Performance analysis of Signal Strength based Routing in 4G Mesh Network

G D Gurumurthy[1], Dr. H S Shivram[2]
[1]*Research Scholar,Mewar university, Rajasthan, India*
[2]*Research Supervisor, Mewar University, Rajasthan, India*

***Abstract* ----** A wireless Mesh network is a fully autonomous local wireless network where the primary objective is to provide internet access to the nodes. Different types of devices may be connected to network using local router, switches or End to End wireless connection. Such a network contains access points called Mesh routers, internet gateway and wireless nodes. These nodes can either get connected with internet through a path or through access point or can even communicate with other nodes in the network.Therefore mesh network comprises of different devices. A Multiradio mesh network is one where Mesh routers connects to different types of LANs for instance 802.11b and Ethernet. Routing is a complex issue in such a network. A node may receive signal from more than one router of different types. In such a case determining the most appropriate router through signal checking and switching next hop to the best router is a critical issue in WMN. In this paper, we propose a local repair on AODV based on Signal Strength with the aid of Vertical Handoff for MultiRadio Mesh Network. We simulate proposed technique with Omnet 4.2 using INET framework and show that the system improves network performance to several fold against a re-route discovery based technique.

I. INTRODUCTION

A. General Introduction

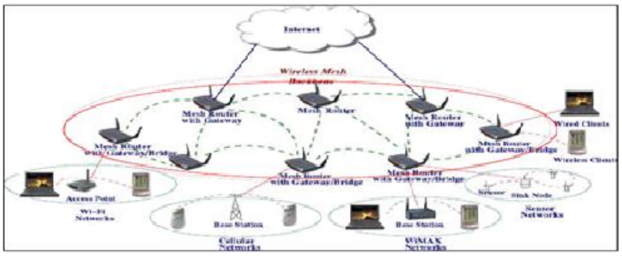


Fig.1: Schematic Architecture of WMN

Fig.1 represents the broad functionality of WMN. End devices like Laptops, Mobiles are connected to access point. An access point may be a physical device or may be a virtual router deployed in a computer. These access points are connected to Mesh routers. A mesh router is one that bridges the connection between several access points. A mesh router can be loaded with internet gateway or may be connected to a system that is connected to internet gateway. For instance a computer with which the router is attached can have a wireless modem through which it is connected to internet. Router exposes access points to internet through this router. Thus WMN can be seen as a functionality of multiple radio links: A) Radio link between wireless nodes to Access Points b) Link between two Access Points c) Access Points to Mesh Router d) Mesh routers to internet gateway (if router is not already connected with gateway). Interestingly this topology is changeable. Suppose if a node moves around the network area and happen to come nearer to the Mesh router, then it has the capability of getting connected to mesh router directly,thereby creating a new radio interface of Node-Mesh Router.

On the other hand a device may get connected with other devices with the aid of local devices thus creating a device-device radio.

B. Multichannel Wireless Mesh Networks

Wireless mesh networks (WMNs) have emerged as a promising concept to meet the challenges in next-generation networks such as providing flexible, adaptive, and reconfigurable architecture while offering cost-effective solutions to the service providers . Unlike traditional Wi-Fi networks, with each access point (AP) connected to the wired network, in WMNs only a subset of the APs are required to be connected to the wired network. The APs that are connected to the wired network are called the Internet gateways (IGWs), while the APs that do not have wired connections are called the mesh routers (MRs).The MRs are connected to the IGWs using multi-hop communication. The IGWs provide access to conventional clients and interconnect ad hoc, sensor, cellular, and other networks to the Internet. Some of the important challenges in designing routing protocols for WMNs are discussed in the literature. At the top layer, are the Internet gateways (IGWs) which are connected to the wired Internet. They form the backbone infrastructure for providing Internet connectivity to the elements in the second level. The entities at the second level are called wireless mesh routers (MRs) that eliminate the need for wired infrastructure at every MR and forward their traffic in a multi-hop fashion towards the IGW. At the lowest level are the mesh clients (MCs) which are the wireless devices of the users. Internet connectivity and peer-to-peer communications inside the mesh are two important applications for a WMN. Therefore, design of an efficient and low overhead routing protocol that avoids unreliable routes, and accurately estimate the end-to end delay of a flow along the path from the source to the destination is a major challenge. Wireless mesh networks (WMNs) are becoming a popular alternative in extending the coverage of the local area networks (WLANs). Mesh networks consist of mobile wireless clients stationary wireless mesh routers. Mesh routers are connected to one another in a multi-hop manner to form a large scale wireless backbone. Some of the routers also act as gateways to the internet via high speed wired links. The performance of the IEEE 802.11a/b/g based WMNs can be increased via the use of multiple channels. In this scenario, each router is equipped with multiple network interface cards (NICs). Each NIC is assigned to a different frequency channel. Two neighbouring routers are able to communicate (and establish a logical link) with each other as long as one of their NICs uses the same channel. Within the IEEE 802.11a band provide 3 and 12 non-overlapping frequency channels, respectively. This implies that some logical links may operate over the same channel. The number of NICs is also limited. In the experimental MC-WMN test-beds each router is equipped with two NICs. A small number of implies that some logical links in a router may need to share an NIC to transmit and receive data packets. Two nearby links that operate over the same channel or share the same NIC cannot be active (i.e., transmit or receive data) simultaneously. It reduces the links' effective capacities. Given the logical topology of an MC-WMN, two important issues should be addressed: channel allocation and interface assignment. The former determines over which frequency channel each logical link should operate and the latter determines which logical links should share an NIC on each router.

