Analysis of CSMA, MACA & EMACA (Enhancement of Multiple Accesses with Collision Avoidance) to Support QoS under varying conditions of No. of Nodes in Ad-Hoc Wireless Networks by means of DSR Routing Protocol

Prof. Neeraj Agrawal
Assistant Professor, Gwalior Engineering College, Gwalior

Dr. Sanjeev Sharma
HOD, SOIT, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Prof. Arun Nahar
Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

ABSTRACT
Ad-Hoc Wireless Network (AWN) is a collection of mobile hosts forming a temporary network on the fly, without using any fixed infrastructure. DSR routing protocol was used to evaluate the MACA and EMACA performance. Results show that the EMACA simulation performs well as compared to MACA in sense of Throughput, Total Packet Receive, Drop Packet Ratio and Average Jitter under varying conditions of no. of nodes. In DSR like all On- Demand routing algorithms, route discovery mechanism is associated with great delay. More Clearly in DSR routing protocol to send route reply packet, when current route breaks, destination seeks a new route. In this paper we will try to change route selection mechanism proactively. We will also define a link stability parameter in which a stability value is assigned to each link. Given this feature, destination node can estimate stability of routes and can select the best and more stable route. Therefore we can reduce the delay and jitter of sending data packets. We have evaluated the operation of DSR through detailed simulation on a variety of movement and communication patterns, and through implementation and significant experimentation in a physical outdoor ad hoc networking testbed we have constructed, and have demonstrated the excellent performance of the protocol.

Keywords
AWNs, QoS, MAC, CSMA, MACA, EMACA, DSR, Throughput, Total Packet Received, Drop Packet Ratio and Average Jitter.

1. INTRODUCTION
MOBILE ad hoc network is a collection of wireless mobile nodes which dynamically form a temporary network without the use of any existing network infrastructure or centralized administration [18], [19], [20]. Since the topology of network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Ad hoc routing protocols can be classified into three main categories: Proactive, reactive and hybrid protocols. Mobile Ad Hoc Networks are wireless networks which do not require any infrastructure support for transferring data packet between two nodes [1], [2], [3], [4], [12]. In these networks nodes also work as a router that is they also route packet for other nodes. Nodes are free to move, independent of each other, topology of such networks keep on changing dynamically which makes routing much difficult. Therefore routing is one of the most concerns areas in these networks. Normal routing protocol which works well in fixed networks does not show same performance in Mobile Ad Hoc Networks. In these networks routing protocols should be more dynamic so that they quickly respond to topological changes.

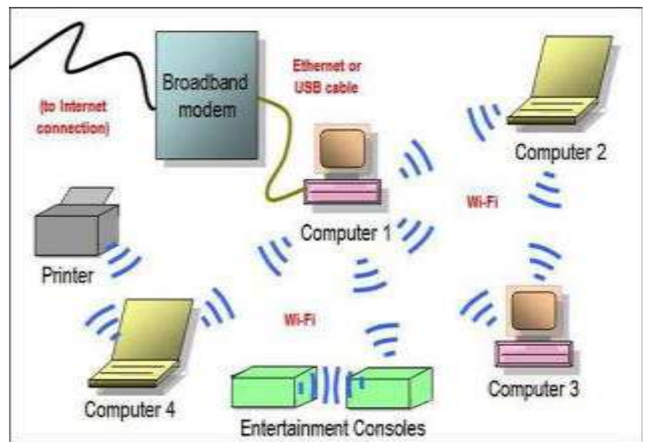


Figure 1: Mobile Ad Hoc Network

Quality of service (QoS) is the performance level of a service offered by the network to the user. The goal of QoS provisioning is to achieve a more deterministic network behavior, so that information carried by the network can be better delivered and network resources can be better utilized [4], [7], [8]. A network or a service provider can offer different kinds of services to the users. Here, a service can be characterized by a set of measurable Pre specified service requirements such as minimum bandwidth, maximum delay, maximum delay variance (jitter), and maximum packet loss rate. After accepting a service request from the user, the network has to ensure that service requirements of the user's flow are met, as per the agreement, throughout the duration of the flow.

