

# STUDY OF MULTIPATH ROUTING, CSMA/CN AND MIMO FOR EFFECTIVE DATA COMMUNICATION IN MANET

Wg. Cdr. (Retd.) Arif Ullah Khan #1, Dr. Shiv Shakti Shrivastava\*2, Dr Asif Ullah Khan #3

Department Computer Science, Rabindranath Tagore University

Bhopal, M.P. (India)

<sup>1</sup>arifukhan2@gmail.com

<sup>2</sup>shivshakti18@gmail.com

Associate Professor (CS)

<sup>3</sup>asifullahkhan@rediffmail.com

Rabindranath Tagore University

Bhopal, M.P. (India)

## Abstract

Mobile Ad hoc Network is a collection of lightweight devices that's capable to transmit packet by point to point and multipoint bases. Data transmission by sensor nodes is a challenging task because limited availability of channels, energy, processing power to transmit the data in rush network. To address this problem by existing work and identifies some solutions such as collision resolution by CSMA/CA or CSMA/CN method, network load sharing through multipath routing and avoid the congestion from the network. In this paper incorporate all those existing work and proposed a module to provide reliable service in any circumstances under mobile ad hoc communication. We solve the collision problem by multiple input and multiple output (MIMO) antenna whose support to carrier sense multiple access with collision notification (CSMA/CN) MAC protocol that enhances the channel utilization with collision resolution. Another aspect to solve the delay and load balancing problem while network is very denser or number of device is grater in single network, that issue resolve by the multipath routing strategies whose gives the multiple path for data communication at the same time to the single or multiple competitor devices. In this study paper we investigate all relative parameters under collision resolution and load balancing and proposed the enhance solution for those problem resolution.

*Keywords*— AOMDV, CSMA/CD, CSMA/CN, MIMO,MANET.

## Introduction

Mobile Ad hoc Network (MANET) consists of lightweight devices that are equipped with sensors and processing power. They also communicate with each other through dynamic routing. For the sensor node communication, many hurdles arise like collision during communication, route decision problem, channel availability problem and resource

utilization etc. In this synopsis we incorporate the multipath routing for network load balancing, because through the multipath routing sender sends the data through multiple paths simultaneously and utilize the idle nodes for the communication. Secondly Carrier Sense Multiple Access with Collision Notification (CSMA/CN) enhances through MIMO (Multi Input Multi Output) antenna. Before the MIMO adoption, collision notification method finds the collision, than simply sends the notification message to the respective sender and sender abort from transmission. CSMA/CN with MIMO antenna resolves this problem of collision. Physical layer MIMO antenna helps to allocate separate antenna and channel for the required devices and avoid the collision. This method is also adopted in 4G technology of wireless communication. In this synopsis our aim is to develop a system to improve the network performance through reliable service adaptation using Ad hoc On-Demand Multipath Distance Vector AOMDV, CSMA/CN and physical layer MIMO antenna based mechanism.

Media Access Control (MAC) layer plays an important role in the WSN. Many media access control techniques are built to provide communication and channel to the wireless devices such as CSMA, CSMA/CA, CSMA/CD and CSMA/CN. But for the scalability of wireless sensor devices, some new techniques are needed to solve the problem of channel availability to all needed devices with collision free environment. The proposed approach of CSMA/CN with MIMO implementation can enhance the network performance with respect to signal to noise ratio, throughput, overhead and delay etc.

## Related Work

In this section, we describe about related work in the field of MAC layer protocol CSMA or CSMA/CD etc. and

Multipath routing mechanism for improve the performance of Mobile Ad hoc Network MANET.

**Souvik Sen et. al. [1]** Propose ‘Carrier Sense Multiple Access with Collision Notification’. In their work, they attempts to approximate CSMA/CD in wireless networks with a novel scheme called CSMA/CN (collision notification). Under CSMA/CN, the receiver uses Physical layer information to detect a collision and immediately notifies the transmitter. The collision notification consists of a unique signature sent on the same channel as the data. The transmitter employs a listener antenna and performs signature correlation to discern this notification. Once discerned, the transmitter immediately aborts the transmission. They show that the notification signature can be reliably detected at the listener antenna, even in the presence of a strong self-interference from the transmit antenna. A prototype test-bed of 10 USRP/GNU Radios demonstrates the feasibility and effectiveness of CSMA/CN.

