

## **MAC Enhancement for Performance Improvement of Routing Protocol**

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### **ABSTRACT**

Mobile Ad hoc network allow wireless devices to dynamically self organize into arbitrary and temporary wireless topologies without fixed communication infrastructure. One of the most popular MAC layer protocol used in Ad hoc network is 802.11b. Since the IEEE 802.11 standard support multiple data rates at the physical layer, many rate adaptation mechanisms have been proposed to utilize this multi rate capability by dynamically switching rates in response to different channel conditions. Because of varying channel condition, 802.11b products degrade the bit rate from the nominal 11Mbps to 5.5,2 or 1Mbps. When a host detects repeated unsuccessful frame transmission, it decreases its bit rate. If there is at least one host with a lower rate, 802.11 cells presents a performance anomaly. The throughput of all the hosts transmitting at higher rate is degraded below the level of the lower rate.

In IEEE 802.11b networks, the guarantee of equal transmission opportunity for all participating nodes results in performance anomaly. We propose a new cross layer MAC mechanism, which allows nodes acquire the whole path's rate information by exchanging information between MAC and Routing layer at every node. The interactions between MAC and Routing Layer are fully exploited to achieve higher performance using AODV routing protocol. Nodes acquire the whole path's rate information by following a cross layer design approach. We evaluate the performance measured on the network simulator OMNet++.

**Keywords:** AODV, Cross layer, IEEE 802.11b, MANET, Routing.

### **1 INTRODUCTION**

Ad hoc networking is a concept in computer communication, which means that the users wanting to communicate with each other form a temporary network, without any form of centralized administration. Each node participating in the network acts as both host and router and willing to forward packet for other nodes.

IEEE 802.11 standards support multiple data rates with dynamic rate switching capability. IEEE 802.11 network, the diversity of data rate could lead to a phenomenon known as performance anomaly. When the host detects repeated unsuccessful frame transmission, it decreases its bit rate from nominal 11Mbps to 5.5, 2 or 1Mbps. If there is at least one host with a lower rate the IEEE 802.11 cell presents the performance anomaly that is the throughput of all other hosts transmitting at the higher rate is degraded below the level of the lower rate. To solve this performance anomaly the idea of cross layer design (CLD) is used in proposed work.

The whole idea behind CLD is to combine the resources available in the different communities, and create a network which can be highly adoptive by sharing state information between different processes or modules in the system. The interactions between the MAC and Routing layer is achieved by popular routing protocol AODV. Nodes can acquire the whole path's rate information which can represent the whole path's data transmission capability and uses it as criteria for allocating the channel.

AODV routing algorithm is quit suitable for dynamic self organizing network. AODV provides a loop free routes there by routes are created on demand. There is no need of periodic routing updates.

### **2 RELATED WORKS**

Mobile Ad hoc networks (MANETs) are often characterized as dynamic wireless networks that do not rely on any form of fixed supporting infrastructure to operate. Conventionally, communication protocols and services in MANETs are designed to adapt in response to traffic demands and changes in network topology and link characteristics [1] [18]. Many rate adaptation mechanisms have been proposed to improve the performance of multi rate MAC protocol. RBAR (Receiver Based Auto Rate) as one of the most popular multi rate MAC protocol was proposed by Gaven in [2]. Rate adaptation is the process of dynamically switching data rates to match the channel conditions, with the goal of selecting the rate that will give the optimum throughput for the given

channel conditions. The novelty of RBAR is that its rate adaptation mechanism is in the receiver instead of the sender. Compared with its poor channel quality estimation and the dependence on RTS/CTS packet, more problems of RBAR came from performance anomaly. In [3], Martin Heusse et al, pointed out that the diversity of data rate in a wireless network could lead to the performance anomaly in IEEE 802.11b networks, because 802.11 DCF make sure every node, whether high rate or low rate has the same opportunity to access the channel. Thus, low-rate nodes will occupy the channel much longer than high-rate nodes eventually leading to the performance degradation of the entire multi-rate network. As pointed by Tan and Guttsig, the throughput-based fairness, which is widely accepted in single-rate network, could not suit multi-rate network well. In [4], a new fairness notion known as time based fairness is considered. In time based fairness, each node receives an equal share of the wireless channel occupancy time. It is demonstrated in [5] that the time based fairness can achieve higher aggregate throughput.