A MAC protocol in a multi-access medium is essentially a distributed scheduling algorithm that allocates the channel to requesting nodes [2], [4], [12], [13]. Two commonly used access principles in wireless networks are fixed assignment channel access and random access method. In the former method, a pair of nodes is statically allocated a certain time slot (frequency band or spread spectrum code), as is the case for most of voice-oriented wireless networks. On the other hand, in random access MAC protocols, the sender dynamically competes for a time slot with other nodes. This is a more flexible and efficient method of managing the channel in a fully distributed way, but suffers from collisions and interference.

Carrier Sense Multiple Access (CSMA) refers to a family of protocols used by stations contending for access to a shared medium like an Ethernet cable or a radio channel. There are multiple "flavors" of CSMA; each has a different way of dealing with the collisions that can occur when more than one station attempts to transmit on the shared medium at the same time.

Multiple Accesses with Collision Avoidance (MACA) is a slotted media access control protocol used in wireless LAN data transmission to avoid collisions caused by the hidden station problem and to simplify exposed station problem [2], [12], [14], [15], [16]. This MACA protocol is not fully solve the hidden node and exposed terminal problem and nothing is done regarding receiver blocked problem.

- Contention Based Protocol
- Nodes are not guaranteed periodic access to the channel.
- They cannot support real time traffic.
- Three way handshaking.
- RTS—CTS—Data packet exchange
- Binary Exponential back off Algorithm
- Sender initiated Protocol
- RTS—CTS carrier information about the duration of time for neighbor nodes.

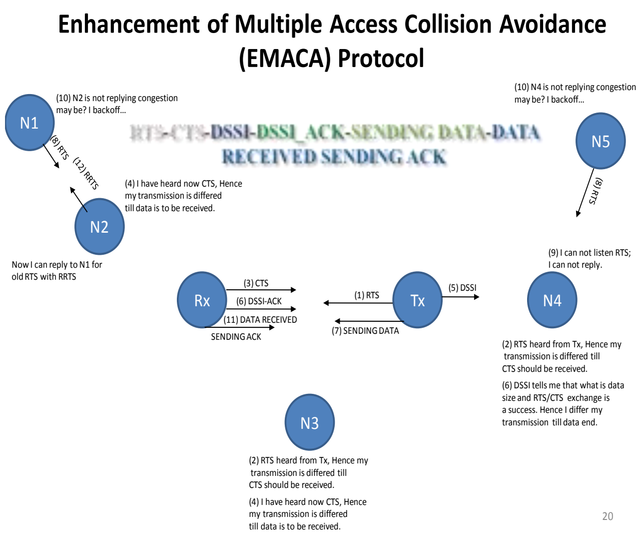


Figure 2: EMACA Protocol

EMACA (Enhancement of Multiple Accesses with Collision Avoidance) Protocol is based on MACA with some modifications over it. Instead of three way handshaking in MACA, EMACA protocol has five way handshaking RTS – CTS – DSSI – DSSI_ACK – DATA Sending – ACK [26].

2. ROUTING PROTOCOL

Routing is the act of moving information from source to a destination in an internet work. During this process, at least one intermediate node within the internet work is encountered. The routing concept basically involves two activities: firstly, determining optimal paths and secondly, transferring the information groups (called packets) through an internet work. The latter concept is called as packet switching, which is straight forward, and path determination is very complex. Routing protocol uses several matrices to calculate the best path for the routing the packet to its destination. These matrices are a standard measurement that could be number of hops, which is used by the routing algorithm to determine the optimal path for the packet to its destination [21], [22]. The process of path determination is that, routing algorithms initialize and maintain routing tables, which contain the total route information for packet. This route information varies from one routing algorithm to another. Routing tables are filled with a variety of information which is generated by routing algorithms. Most common entries in the routing table are ip-address prefix and the next hop. Routing tables Destination/next hop associations tell the router that a particular destination can be reached optimally by sending the packet to router representing the "next hop" on its way to final destination and ip-address prefix specifies a set of destinations for which the routing entry is valid for.

Figure 3: Routing Protocol

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 network infrastructure or administration [19], [20], [21], [22]. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. All aspects of the protocol operate entirely on-demand, allowing the routing packet overhead of DSR to scale automatically to only that needed to react to changes in the routes currently in use. Routing in mobile ad hoc networks is a challenging task because nodes are free to move randomly.

The use of source routing allows packet routing to be trivially loop-free, avoids the need for up-to-date routing information in the intermediate nodes through which packets are forwarded, and allows nodes forwarding or overhearing packets to cache the routing information in them for their own future use. All aspects of the protocol operate entirely on-demand, allowing the routing packet overhead of DSR to scale automatically to only that needed to react to changes in the routes currently in use.