**Yishan Su et al. [2]** propose a scheme in which they attempt to combine channel state estimation in the physical layer, the actual measurement matrix, with the requests/grants in the data link layer to improve the efficiency of the MAC scheme. Here, a new, cross-layer CS-MAC (CL CS-MAC) scheme, which combines the channel state of the physical layer with requests in the MAC layer to deal with the collision of the multiple transmitted packets based on compressed sensing, is proposed. The compressive complex requests are used to identify the active sensor node which makes the scheme more efficient. Because the reconstruct process is executed in the complex field of the physical layer, no bit and frame synchronizations are needed.

**Han-Chiuan Luo et al [3]** propose “A Transmission Power/Rate Control Scheme in CSMA/CA-Based Wireless Ad Hoc Networks”. In this work, a new transmission power and rate management theme is planned to increase the network throughputs of carrier-sense-multiple access with collision avoidance (CSMA/CA)-based wireless unexpected networks with multiple transmission rates. The principle of the scheme is to utilize the space–time resource expeditiously. For this purpose, the space–time resource consumption per bit transmission is introduced. Simulation results show that the planned scheme is effective in network throughputs beneath the two-ray ground reflection model and also the Ricean model

**Mariam Kaynia et al.[4]** propose “Improving the Performance of Wireless Ad Hoc Networks through MAC Layer Design”. In this work, they study and analyze performance of the ALOHA (Additive Links On-line Hawaii Area) and CSMA. MAC protocols are analyzed in spatially

distributed wireless networks. Researchers’ objective is to correct the reception of data packets, and thus the analysis is performed in terms of outage probability. In network model, packets belonging to specific transmitters arrive randomly in space and time according to a 3-D Poisson point process, and are then transmitted to their intended destinations using a fully-distributed MAC protocol.

In this work they analyze that packet transmission is successful if the received SINR (signal-to-interference-plus-noise ratio) is above a predefined threshold for the duration of the packet. Accurate bounds on the outage probabilities are derived as a function of the transmitter density, the number of backoffs and retransmissions.

**Lu Zheng et al.[5]** have focused the work” Decentralized Detection in Ad hoc Sensor Networks With Low Data Rate Inter Sensor Communication ” They propose a consensus based detection scheme where sensors exchange their local decisions, update their own decisions based on the exchanges and finally reach a consensus about the state of nature. They analyze the error probability and convergence of this decision consensus scheme. They show that with their scheme, the detection performance in ad-hoc networks is asymptotically equivalent to that of a parallel sensor network where all the local decisions are processed by a central node (fusion centre) in the sense that the error exponents are the same. The probability distribution of the consensus time is also studied.

**Kai-Ten Feng et al.[6]** have proposed “Design and Analysis of Adaptive Receiver Transmission Protocols for Receiver Blocking Problem in Wireless Ad Hoc Networks ”. In this paper, the multiple receiver transmission (MRT) and the fast NAV truncation (FNT) mechanisms are proposed to alleviate the receiver blocking problem without the adoption of additional control channels. The adaptive receiver transmission (ART) scheme is proposed to further enhance the throughput performance with dynamic adjustment of the selected receivers. Analytical model is also derived to validate the effectiveness of the proposed ART protocol. Simulations are performed to evaluate and compare the proposed three protocols with existing MAC schemes. It can be observed that the proposed ART protocol outperforms the other schemes by both alleviating the receiver blocking problem and enhancing the throughput performance for the wireless multihop ad hoc networks.

**Rajalekshmy.R.S et. al. [7]** propose “CSMA Based Cross Layer Framework with Integrated Routing and Scheduling In Ad Hoc Networks”. A framework which finds the applications in military fields and other emergency issues is developed.