Several solutions were proposed to solve performance anomaly. Initial contention window adaptation [6] achieves the time based fairness by adjusting its CWmin inversely proportional to the data rate to make sure the high rate node have more opportunity to access the channel. It was suggested in [7] that performance anomaly can be reduced by adjusting MAC frame sizes according to data rates, which could be achieved by controlling the size of maximum transmission unit(MTU). In [8], Sadeghi et al. proposed a solution called OAR (Opportunistic Auto Rate) protocol, which allows the nodes with high data rate to transmit multiple packets in order to take advantage of the high rate channel. Yongho proposed a multi rate Aware Sub layer (MAS) [9] which is independent of IP protocol to utilize the MAC and Physical layer when packets are routed in MANETs. The key function of MAS is to change its next hop node to another node through which higher data rate is available. Following the idea of MAS, many cooperative relay based medium access schemes are proposed to enable the full utilization of the multi rate channel characteristics. RBMAC (Relay Based MAC) [10], Relay enable DCF [11] and CRBAR (Cooperative Relay Based Auto Rate MAC) [12] all take the whole path's data rate or the path's average end to end delay into consideration for selection of appropriate path.

In recent years, the idea of cross layer design (CLD) has drawn more and more attentions. In [13] [16] [17], the cross layer survey says protocols can be designed by violating the reference architecture, by allowing direct communication between protocols at nonadjacent layers or sharing variable between layers. Such violation of the layered

architecture is cross layer design with respect to the reference architecture.

AODV Routing protocol provides on demand route discovery in mobile ad hoc networks. In [14] it uses an on demand approach for finding routes, that is, a route is established only when it is required by a source node for transmission of data packets. Power Aware AODV (PAAODV) protocol for ad hoc networks [15] [19], which is an enhancement of existing AODV ad hoc routing protocol. The principal goal behind devising PAAODV is to optimally reduce power consumption to a possible minimum level in an ad hoc network with the connectivity of the network not being disrupted.

### 3 PROPOSED TECHNIQUE

In our work we develop a unique solution to deduce the performance anomaly in MANET by introducing a Cross layer MAC mechanism to enhance the performance. A cross layer MAC mechanism for selection of route from source to destination acquire the whole path's rate information and allocation the channel based on the relative ratio of competitive path's data transmission capability.

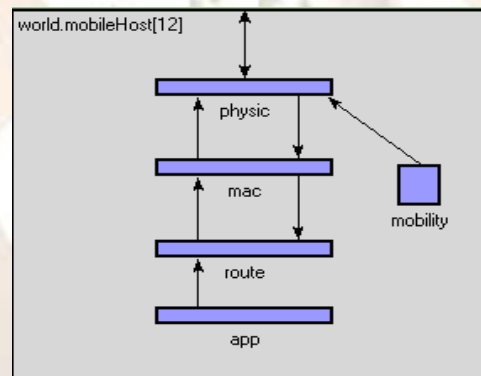


Fig 1 illustrate flow of data using cross layer

We use "link" to refer to the point to point connections between two nodes through a wireless MAC, where as we use a "path" to refer to end to end connections between two nodes through AODV routing protocol. Two new sub structures are introduced to store its neighbor nodes MAC address and data rate.

Neighbor List	Path List
Neighbor node address	Source node address
Rate	Destination node address
	Path Rate
	Path Level

(a) Neighbor List structure

(b) Path List structure

Fig 2 illustrates storage structure

A new structure denoted by Path List, is introduced to store path's information. The first two substructures of Path List are used to store path's source node and destination node's IP addresses. The Path Rate substructure is used to record the reciprocal of the time that spent transmitting unit data packet from path's source node to the destination node. Path Rate, which can be recognized as the average data rate of the whole path, represents the whole path's data transmission capacity so nodes on the same path have the same Path Rate. Competitive node's competitive level which is the ratio of its own Path Rate to the competitive node's Path Rate, is stored in Path Level substructure.