C. Identification of Problem

Obtaining an optimum route in such a network is always a challenge mainly due to two factors. Firstly demand for bandwidth is unequal. For instance a node watching movie in internet will always need more bandwidth than a node just browsing HTML file. On the other hand if a node is streaming songs or video to other device without being connected to internet, then demand will be different. Change of state of access categories also changes the state of link quality. More demand for bandwidth leads to more collision and hence reduces signal to noise ratio. Thus instead of relaying upon a single path throughout the session, nodes are better off to a flexible connectivity where they can choose the peer they want to connect to on the fly. This is call vertical handoff where the node without dropping the call decides to which node it wants to get connected to.

D. Contribution

Vertical Handoff is studied extensively for 4-G and Mesh network. In a vertical handoff a node decides the peer it wants to get connected to. Even if the radio link quality observed at a node with an access point is good, the access point may itself suffer from packet congestion due to too many connections. Therefore access points must also be capable of repairing the connection locally and passing a current active connection to other node which may be a router or a wireless node. This is the main contribution of the work. We propose a Vertical Handoff in conjunction with Local Repair for a Multiradio Wireless Mesh Network.

E. Organization

The paper is organized into following section. Section II is an overview of the related work. The proposed system model is described in section III. Section IV deals with the system design. The research findings are discussed in section V. The conclusive remarks are given in section VI.

II. LITERATURE SURVEY

In recent years, many researchers have done research on wireless mesh networks. Following are some articles/journals highlighting research on various facts on WMN.

Lundgren and Nordstorm [1] observed that in wireless ad hoc networks like WMNs, nodes receiving broadcast messages introduce communication gray zones. In such zones, data messages cannot be exchanged although the hello messages reach the neighbours. This leads to disruption in communication among the nodes. Since the effective bandwidth of wireless channels vary continuously, reduction of control overhead is important in order to maximize throughput in the network.

Akyildiz, I.F. and Xudong Wang [2] published an article on Wireless mesh networks (WMNs) mentioning that they consist of mesh routers and mesh clients, where mesh routers have minimal mobility and form the backbone of WMNs. They provide network access for both mesh and conventional clients. The integration of WMNs with other networks such as the Internet, cellular, IEEE 802.11, IEEE 802.15, IEEE 802.16, sensor networks, etc., can be accomplished through the gateway and bridging functions in the mesh routers. WMNs are anticipated to resolve the limitations and to significantly improve the performance of ad hoc networks, wireless local area networks (WLANs), wireless personal area networks (WPANs), and wireless metropolitan area networks (WMANs). WMNs will deliver wireless services for a large variety of applications in personal, local, campus, and metropolitan areas.. WMN can be considered as a type of wireless ad-hoc network because nodes can automatically establish network and maintain the connectivity in an ad-hoc manner. In addition, the WMN can also be dynamically self-organized and self-configured.

Dong et al.,[3] explained that enforcing cooperation among the nodes in WMNs is a critical issue and a routing protocol should make use of such a cooperation enforcement scheme in order to ensure efficiency in packet forwarding and minimizing packet drops. To enforce cooperation among nodes and detect malicious and selfish nodes in self-organizing networks such as MANETs,.