The MANETS are used in such applications. A cross layer framework is utilized in the proposed framework in which protocols of different layers share the network information by keeping the separation between the layers. The mesh driven routing is included in the framework. For Scheduling, instead of TDMA approach, CSMA/CD algorithm is exploited. This algorithm detects the collisions more efficiently and reduces the collisions. The bandwidth is calculated and is shared among the channels efficiently using CSMA/CD approach. The CSMA protocol also offers less control overhead and offers high bandwidth efficiency.

**Gopal Singh Bhadoriya et. al. [8]** Propose “Analyzing MAC Protocol for Wireless Ad-hoc Networks”. In this survey title they present a classification of MAC protocols and their brief decryption, based on their operating principles and underlying features. Medium Access Control (MAC) protocols are responsible for coordinating the access from active nodes in this network. MAC protocols are very importance since the wireless communication channel is inherently prone to errors and some problems such as hidden terminal problem and exposed terminal problem. Although a lot of researches have been conducted on MAC protocols, the various issues involved have mostly been presented in isolation of each other.

**Rahman Doost-Mohammady et. al. [9]** Propose “Performance Analysis of CSMA/CA based Medium Access in Full Duplex Wireless Communications”. They formulate the first analytical model of a CSMA/CA based full duplex MAC protocol for a wireless LAN network composed of an access point serving mobile clients. There are two major contributions of their work: First, Markov chain-based approach results in closed form expressions of throughput for both the access point and the clients for this new class of networks. Second, study provides quantitative insights on how much of the classical hidden terminal problem can be mitigated through full duplex. They specifically demonstrate that the improvement in the network throughput is up to 35-40% over the half duplex case.

**Nikolaos A. Pantazis et. al. [10]** have proposed “Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey” In this work, energy efficient routing protocols are classified into four main schemes: Network Structure, Communication Model, Topology Based and Reliable Routing. The routing protocols belonging to the first category can be further classified as flat or hierarchical. The routing protocols belonging to the second category can be further classified as Query-based or Coherent and non coherent based or Negotiation based. The routing protocols belonging to the third category can be further classified as Location based or

Mobile Agent based. The routing protocols belonging to the fourth category can be further classified as QoS-based or Multipath based.

**Sneha R.Deshmukh et. al. [11]** propose “EALBM: Energy Aware Load Balancing Multipath Routing Protocol for MANETS” The primary objective of load balancing routing protocols is to divert traffic from routes which are currently congested. The drawback of current routing protocols is that they select paths with least node activity, least cost, least hop count, least load or those with smaller interface queues. However, if the path with the least metric will be selected every time then this could congest this path could get more loaded than others. Eventually some of the nodes along path could die. This problem is addressed by proposing Energy efficient and Load Balancing Multi-path (EALBM) routing protocol which uses multiple paths at the same time. EALBM is an on demand routing protocol, it has three phases of working: neighbor discovery, multipath discovery and data transmission. The source initiates multipath discovery process to determine all existing disjoint multipath from source to destination. Each disjoint path is assigned a weight based on the energy level of nodes along that path. The path with maximum energy has least weight i.e. most preferred. To validate our protocol we implemented EALBM in

**Manu J Pillai et. al. [12]** propose “Dynamic Multipath Routing for MANETS – A QoS Adaptive Approach” In this title they discuss a new dynamic multipath routing method which avoids stale routes by periodic maintenance, provides route switching prior to route breakage. This method always selects the best quality route based on the value of a tunable route metric which is calculated dynamically by considering the durability, consistency and quality of all individual paths and thereby gives quality routes suitable for diverse QoS requirements.