In DSR the sender (source, initiator) determines the whole path from the source to the destination node (Source- Routing) and deposits the addresses of the intermediate nodes of the route in the packets. Compared to other reactive routing protocols like ABR or SSA, DSR is beacon-less which means that there are no hello-messages used between the nodes to notify their neighbors about her presence.

- ❖ Route Discovery (find a path)
- ❖ Route Maintenance (maintain a path)

Route Discovery

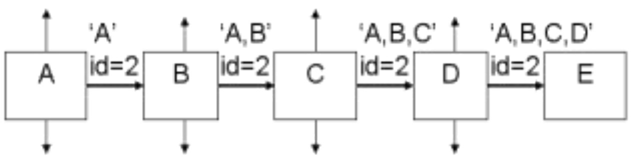


Figure 4: Route Discovery

If node A has in his Route Cache a route to the destination E, this route is immediately used. If not, the Route Discovery protocol is started:

- ❖ Node A (initiator) sends a Route Request packet by flooding the network
- ❖ If node B has recently seen another RouteRequest from the same target or if the address of node B is already listed in the Route Record, Then node B discards the request!
- ❖ If node B is the target of the Route Discovery, it returns a RouteReply to the initiator. The RouteReply contains a list of the "best" path from the initiator to the target. When the initiator receives this RouteReply, it caches this route in its Route Cache for use in sending subsequent packets to this destination.
- ❖ Otherwise node B isn't the target and it forwards the Route Request to his neighbors (except to the initiator).

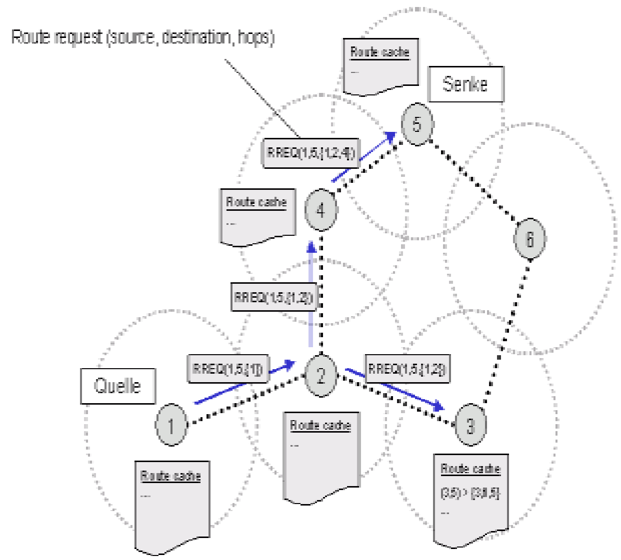


Figure 5 (a): Route Request

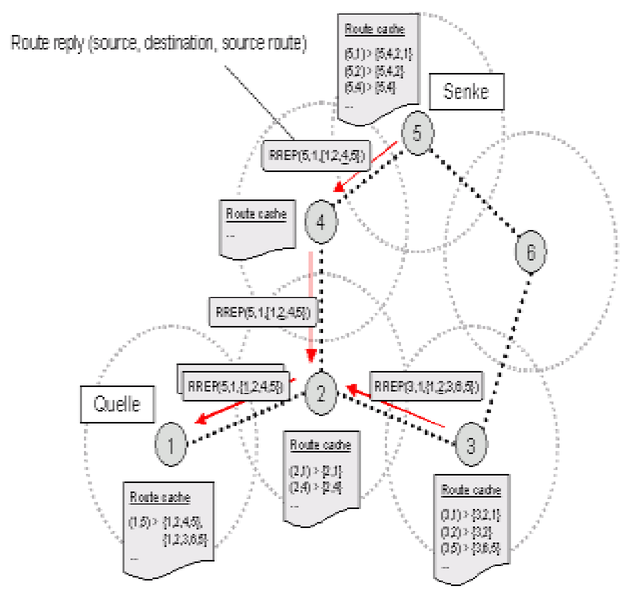


Figure 5 (b): Route Reply

Route Maintenance

In DSR every node is responsible for confirming that the next hop in the Source Route receives the packet. Also each packet is only forwarded once by a node (hop-by-hop routing). If a packet can't be received by a node, it is retransmitted up to some maximum number of times until a confirmation is received from the next hop.