Santhanam et al [4] .proposed various collaboration schemes and most of these proposals are based on trust and reputation frameworks which attempt to identify misbehaving nodes by an appropriate detection and decision making system, and then isolate or punish them.

Shi et.al.,[5] described how the vulnerabilities can be exploited by the attackers to degrade the performance of the network. As with any radio-based medium, the possibility of jamming attacks in physical layer of WMNs is always there. Jamming is a type of attack which interferes with the radio frequencies that the nodes use in a WMN for communication. A jamming source may be powerful enough to disrupt communication in the entire network.

Ann Lee al.,[6] explained on Routing with Load-Balancing in multi-radio Wireless Mesh Networks. This paper addresses the interference and load imbalance problems in multi-radio infrastructure mesh networks, where each mesh node is equipped with multiple radio interfaces with a subset of nodes serving as Internet gateways. To provide backbone support, it is necessary to reduce interference and balance load in Wireless Mesh Networks (WMNs). In this paper, we proposed a new Load-Aware Routing Metric, called LARM, which captures the differences in transmission rates, packet loss ratio, intra/inter-flow interference and traffic load in multi-radio mesh networks. This metric is then incorporated into their proposed load-balancing routing protocol, called LBM, so as to provide load balancing for multi-radio mesh networks. Simulation results show that LARM provides better performance when compared to WCETT and hop-count routing metrics.SpringerLink

Ritu Malik and Meenakshi Mittal [7] emphasised that Wireless Mesh Network (WMN) is one of emerging technology of the next generation networks, and it is going to address the internet provision to users at low cost anytime from anywhere. Being a broadband wireless network of the future, still it is facing a lot of technical and critical issues which are prohibiting it from the world wide deployment and acceptance. Multi-hop nature of this broadband wireless technology increases routing overhead and poor packet delivery ratio. The detailed architecture of IEEE 802.11 WMN, and then a new architecture for WMN has been proposed, which consists two components, one is Mesh Backbone, the other is Mesh Domain. Then some security attacks on WMN and then a proposed architecture which will solve most of the existing and the future problems. The main concerns of this architecture is that its multi-hop nature and ad hoc connectivity amongst the nodes of WMN with current as well as future prospective.

Nikhil Saxena and Mieso Denko[8] presented that Wireless mesh networks (WMNs) consist of dedicated nodes called mesh routers which relay the traffic generated by mesh clients over multi-hop paths. According to them in a community WMN, all mesh routers may not be managed by an Internet Service Provider (ISP). Limited capacity of wireless channels and lack of a single trusted authority in such networks can motivate mesh routers to behave selfishly by dropping relay traffic in order to provide a higher throughput to their own users. Existing solutions for stimulating cooperation in multi-hop networks use promiscuous monitoring or exchange probe packets to detect selfish nodes and apply virtual currency mechanism to compensate the cooperating nodes. These schemes fail to operate well when applied to WMNs which have a multi-radio environment with a relatively static topology. The proposed architecture for a community WMN which can detect selfish behaviour in the network and enforce cooperation among mesh routers. The architecture adopts a decentralized detection scheme by dividing the mesh routers into manageable clusters. Monitoring agents hosted on managed mesh routers monitor the behaviour of mesh routers in their cluster by collecting periodic reports and sending them to the sink agents hosted at the mesh gateways.

Longjam Velentina and Sheeba Praveen [9] described that Wireless Mesh Networks (WMNs) are gaining increasing popularity due to its features like self organization, self-configuration and self-healing. WMNs reduces the authentication time by up to a factor of 3 compared to WLAN, while allowing mobile stations to move without performing additional authentications. Wireless Mesh Networks have been envisioned as an important solution to the next generation wireless networking. As various standards are being specified for different mesh networking technologies in many application areas. Among the various standard organizations, the IEEE standards committee is the most enthusiastic at promoting WMN as a networking technology in all its aspects. IEEE 802 standards committee includes different working groups for Personal Area Network (PAN), Local Area Network (LAN) and Metropolitan Area Network (MAN) based WMNs. In this paper, we focus on IEEE 802 standards.