The source node generates RREQ packet for the route discovery from source to destination. Each RREQ packet generated by the source node is appended with a new field of path rate. Source node of a path needs to get the rate information of the whole path. The interactions between MAC and Routing layers are achieved with the protocol AODV, a widely used ad hoc routing protocol. Each node calculates its MAC QUEUE SIZE which is further used for the calculation of the rate parameter (RP):

$$RP = 11.2e+6/nbCount * MAC\_QUEUE\_SIZE + 1 \quad (1)$$

Where RP=Rate Parameter, nbCount=number of neighbor count, MAC\_QUEUE\_SIZE=Queue size of each node. All the neighbor nodes receiving RREQ packet adds its RP value to the rate field of the RREQ packet accept the destination node.

Number of RREQ packets reaching to destination contains the total RP value of all the nodes lying as intermediate nodes in the path from source to destination. Destination node stores all the RREQ packets from different path in a route cache. The Path Rate which is average data rate of the whole path is calculated at the destination which is considered as the cost:

$$rp = rp + RP \quad (2)$$

$$Cost = rp + en \quad (3)$$

Where rp is the rate parameter of the whole path, Cost is the sum of rate parameter and energy used.

$$cost = Cost / hopcount \quad (4)$$

Where cost is the average cost for the whole path.

The destination node compares the current cost with the calculated cost of each path and then selects the best path. Once the path is been selected the destination generates RREP packet with new field

path rate transmits to the source node. Only a source node of the path can update its Path List based on information piggyback by RREP because only when receiving RREP, source node has acquired the whole path's rate information. Source node stores the path's information in its Path List which includes source node's IP address, destination IP address, Path Rate and Path Level. Hence the source node transmits the data to the destination.

### 3.1 METHODOLOGY

Step 1: Generate RREQ packet at the source node. Each RREQ packet is appended with a new field path rate.

Step 2: Each intermediate node transmits the RREQ packet unless it finds itself as a destination node.

Step 3: Each intermediate node takes its MAC QUEUE SIZE and calculates its RP value which is added to the RREQ packet.

Step 4: Once the RREQ packets are received by the destination node from different paths, the destination calculates the cost of each path.

Step 5: Destination compares the current cost with the calculated cost and selects the best path.

Step 6: Destination generates RREP packet for the best path.

Step 7: Source node on receiving RREP packet updates its Path List with the Path Rate and Path level and transmits the data

### 4 SIMULATION

The simulation is carried out in OMNet++ 3.3 network simulator. The setup of the simulation depicts an ad hoc network that consists of a varying number of Mobile Hosts (MHs) that move randomly in a square field free of obstacles. OMNET++ is a freely distributed, object oriented, modular, discrete event simulator written in C++. It is designed for general purpose discrete event simulation and provides model libraries for communication protocols and network systems. A Network Descriptor (NED) language is used to model definitions based on system modules written in visual C++.

Simulation is carried out for the proposed technique in MANET with the routing layer along with the comparison of present system. The simulation is carried out by varying parameters such as nodes, sessions, area, pause time, packet rate, and simulation time. We measure the out put parameters such as throughput (Mbps), packet delivery ratio (%), control overhead (sec) and latency (sec).

4.1 Simulation Results:

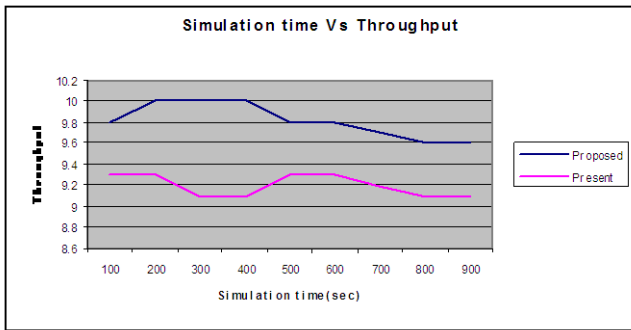


Fig 3 illustrates Throughput with the varying Simulation time.