Only if retransmission results then in a failure, a RouteError message is sent to the initiator that can remove that Source Route from its Route Cache. So the initiator can check his Route Cache for another route to the target.

If there is no route in the cache, a Route Request packet is broadcasted.

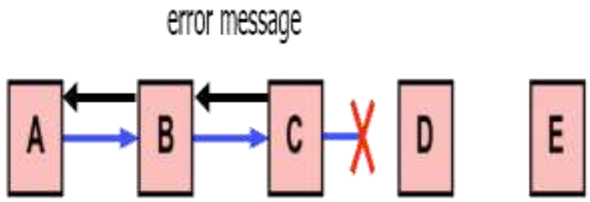


Figure 6: Route Maintenance

- If node C does not receive an acknowledgement from node D after some number of requests, it returns a RouteError to the initiator A.
- As soon as node receives the RouteError message, it deletes the broken-link-route from its cache. If A has another route to E, it sends the packet immediately using this new route.
- Otherwise the initiator A is starting the Route Discovery process-again.

3. PROBLEM DESCRIPTION

There are three problems, First one is Hidden terminal and Exposed terminal problems, second one is the congestion problem because more than one source sends the RTS message for transmission and third one is, MACA does not use the Acknowledgement control message, so it's not a reliable. In the pre existing MACA protocol hidden terminal and exposed terminal problems were avoided and not considered crucial. EMACA Protocol is based on MACA Protocol, so it's only the solution of the pre existing problems. Second control message DSSI (Data Sending for Synchronization Information), its uses for what is Data length and RTS/CTS exchange is a success, Hence defer transmission till data ends. With simple unidirectional transmissions the only relevant congestion is at the receiver; however, with our bidirectional RTS-CTSDATA message exchange, congestion at both ends of the transmission is relevant. The last control message is ACK. ACK uses for reliability. When TX sends the Data and Rx receive the Data then after completed transmission the Rx sends the ACK for intimation that Data received.

4. EXPERIMENT CONFIGURATION

S.No.	Parameters	Values
1	Area	1500mx1500m
2	Number of nodes	10, 20, 30, 40 and 50 Nodes
3	Application	CBR (Constant Bit Rate) 2 to 3 Nodes
4	Mobility Model	Random Waypoint
6	Data Packet	Constant, 512 bytes packet size
7	Simulation Time	Constant, 100 Seconds
8	Max. Speed	Constant, 10 m/s
9	MAC Protocols	CSMA, MACA and EMACA
10	Routing Protocols	DSR Routing Protocol
11	Node Placement	Random
12	Seed	1

Table 1: Parameters Value

A. Performance Metrics

1) *Throughput (bits/s):-* **Throughput** is the measure of the number of packets successfully transmitted to their final destination per unit time. It is the ratio between the numbers of sent packets vs. received packets [4], [10], [17].

2) *Total Packets received:* - **Packet delivery ratio** is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source (i.e. CBR source). It specifies the packet loss rate, which limits the maximum throughput of the network. The better the delivery ratio, the more complete and correct is the routing protocol [4], [10], [17].

3) *Drop Packet Ratio:-* **Packet drop ratio** is calculated by subtract to the number of data packets sent to source and number of data packets received destination through the number of packets originated by the application layer of the source (i.e. CBR source) [4], [10], [17].

4) *Average Jitter:* - **Average Jitter Effect** signifies the Packets from the source will reach the destination with different delays. A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably [4], [10], [17].

