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

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Abstract— **Ad hoc wireless network (AWN) is a collection of mobile hosts forming a temporary network on the fly, without using any fixed infrastructure. QoS (Quality of Service) is the idea that transmission rates, error rates, and other characteristics can be measured, improved, and to some extent guaranteed in advance in ad hoc network however in particular concern for the continuous transmission of high bandwidth video and multimedia information this kind of content dependably transmitting is difficult in public networks using ordinary "best effort" protocols. Medium Access Control (MAC) protocols are responsible for coordinating the access from active nodes. 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. ALOHA protocols are often used in satellite communications systems and cellular radio systems and are a precursor to the popular Ethernet protocol. MACA (Multiple Accesses with Collision Avoidance) Protocol is a Contention based Sender initiated Protocol which uses Three way handshaking means that RTS—CTS—Data packet exchange. It used in network congestion avoidance to help in determining the correct sending rate by binary exponential back off (BEB) Algorithm in which if any packet transmitted by a node is lost, the node uses the binary exponential back-off (BEB) algorithm to back off a random interval of time before retrying which is also inadequate trustworthy because of data sending acknowledgement is not received. A comparative study was done on QualNet 4.0 Version simulator over CSMA, MACA & ALOHA. AODV routing protocol was used to evaluate the CSMA, MACA and ALOHA performance. Results show that the ALOHA simulation performs well as compared to MACA in sense of Throughput, Total Packet Received, Average Jitter and Drop Packet Ratio under varying conditions of no. of nodes.**

Keywords- AWNs, QoS, MAC, MACA, CSMA, ALOHA, AODV, Throughput, Total Packet Received, Average Jitter and Drop Packet Ratio.

I. INTRODUCTION

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.

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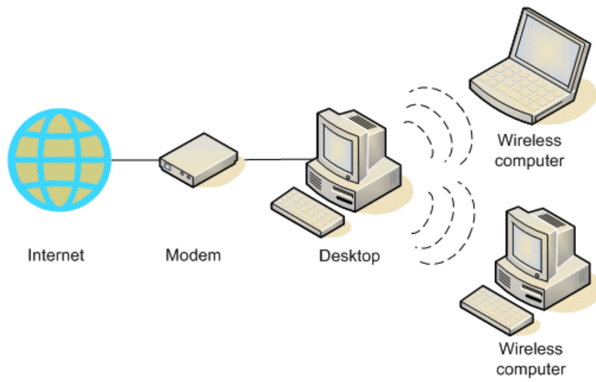

Figure 1: Mobile Ad Hoc Network

Ad hoc wireless networks (AWNs) are zero configurations, self organizing, and highly dynamic networks formed by a set of mobile hosts connected through wireless links [1], [2], [3], [4], [5], [6], [12]. As these are infrastructure less networks, each node should act also as a router. Hence they, the termed ''mobile host'', ''node'', and ''station'' and used interchangeably. As a router, the mobile host represents an intermediate node which forwards traffic on behalf of other nodes. If the destination node is not within the transmission range of the source node, the source node takes help of the intermediate nodes to communicate with the destination node. Tactical communication required on battle-fields, among a fleet of ships, or among a group of armored vehicles are some of the military applications of these networks. Civilian applications include peer-to-peer computing and file sharing, collaborated computing in a conference hall, and search and rescue operations.

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 [1], [2], [3], [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 packet stream from the source to the destination).

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.