The above graph shows the performance of the proposed technique in terms of throughput. The throughput is much better than the present system.

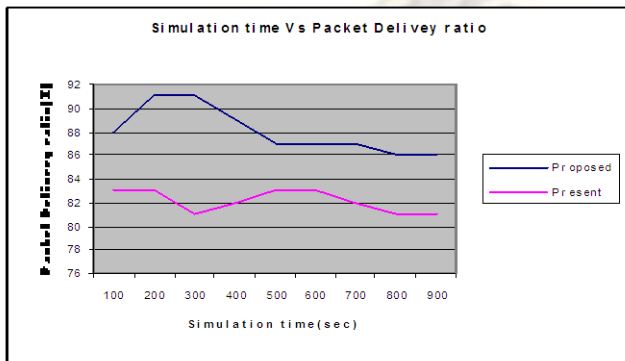


Fig 4 illustrate Simulation time Vs Packet delivery ratio

Graph elaborates packet delivery ratio with respect to the varying simulation time. The proposed system provides high packet delivery compared to the present system.

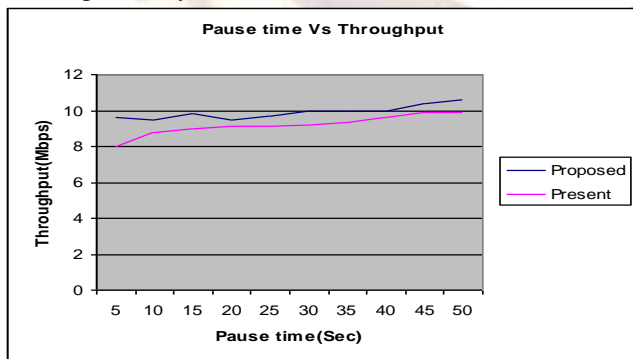


Fig 5 illustrate Pause time Vs Throughput

Graph illustrates the throughput with respect to varying pause time. The proposed technique shows high performance with the high throughput compared to the present. The throughput increases with the increase in the pause time which decreases the high mobility in MANET.

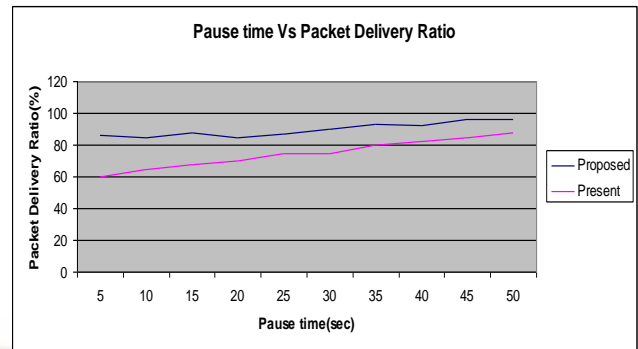


Fig 6 illustrate Pause time Vs Packet delivery ratio

Packet delivery ratio increases with the increase in the pause time which indicates a complete stability in the network and hence reduces packet drop. Hence the packet delivery ratio is best than the present.

5 CONCLUSION AND FUTURE WORK

The traditional techniques have some limitations when solving performance anomaly especially when dealing with the multi hop network because in MANET the network condition and route quality differs from time to time due to various issues like node mobility, no power control, congestion in the network and so on which ultimately affects the reception quality and effective packet and data rate.

Therefore in our work we propose a novel technique for QoS provisioning in MANET by calculating the route cost based on both energy and Rate in a node. The cost is incorporated in RREQ. Destination forwards RREP only if cost of the most recent RREQ is better than the already ensured RREQ. Thus the work utilizes the advantages of multipath routing without adding extra overhead through route caching.

Results show that the system performs better with the cost based AODV. The system can be further improved by comprehensive Rate measurement technique which should measure rate from Bandwidth, Delay and collision in the channel and interference.

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