Luke Shillington and Daoqin Tong [10] presented that wireless mesh network (WMN) technology allows data transmission from one node to another without extensive cabling. In this article, spatial characteristics of maximal covering problems are explored, and a novel spatial optimization model is proposed for WMN topology planning. The model selects the optimal locations for network infrastructure to achieve the maximal coverage of spatial demand. Additionally, important WMN design requirements have been accounted for, including network topology and throughput capacity. The validity of the model is tested through a WMN deployment developed for an emergency medical service application in Tucson, Arizona.

Zhuang Wang and Cungang Yang [11] described a Security Enhanced AODV routing protocol for wireless mesh networks (SEAODV). SEAODV employs Blom's key pre-distribution scheme to compute the pair-wise transient key (PTK) through the flooding of enhanced HELLO message and subsequently uses the established PTK to distribute the group transient key (GTK). PTK and GTK are used for authenticating Uni-cast and broadcast routing messages respectively. In wireless mesh networks, a unique PTK is shared by each pair of nodes, while GTK is shared secretly between the node and all its one-hop neighbours. A message authentication code (MAC) is attached as the extension to the original AODV routing message to guarantee the message's authenticity and integrity in a hop-by-hop fashion.Security analysis and performance evaluation show that SEAODV is more effective in preventing identified routing attacks and outperforms ARAN and SAODV in terms of computation cost and route acquisition latency.

III. PROPOSED SYSTEM

The channel models express radio propagation effects as time variant factors of the instantaneous Signal-to-Noise Ratio (SNR) of the received signal. Although such SNR-based models abstract the exact signal behaviour, e.g. the current phase shift, they enable the separate calculation of channel effects and, thus, adjusting the required accuracy by selecting the modelled effects and time-scale. On this SNR-level, we included the following widely accepted channel models for path-loss, shadowing, large and small-scale fading (adapted from MiXiM). Small-scale fading, i.e. determining the variation of a wireless channel at small time scale, is caused by mobility in the propagation environment.

We model small-scale fading using the typical “Jakes-like” method with the “land mobile” Autocorrelation Function (ACF). This model is parameterized by a maximum Doppler shift according to carrier frequency fc and velocity v of the fastest moving object in the propagation environment, e.g. a moving user. This fading model is based on an Non-Line Of Sight (NLOS) assumption modeled by Rayleigh distributed signal amplitudes resulting in an exponentially distributed instantaneous SNR _(i,j) for the channel from user i to user j. The model supports frequency-selective fading which appear in WMNs, which is parameterized by the mean delay spread and can be easily extended to further dimensions of the signal, e.g. spatial fading for multi antenna systems.While the model as such supports reciprocal channels and correlation between multiple signal dimensions, in typical scenarios, the instantaneous SNR is assumed to be independent and identically distributed i_i.d for different channels (i; j). Finally, the effect shadowing abstracts many physical effects such as reflection, diffraction, scattering, and absorption. Typically, shadowing is modeled by i.i.d. log-normal attenuation reflecting urban environments.To implement shadowing and fading, a block model has to be used requiring that (i,j) stays constant during a so-called block time. This interval typically refers to a Physical layer (PHY) inter leaver block or to the minimal coherence time of the channel. Therewith, each of these blocks experiences a quasi-static channel while the ACF defines whether consecutive blocks fade independently. The required physical layer models for mesh network simulation were adapted from the MiXiM framework. At the physical layer, essentially the used modulation and Forward Error Correction (FEC) coding and decoding functions define the bit error rate and throughput of a system. As for the effects of wireless channels, the effect of these functions can be modeled at SNR-level. At this level, FEC introduces a so-called coding gain at the receiver, which can be expressed by a factor g to the SNR of the detected signal. This coding gain depends on the used code, its rate Rc, and the employed decoding algorithm. While an uncoded transmission is expressed by g = 1, typical channel codes provide coding gains larger than 2. Typically, the SNR threshold calibrates the system to stay below a givenPacket Error Rate (PER) bound, e.g. as defined in the standard of the communication system.

It is selected apriority depending on the receiver sensitivity for the chosen modulation scheme as given in the transceiver data sheet or approximated. By selecting thresholds and coding gain independently per terminal, terminals employing different PHY parameters can be modelled. Furthermore, by varying thresholds and coding gain over time, rate adaptation is supported.