**Ms. Madhuri Shinde et. al. [13]** Propose “PALBMRP: Power Aware Load Balancing Multipath Routing Protocol for MANET. According to the author, most of the existing energy efficient protocols focuses on selection a route or path through the nodes with maximum residual energy and share a network traffic blindly along with generated paths. Network congestion caused due to traffic and node packet moving capability based on its residual energy are not careful that leads to increasing number of dead nodes and result in more energy depletion. According to author they have proposed a Power Aware Load Balancing Multipath Routing Protocol (PALBMRP) that selects an optimal energy efficient route based on multiple parameters i.e. residual energy, delay, congestion and hop count and execute load balancing by

considering nodes minimum residual energy to transmit packets according to its capacity.

**Gaurav Pathak et. al. [14]** propose “Traffic aware load balancing in AOMDV for mobile Ad-hoc networks” As per author they also became more diverse and wide due to that better performance is needed in MANETs. QoS is needed for applications for an efficient communication and load balancing is a feature in the routing protocol that can help in a better use of the resources and can help to increase the performance of the network. They propose a new approach for load balancing in AOMDV routing protocol for MANETs that can enhance the network performance by selecting paths using the temporal load on the intermediate nodes and by distributing the load between the free nodes while transmission of data, that is proved by simulations in NS-2.

**Sunita Gupta et. al. [15]** propose “Enhanced Load Balancing and Delay Constraint AOMDV Routing in MANET” According to author, predictable congestion management multipath mechanism is to limit the delay and management rate that's the most reason for congestion and provide higher performance of the network. In this analysis the expected congestion management theme with AOMDV protocol square measure uses information measure estimation technique. The information measure estimation is finished through acknowledgement delay distinction. Sender changes causing rate in line with this delay distinction so avoiding congestion. Dynamic queuing reduces further overhead in network and AOMDV balances load by multiple causing methods. The performance comparison of traditional AOMDV routing, existing analysis is compare with expected theme and known that the expected theme is provides higher routing performance by minimizing delay and management overhead.

**Jayashree V. Agarkhed et. al. [16]** propose “Load Balancing Technique for Congestion Control Multipath Routing Protocol in MANETs”. According to author, an efficient routing technique called the multipath load balancing technique is introduced for congestion control (MLBCC) in MANETs to efficiently balance the load between multiple paths by reducing the congestion. MLBCC introduces a congestion control mechanism and a load balancing mechanism during the data transmission process. The congestion control mechanism detects the congestion by using an arrival rate and an outgoing rate at a particular time interval T. The load balancing mechanism selects a gateway node by using the link cost and the path cost to efficiently distribute the load by selecting the most desirable paths. For an efficient flow of distribution, a node availability degree standard deviation parameter is introduced.

**Saleh A. Alghamdi [17]** propose “Load balancing ad hoc on-demand multipath distance vector (LBAOMDV) routing protocol” Researchers working in the area of a mobile ad hoc network (MANET) attempt to conserve the battery energy of individual nodes to reduce the frequency of a node breakdown. The model of multiple-path on demand data routing protocols has been an effective method for the majority of MANET application scenarios in recent times. The availability of multiple paths for data transfer can both prove to be effective as well as dismal in certain cases. The choice of the most suitable path is always delicate, if not associated with exact metrics of concern. The contribution of this work load balancing ad hoc on-demand multipath distance vector (LBAOMDV) protocol, an adaptation of AOMDV, and an ad hoc on-demand multipath distance vector protocol. The adaption is done in order to enhance the reliability of the given network by considering the parameter of path weight (energy) of all the available multiple paths. The LBAOMDV regulates the fair tradition of both node energy and available bandwidth by exploiting the availability of multiple paths for data transfer.

**Sujata V. Mallapur et. al. [18]** propose “Multipath Load Balancing Technique for Congestion Control in Mobile Ad Hoc Networks”. Authors explore an efficient routing technique called multipath load balancing technique for congestion control (MLBCC) in MANETs to efficiently balance the load among the multiple paths by reducing congestion. They propose protocol that performs two major functions during the data transmission process. Firstly, congestion detection by using an arrival rate and an outgoing rate at a particular time interval T. Secondly, choice of gateway node using link cost and the path cost to efficiently distribute the load by selecting the most desirable paths.