5. IMPLIMENTATION AND RESULTS

Figure 7: Various Performance Parameter V/s Numbers of Nodes

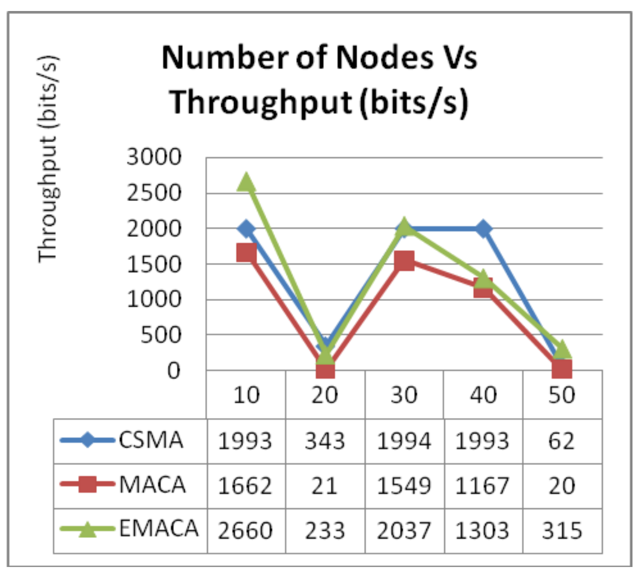
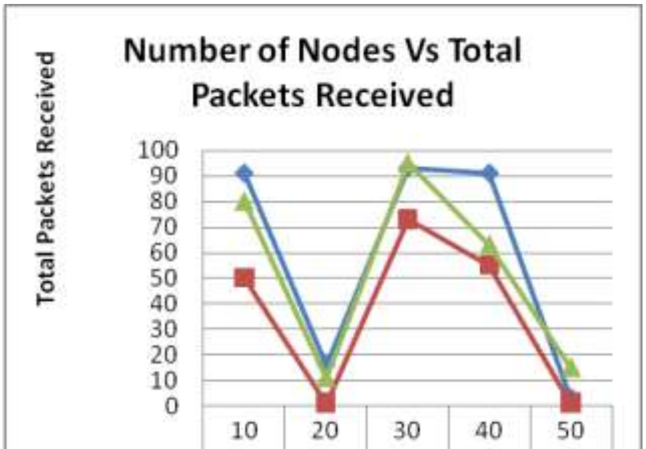
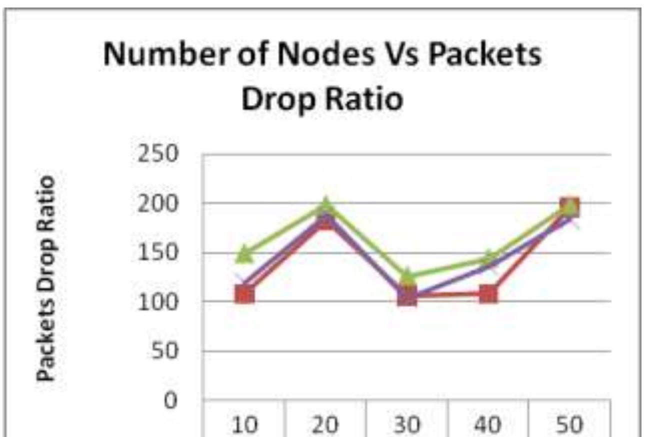


Figure 7 (a): Number of Nodes Vs Throughput (bits/s)



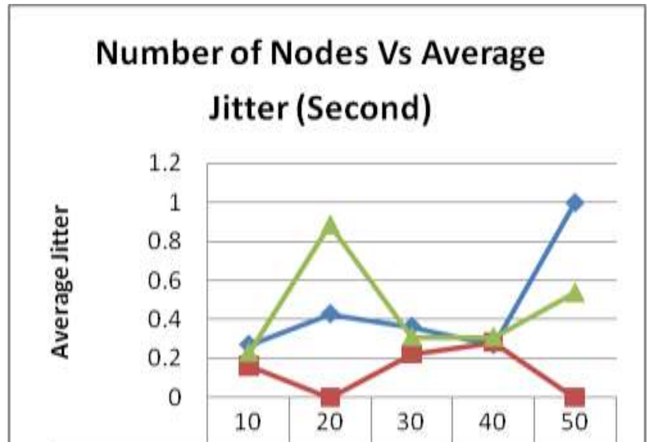
	10	20	30	40	50
CSMA	91	16	93	91	3
MACA	50	1	73	55	1
EMACA	80	11	95	63	15