In addition to systems detecting a bit from a single channel, this SNR-based model easily extends to diversity receivers where several channels are joined before the bit detection is made. Such systems exploit differently faded channels and employ a filter, e.g. Maximum Ratio Combining (MRC), to combine the signals received from L channels to a single signal used for bit detection. For each employed channel, a different code or modulation may be chosen by defining an independent coding gain or threshold. This combining model can be used to model diversity receivers combining signals in different dimensions, e.g. OFDM subcarriers, or multi-antenna systems. Each node (router, Access Point, wireless nodes) calculate Signal to Noise ratio in all it's links and updates the routing table accordingly. We define a routing table refreshing interval after which a node checks if new SNR values in a link towards the destination is better than the current one or not. If AP measures such a change, it runs a horizontal handoff and handover the connection to a node to another access point. If a node finds that link quality with another access point is better than it sends a join request to that node.

IV. SYSTEM DESIGN

Here is a diagrammatic representation of working of project. Initially source node has to be updated where actually the source node iis as it is a mobile network where all nodes are mobile nodes which will be always moving hence it is necessary to know the source node.

Then source node sends a request to router or relay unit of access point which calculates the sinr and choose the next node on the bases of higest sinr value. This follows until it reaches the required destination.

The source node sends the data to transmission unit once source gets destination address it starts sending data packets to destination. In turn the destination sends the ack to transmission unit that is has received data packets.

Destination checks the old sinr value and new sinr values and gets updated accordingly.

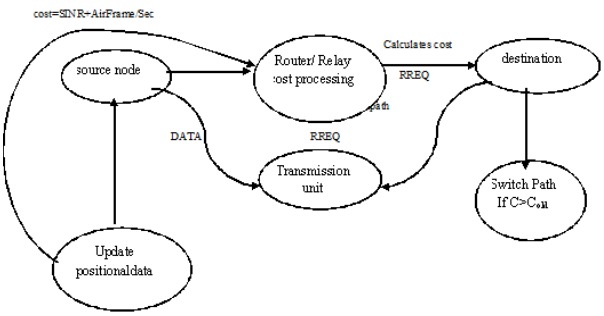


Fig.2 represents the working process

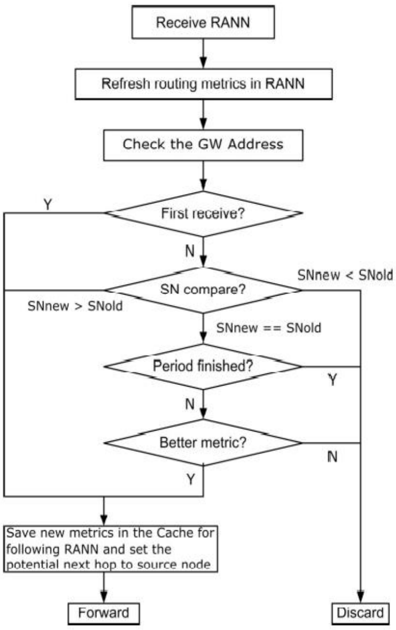
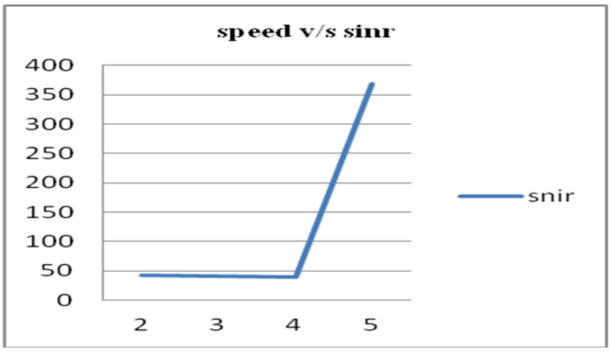
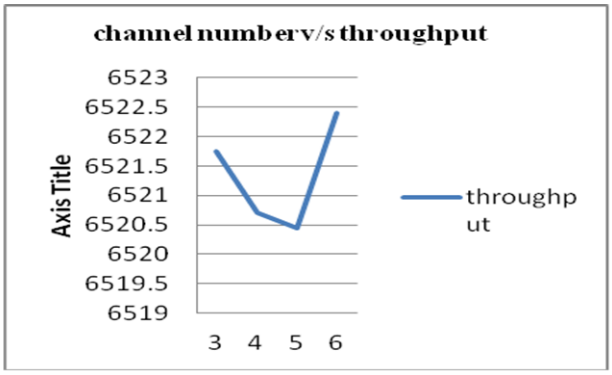