**Chunlei Yin et. al. [19]** have focused on achieving high data rate through the MIMO-OFDM (Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing) technology. The research shows that MIMO-OFDM system can transmit information with higher data rate and better QoS. Therefore, the IEEE 802.11n will be able to reach data rates of 600 Mbps, and it guarantees a minimum of 100 Mbps of throughput, meanwhile, it depresses the Inter-Symbol Interference caused by multi-path fading, enhances immensely transmission performance of wireless communication system.

## Proposed Methodology

Mobile Ad hoc Network gives the new age to the communication technology. It provides the anywhere anytime

communication to the end user, so that we contribute our idea to the particular environment and strength to the WSN. Our proposed work divided into sub module such as MIMO (multiple input, multiple output), CSMA/CN and multipath routing module and resolve the problem of collision and network bandwidth utilization for achieving the network quality of service.

*A. MIMO Module:*

The MIMO is the Multiple Input Multiple Output network technique in which combinations of more than one transmitter / receiver or antenna at both sides of digital communication systems are used. It can be expressed as facsimile of smart antennas array group. In wireless communications MIMO technique is growing and offers substantial increase in data bandwidth devoid of any extra transmission power. The MIMO performance is improved by applying OFDM technique to reduce S/N ratio and enhance signal strength that reduces the BER (Bit Error Rate).

*B. CSMA/CN Module:*

Carrier sense multiple access with collision notification is enhanced through the MIMO method. In this method, multiple antennas are deployed in sender as well as receiver end. Multiple senders compete for channel access. MIMO multiplexes all the sender data and convert into code format. The coded data de-multiplexed and decoded by the receiver nodes which resolves the problem of collision. MIMO use different receiving and transmitting antenna for the communication, so that collision is minimized. Our proposed MIMO-CSMA/CN mechanism reduces the network collision.

*C. Multipath Routing:*

Multipath routing from source to receiver can overcome the problem of collision and congestion and improve the network performance. During the route initiation phase, source node broadcast the routing packet using MIMO method and searches the route. Multiple routes are identifies from source to receiver than we select the best three route based on capacity (processing, energy, and bandwidth) and establish the communication. Multipath routing scheme source node sends the data packet simultaneously through all established routes and balances the network load as well as minimizes the network collision and congestion. In this case CSMA/CN uses the request to send (RTS) and clear to send (CTS) message and avoid the collision in future communication.

Proposed methodology can work in MAC with routing layer and minimize network congestion, collision, network delay, overhead and improve the network performance in terms of throughput, percentage of data receiving etc.

## Tools for data collection

In our approach we use data collection tool as network simulator -2 that gives the behavior of network and analyses approach for our work.

A network simulator is a piece of software or hardware that predicts the behavior of a network, without an actual network being present. A network simulator is a software program that imitates the working of a computer network. In simulators, the computer network is typically modeled with devices, traffic etc. and the performance is analyzed. Typically, users can then customize the simulator to fulfill their specific analysis needs. Simulators typically come with support for the most popular protocols in use today, such as WLAN, Wi-Max, MAC WSN, MANET protocols etc.