Figure 7 (b): Number of Nodes Vs Total Packets Received



	10	20	30	40	50
CSMA	108	183	106	108	196
MACA	149	198	126	144	198
EMACA	119	188	104	136	184

Figure 7 (c): Number of Nodes Vs Packets Drop Ratio



	10	20	30	40	50
CSMA	0.269	0.428	0.362	0.269	1
MACA	0.161	0	0.225	0.283	0
EMACA	0.230	0.888	0.312	0.311	0.538

Figure 7 (d): Number of Nodes Vs Average Jitter

6. CONCLUSIONS

The Dynamic Source Routing protocol (DSR) provides excellent performance for routing in multi-hop wireless ad-hoc networks. As shown in our detailed simulation studies and in our implementation of the protocol in a real ad-hoc network of cars driving and routing among themselves, DSR has very low routing overhead and is able to correctly deliver almost all originated data packets, even with continuous, rapid motion of all nodes in the network. A key reason for this good performance is the fact that DSR operates *entirely* on demand, with *no* periodic activity of *any kind* required at *any level* within the network. This entirely on-demand behavior and lack of periodic activity allows the number of routing overhead packets caused by DSR to scale all the way down to *zero*, when all nodes are approximately stationary with respect to each other and all routes needed for current communication have already been discovered. As nodes begin to move more or as communication patterns change, the routing packet overhead of DSR *automatically* scales to only that needed to track the routes currently in use. The Dynamic Source Routing protocol (DSR) is an important component of such a system. The Efficient MAC protocols can provide significant benefits to mobile ad hoc networks, in terms of both performance and reliability. The simulation results show that the protocol EMACA has been found better in performance than MACA protocol. Preliminary simulation results presented here validate the operational correctness of EMACA and show the potential for significant throughput improvement (at least in selected topologies). So EMACA protocol is more reliable. Consequently it identified and rectified additional performance drawbacks in EMACA through the use of adaptive learning strategies and better physical layer capabilities.

7. FUTURE WORK

Although EMACA performs well under different conditions but how much of the savings from avoided collisions in EMACA will spent on RTS/CTS and DSSI/DSSI-ACK overhead given typical modem turnaround times and data packet sizes? How much better does power-controlled EMACA perform than the basic EMACA scheme? Simulations gave further confidence in the protocol and showed further possible improvements in performance. The protocol can also be improved by adding carrier sensing. Simulations suggest that this could improve utilization under heavy load by about 5%. From the results it is expected that RRTS, a new control message addition will abolish the expose terminal and hidden terminal problems and EMACA in multi casting application may be potential future outcome.

8. ACKNOWLEDGMENTS

I am deeply indebted to my supervisor Prof. Sanjeev Sharma, HOD School of Information Technology whose help, stimulating suggestions and encouragement helped me in all the time of research.

9. REFERENCES

[1] T. Bheemarjuna Reddy, I. Karthikeyan, B.S. Manoj, C. Siva Ram Murthy, "Quality of service provisioning in ad hoc wireless networks: a survey of issues and solutions", Department of Computer Science and Engineering, Indian Institute of Technology, Madras 600036, India, Ad Hoc Networks 4 (2006) 83–124.

[2] Imrich Chlamtac, Marco Conti, Jennifer J.N. Liu, "Mobile ad hoc networking: imperatives and challenges", University of Texas at Dallas, Dallas, TX, USA, Ad Hoc Networks 1 (2003) 13–64.

[3] C.K. Toh, "Ad Hoc Mobile Wireless Networks: Protocols and Systems", Springer Prentice Hall Publishers, ISBN 013 007 8174, 2001.

[4] Azzedine Boukerche, "Algorithms and Protocols for Wireless and Mobile Ad Hoc Networks", University of Ottawa, Ottawa, Canada, ISBN 978-0-470-38358-2 (cloth) TK5105.77.A44 2008.

[5] Arun Kumar B. R., Asst. Prof. Dept. of MCA, Sir MVIT, Bangalore & Research Scholar, Dept. of CS, School of Science & Technology, "Performance Comparison of Wireless Mobile Ad-Hoc Network Routing Protocols", Dravidian University, Kuppam-517425, A. P., India, June 2008.

[6] P Mohapatra, S Krishnamurthy, "Ad-Hoc Networks - Technologies and Protocols" Springer Publishers, 2004 (ISBN: 0-387-22689-3).

[7] Changzhou Wang, Guijun Wang, Haiqin Wang, Alice Chen, "Quality of Service (QoS) Contract Specification, Establishment, and Monitoring for Service Level Management", Rodolfo Santiago Boeing Phantom Works Seattle, WA, USA 0-7695-2743-4/06, 2006.

[8] El-Bahlul Fgee, Jason D. Kenney, William J. Phillips, William Robertson Dalhousie University, Department of Engineering Mathematics, and Halifax, "Comparison of QoS performance between IPv6 QoS management model and IntServ and DiffServ QoS models" , ISBN:0-7695 2333-1, 2005.

[9] QualNet 4.5 Programmer's Guide, Scalable Network Technologies, Inc., 6701 Center Drive West, Suite 520, Los Angeles, CA 90045.