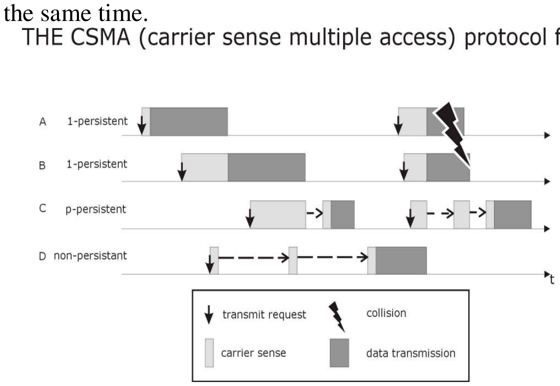

Figure 2: CSMA Protocol

Aloha means "Hello". Aloha is a multiple access protocol at the data link layer and proposes how multiple terminals access the medium without interference or collision. The protocol allows every system to send a frame if it ready to send. But when a collision occurs the node will wait for a random amount time and then send the frame again. The process continues till the node has sent all the frames. Since the nodes send their frames without sensing the medium there is a high probability for collisions to occur. The maximum success rate or throughput that can be achieved with Aloha protocol is only 18%. ALOHA is a random (or contention) access protocol developed at the University of Hawaii for sharing broadcast channel access among a number of users with relatively low throughput demand. There are two main ALOHA versions: unslotted, which has no coordination between system stations, and slotted, which uses a master clock to provide synchronized channel time slots to improve throughput . ALOHA protocols are often used in satellite communications systems and cellular radio systems and are a precursor to the popular Ethernet protocol.

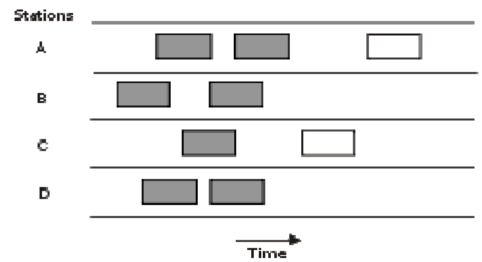

Figure 3: ALOHA Protocol

Multiple Access 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.

The basic idea of MACA is a wireless network node makes an announcement before it sends the data frame to inform other nodes to keep silent. When a node wants to transmit, it sends a signal called *Request-To-Send* (RTS) with the length of the data frame to send. If the receiver allows the transmission, it replies the sender a signal called *Clear-To-Send* (CTS) with the length of the frame that is about to receive. Meanwhile, a node that hears RTS should remain silent to avoid conflict with CTS; a node that hears CTS should keep silent until the data transmission is complete.

- When a node wants to transmit a data packet, it first transmits a RTS (Request to Send) frame.
- The receiver node, on receiving the RTS packet, if it is ready to receive the data packet, transmits a CTS (Clear to Send) packet.
- Once the sender receives the CTS packet without any error, it starts transmitting the data packet.

- ❖ If a packet transmitted by a node is lost, the node uses the binary exponential back-off (BEB) algorithm to back off a random interval of time before retrying.

II. PROBLEM DESCRIPTION

The objective research was to evaluate proposed EMACA (Enhancement Multiple Access with Collision Avoidance) Protocol for wireless ad-hoc networks through in given network based on performance.

There are three problems in this protocol.

- ❖ 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
- ❖ Third one is, MACA does not use the Acknowledgement control message, so it's not a reliable.

III. EXPERIMENT CONFIGURATION

S.No.	Parameters	Values
1	Area	1500mx1500m
2	Number of nodes	10, 15, 20, 30, 40 and 50 Nodes
3	Application	CBR 2 to 3 Nodes
4	Mobility Model	Random Waypoint
5	Pause Time	30 Seconds
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 ALOHA
10	Routing Protocols	AODV
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].

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].

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].

IV. SIMULATION AND RESULTS

1) *Effect of Varying Number of Nodes*

Number of nodes may be another varying parameter as it plays important role in performance. Figure 4 (4a, 4b, 4c, 4d) shows various performance parameters versus number of nodes. From figure we can observe that routing overload for all protocol increased as number of nodes increased but among them AODV performed poorer as this might be due to flooding of routing packets. While in case of less number of nodes all protocols performed poorer in terms of delivery ratio as nodes breakage may be more and no route may be available.