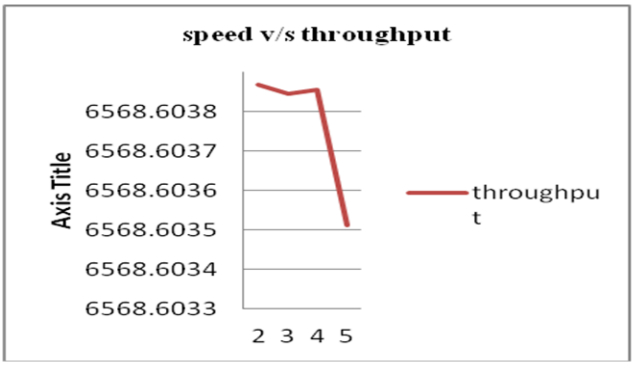
Fig.3 Flow chart

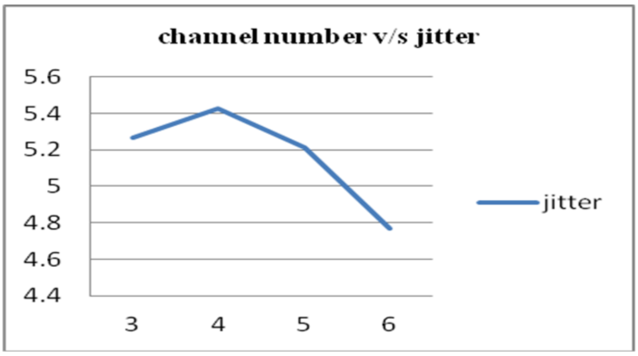
V. RESULTS

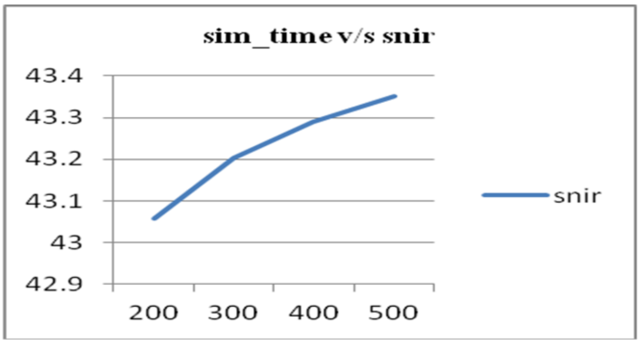
The research findings are presented in the form of graphs (i) speed v/s sinr, (ii) channel number v/s throughput, (iii) speed v/s throughput (iv)channel number v/s jitter, (v) sirn time v/s snir, (vi)channel number v/s delay and (vii)sim time v/s throughput .

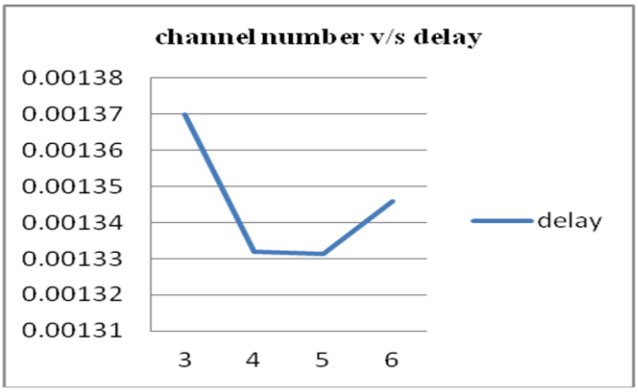


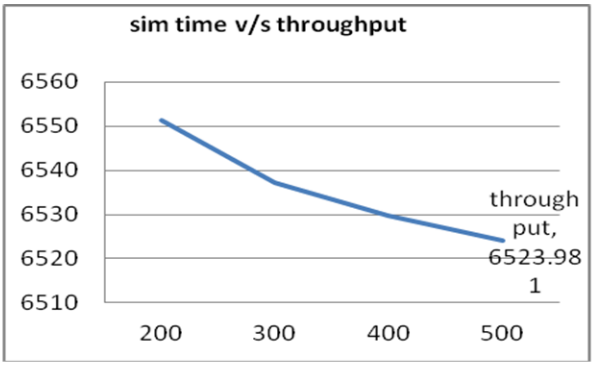












Observations and Analysis of graphs:

1) As the speed increases sinr increases, throughput decreases.
2) As the channel number increases jitter decreases, delay increases and throughput increases
3) As the sim_time increases, throughput decreases and sinr increases

VI. CONCLUSION

Mesh network is a popular standard now for in-campus media streaming, file exchange and mainly internet access. With more and more devices joining such a network adopting different PHY and MAC standards, ensuring better services in terms of seamless connectivity becomes a major challenge. Vertical Handoff and QOS routes are two of the most popular solutions for this . However using neither of them ensures best quality under different channels. As fading and loss rate in the channels keep varying, a more didirectional solution is needed. Therefore in this work we have proposed a unique technique for SINR aware solution for Multiradio wireless mesh Network with the aid of both Vertical Handoff and local route repair at the routers. Simulation results depict promising gain in the proposed system in comparison to pure handoff based solution.

VII. REFERENCES

[1] Lundgren and Nordstorm “A large-scale testbed for reproducible ad hoc protocol evaluations,” Wireless Communications and Networking Conference, 2002
[2] Akyildiz, Ian F,Xudong Wang, and Weilin Wang, Wireless Mesh Networks: A Survey, Computer Networks, 2005, 47.4
[3] Dong, Jing; Burtmola, Reza; and Nita-Rotaru, Cristina, "Secure High-Throughput Multicast Routing in Wireless Mesh Networks" (2008). Computer Science Technical Reports. Paper 1701.
[4] D. Nandiraju, L. Santhanam, N. Nandiraju and D. P. Agrawal, “Achieving Load Balancing in Wireless Mesh Networks Through Multiple Gateways,” in Proc. of 2006 IEEE International Conference of Mobile Ad hoc and Sensor Systems (MASS), pp. 807- 812, 2006.
[5] Shi, Eberhart, Chen“Implementation of Evolutionary Fuzzy Systems” IEEE Transactions on Fuzzy Systems April 1999
[6] Ann Lee and Paul A.S. Ward, “A Study of Routing Algorithms in Wireless Mesh Networks”, Australian Telecommunication Networks and Applications Conferenc, December, 2004
[7] Ritu Malik and Meenakshi Mittal “Wireless Mesh Networks (WMN)” International Journal of Computer Applications (0975 - 8887) Volume 1 – No. 23, 2010.
[8] Nikhil Saxena, Mieso Denko, Dilip Banerji, “A hierarchical architecture for detecting selfish behaviour in community wireless mesh networks,” Elsevier Journal of Computer Communications, 2010.
[9] Longjam Velentina Devi, Sheeba Parveen and Prof. Rizwan Beg, “Standard Activities of Wireless Mesh Networks”, International Journal of Computer Applications 12(10), pp.12-16, January 2011.
[10] Luke Shillington and Daoqin Tong "Maximizing Wireless Mesh Network Coverage" International Regional Science Review (Impact Factor: 0.73). 01/2011; 34(4):419-437. DOI: 10.1177/0160017610396011
[11] Celia Li, Zhuang Wang, Cungang Yang: Secure Routing for Wireless Mesh Networks. I. J. Network Security 13(2): 109-120 (2011)

Gurumurthy G.D obtained his BE in Electrical & Electronics Engg., In the year 1990 from Mysore University & M Tech in Digital Electronics and Communication Systems in the year 1995 From Mysore University. He is persuing his PhD in Electronics and Communication Engg in Mewar University, Rajasthan. He has 20 years of teaching experience and presently he is working as Assistant Professor, Dept. of E&C, Kalpataru Institute of Technology, Tiptur, Karnataka. His research area is Wireless Networks.

Dr.H.S.Shivaram procured BE in Electrical Engineering, University of Mysore, 1967, M Tech in Electron Devices Technology, Indian Institute of Technology, Bombay, 1974 & PhD in Electronics /Instrumentation , Indian Institute of Science, Bangalore, 1983. He has more than 43 years of teaching experience & currently he is working as a Research supervisor and Visiting Professor at Mewar University Chittorgarh, Rajasthan, India. He has published 4 International Journals and presented research papers in 5 national conferences. His area of interest being communication Engineering and Networking