Energy Efficient Routing Protocol for Mobile Ad hoc Networks using Trust Based Security , International *Journal of Advanced Research in Computer and Communication Engineering,* 1 (9) November.

[6] Zhang, X., Jacob, L. (2004). MZRP: an extension of the zone routing protocol for multicasting in MANETs, *Journal of Information Science and Engineering*, 20 (3) 535– 551.

[7] Lee, S.-J., Su, W., Gerla, M. (2002). On-demand multicast routing protocol in multihop wireless mobile networks, *Mobile Networks and Applications*, 7 (6) 441–453 2002.

[8] Royer, E. M., Perkins, C. E. (2000). Multicast ad hoc on demand distance vector (MAODV) routing, Internet-Draft, draft-ietfdraft- maodv-00.txt, 2000.

[9] Sisodia, R. S., Karthigeyan, I., Manoj, B. S., Murthy, C. S. R. (2003). A preferred link based multicast protocol for wireless mobile ad hoc networks, *In*: Proceedings of the IEEE International Conference on Communications (ICC '03) 3. 2213– 2217.

[10] Das, S. K., Manoj, B. S., Murthy, C. S. R. (2002). Weight based multicast routing protocol for ad hoc wireless networks, *In*: Proceedings of the IEEE Global Telecommunications Conference (GLOBECOM '02) 1, p. 117–121.

[11] Stanze, O., Zitterbart, M. (2005). On-demand overlay multicast in mobile ad hoc networks, *In:* Proceedings of the IEEEWireless Communications and Networking Conference (WCNC '05), 4, 2155–2161.