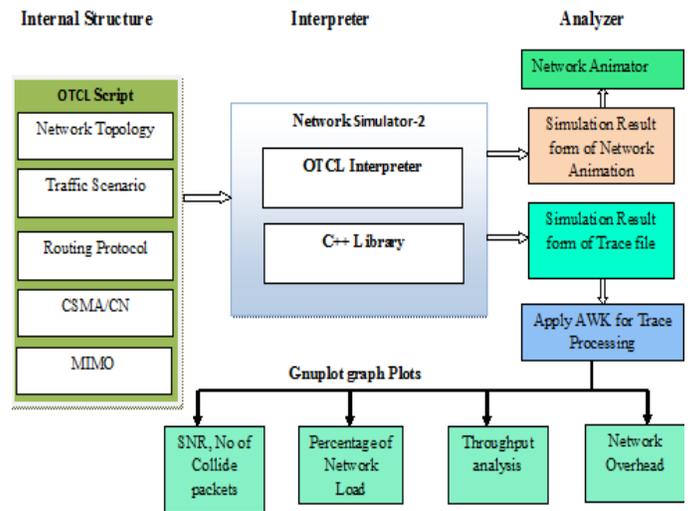


Figure 1: Data collection module Architecture

The data collection module provides the information about internal, intermediate and outer structure of simulation structure through this scheme we collect data and analyze them. All the internal module coded through C++ (object oriented approach) and outer module coded through TCL (tool command language base) both are interlinked via object file that generated after compilation of internal C++ file and all are collectively called OTCL (object tool command language). For analysis purpose we use AWK (abstract window tool kit) and generate result in the form of graphically approach [20]. In 1996-97, work on ns version 2 (ns-2) was initiated based on a refactoring by Steve McCanne . Use of Tcl was replaced by MIT's Object Tcl (OTcl), an object-oriented dialect of Tcl. The core of ns-2 is also written in C++, but the C++ simulation objects are linked to shadow objects in OTcl and variables can be linked between both language realms. Simulation scripts are written in the OTcl language, an

extension of the Tcl scripting language. This structure permits simulations to be written and modified in an interpreted environment without having to resort to recompiling the simulator each time a structural change is made. In the timeframe in which ns-2 was introduced (mid-1990s), this provided both a significant convenience in avoiding many time-consuming recompilations, and also allowing potentially easier scripting syntax for describing simulations. ns-2 has a companion animation object known as the Network Animator, nam-1, originally written by Mark Handley, used for visualization of the simulation output and for (limited) graphical configuration of simulation scenarios.

In 1997, the DARPA Virtual Inter Network Test bed (VINT) project was initiated, including LBNL, Xerox PARC, UC Berkeley, and USC's Information Sciences Institute (ISI). The bulk of ns-2 development occurred during this timeframe. Software maintenance activities also migrated to ISI during this time period, eventually led by John Heidemann. After the conclusion of the VINT project, ns-2 continued to be funded during the 2001-04 timeframe by the DARPA SAMAN and NSF CONSER awards to USC/ISI.

#### A. Tools for Data Analysis:

Proposed approach simulates through the network simulator and generates the rush of data which contain the number of various fields. That value file name as trace file but it is uncounted data without and tool used. So that use for the data analysis tool as Alfred Aho, peter Weinberger and brain Kernighan (AWK) is a programming language designed for text processing and typically used for data extraction and reporting tool. It is a standard feature of UNIX, LINUX operating system.

#### B. Tools for simulation:

For the network simulation we use the network simulator -2 that is free ware and support the all defined protocol and also add new modification under protocol, its work under the Linux and Windows platform. For the protocol design C++ code are uses, for network architecture and parameter configuration TCL code are uses and data analysis AWK programming concept are used.

### Expected Outcome:

- A. **Increased Throughput:** Throughput is a number of packets receive per unit time. If the throughput increases means network performance is better.
- B. **Decreased Routing Overhead:** Routing overhead is a number of search packet spread over network and measure

through that ratio of total number of routing packet flood over the network out of total data receives.

- C. **Reduced Delay in data transmission:** Delay is a time taken for data transmission to receiving, which includes channel, queuing and processing time.
- D. **Better Signal to Noise Ratio:** Signal to noise ratio compares a level of signal power to a level of noise power. The ratio usually measures in decibels (dB) using the following formula.

$$\frac{S}{N} = 20 \log_{10} \left( \frac{v_n}{v_s} \right)$$

- $V_s$ : incoming signal strength in microvolts
- $V_n$ : noise level in microvolts

### Conclusion

Network collision and network unreliability is a common issue for the MANET because limited channel availability for the communication. In this paper we study about the different multi-path techniques, CSMA/CN and MIMO strategies. For achieving the network quality of service we design the system and solve by sub module based methodology, which is MIMO, CSMA/CN and multipath routing module. Through those modules in future adaptation we gain the performance in terms of signal to noise ratio, routing overhead, delay, throughput etc.

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