Figure 4: Various Performance Parameter V/s Numbers of Nodes

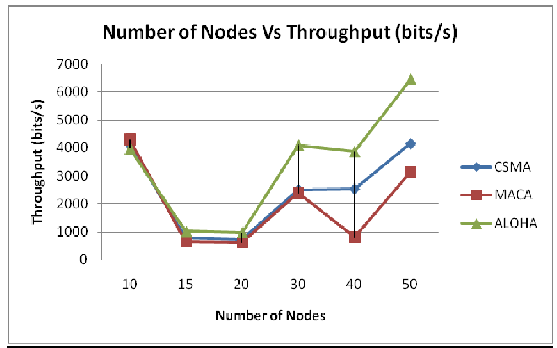

Figure 4 (a): Number of Nodes Vs Throughput (bits/s)

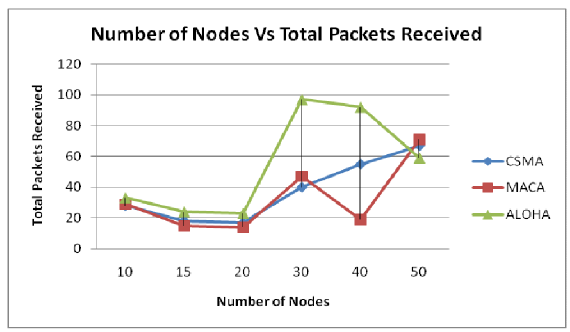

Figure 4 (b): Number of Nodes Vs Total Packets Received

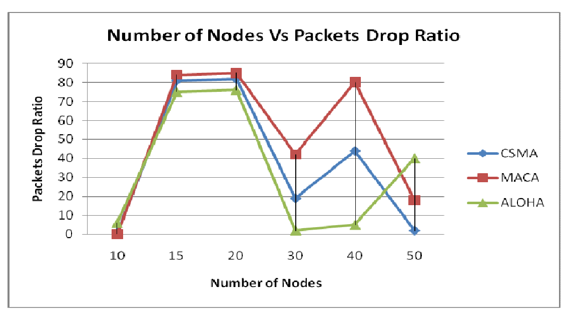

Figure 4 (c): Number of Nodes Vs Packets Drop Ratio

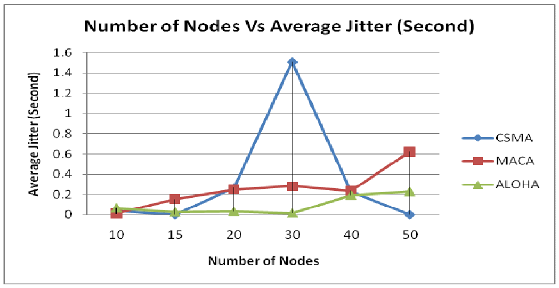

Figure 4 (d): Number of Nodes Vs Average Jitter (Second)

V. CONCLUSIONS

The Efficient MAC protocols can provide significant benefits to mobile ad hoc networks, in terms of both performance and reliability. The issues associated with the design of a MAC protocol for wireless ad hoc networks are: node mobility; an error- prone, broadcast and shared channel; time-synchronization; bandwidth efficiency; QoS support. Many MAC protocols for such networks have been proposed so far but their performance in terms of Throughput, Total packet received, Average Jitter and drop packet ratio is questionable and is not satisfactory.

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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., "Performance Comparison of Wireless Mobile Ad-Hoc Network Routing Protocols", Bangalore & Research Scholar, Dept. of CS, School of Science & Technology, Dravidian University, Kuppam-517425, A. P., India, June 2008.

[6] S Krishnamurthy, "Ad-Hoc Networks - Technologies and Protocols – P Mohapatra", 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, "Comparison of QoS performance between IPv6 QoS management model and IntServ and DiffServ QoS models", Dalhousie University, Department of Engineering Mathematics, and Halifax, 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] C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", 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", University of Oulu, Finland.

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