[10] Scalable Network Technologies, "QualNet simulator 4.0 Version", tutorial on http://www.cs.binghamton.edu /~vinkolar/QualNet/qualnet-tut1.pdf.

[11] C.E. Perkins, "Ad Hoc Network", Pearson Education, ISBN: 8131720969, 2008.

[12] Ad Hoc Wireless Networks: Architectures and Protocols, C. Siva Ram Murthy and B. S. Manoj, Pearson Education, ISBN13: 9780131470231 ISBN10: 0-13-147023-X, 2008.

[13] Blerta Bishaj, "MAC protocols, contention-based with reservation and scheduling", Helsinki University of Technology.

[14] Bartlomiej Zielilski, "Contention MAC Protocols Efficiency Testing in a Small Wireless Network", Silesian Technical University, Bartlomiej.

[15] Alan Demers, Scott Shenker, Lixia Zhang, "Media Access Protocol for Wireless LAN's", University of California at Berkeley.

[16] Akhilesh Kumar Dubey Anjana Jain S.V. Charhate, "Performance Evaluation of MAC layer Protocols for Ad-hoc WLAN", 23 Park Road Indore (M.P.) INDIA DOI 10.1109/ICETET.2008.66.

[17] Jun-Zhao Sun Media Team, "Mobile Ad Hoc Networking: An Essential Technology for Pervasive Computing", Machine Vision and Media Processing Unit, University of Oulu, Finland.

[18] Mehdi Alilou, Mehdi Dehghan.t, Upgrading Performance of DSR Routing Protocol in Mobile Ad Hoc Networks, World Academy of Science, Engineering and Technology 5, March 29 2005.

[19] The MANET web page, http://www.ietf.org/html.charters/manetcharter.html.

[20] Xi J.; Bettstetter C.Wireless Multihop Internet Access: Gateway Discovery, Routing and Addressing, in Proceedings of the International Conference on Third Generation Wireless and Beyond (3Gwireless'02), San Francisco, USA, May 2002.

[21] Tom Goff, Nael B. Abu-Ghazaleh, Dhananjay S. Phatak, Ridvan Kahvecioglu ,Preemptive Routing in Ad-Hoc Networks, MobiCom 2001.

[22] David B. Johnson David A. Maltz Josh Broch, DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks, Computer Science Department Carnegie Mellon University Pittsburgh, PA 15213-3891.

[23] Neeraj Agrawal, Prof. Sanjeev Sharma, School of Information Technology, RGPV, Bhopal, " Performance and Analysis of CSMA, MACA & ALOHA to support Quality of Services (QoS) under varying conditions of no. Of nodes in Ad-Hoc wireless Networks", International Journal of Information Technology and Knowledge Management, January-June 2010, Volume-3, No.-1, PP. 19-23, ISSN: 0973-4414, INDIA. http://www.csjournals.com/IJITKM/SpecialIssue.html

[24] Neeraj Agrawal, Prof. Sanjeev Sharma, Prabhat Sharda, School of Information Technology, RGPV, Bhopal, " A Comparative Study of MAC to support Quality of Services (QoS) in Ad-Hoc wireless Networks ", Proceeding of International Conference on Mathematics and Computer Science (ICMCS) -2010, PP. 227-231, INDIA.

[25] Neeraj Agrawal, Prof. Sanjeev Sharma, Renu Kachhoria, Sonal Chaudhary, School of Information Technology, RGPV, Bhopal, " Evaluation of CSMA, MACA & ALOHA to support Quality of Services (QoS) under varying conditions of Pause Time in Ad-Hoc wireless Networks ", National Conference on Advanced Pattern Mining and Multimedia Computing (APMMC)- 2010, Excel India Publishers, New Delhi, PP. 422-424, ISBN: 978-93-80043-83-8, INDIA.

[26] Neeraj Agrawal, Prof. Sanjeev Sharma, School of Information Technology, RGPV, Bhopal, " ***MAC Enhancement to support Quality of Services (QoS) in Ad-Hoc wireless Networks: EMACA (Enhancement of Multiple Accesses with Collision Avoidance)*** ", International Journal of Computer Applications (IJCA)-2010 (0975-8887), Volume-1, No.-2, PP. 64-70, ISBN: 978-93-80746-01-2, February 2010, Published by Foundation of Computer Science, INDIA.
http://www.ijcaonline.org/archives/number2/45-152