

# A QoS Oriented Cognitive Radio based VHOM Scheme for WIMAX/WIFI Overlay Networks

<sup>1</sup>CH. Srilakshmi Prasanna, <sup>2</sup>S. Jessica Saritha

<sup>1</sup>M. Tech, Department of CSE, JNTUA College of Engineering, Pulivendula, India

<sup>2</sup>Assistant Professor, Department of CSE, JNTUA College of Engineering, Pulivendula, India

**Abstract:** The integration of WIMAX and WiFi has been a promising approach toward 4G. As a result of this integration I, realize totally different vital problems for the interworking of WIMAX and WiFi networks. Thus I planned a tightly coupled interworking structure and additionally planned VHOM schemes which may keep stations continually being best connected because of ad-hoc mode. An ad-hoc network could be a assortment of wireless mobile nodes wherever communication are often done by victimization intermediate mobile nodes. However during this paper I thought of a technology referred to as cognitive Radio technology that provides communication for providing mobile terminals always being best connected to network and also services user's special requirements.

**Keywords:** WIMAX, WIFI, mobility, 4G, Ad-hoc Network (as cognitive Radio).

## 1. Introduction

Mobility is the very important feature of a wireless cellular communication system. Normally, continuous service is achieved by supporting handover from one cell to another cell. Handoff process starts, once mobile terminal is extinct of the vary of communication; here quality is plays key facet. This active call should be transferred from one cell to another one so as to realize call continuation throughout crossing of cell boundaries. The handoff process is transferring an active call from one cell to another as shown in Fig1. Handover initiation is the process of deciding that network is suitable for user in line with his necessities. Handoff decision relies on the Received Signal Strength of Base Station and obtainable bandwidths of various networks.. In my project i assumed that nodes position and distance is known.

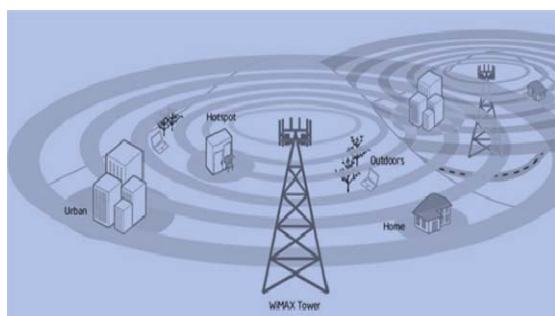


Figure 1: WIMAX And WIFI Nodes

## 2. Handoff Description

Handover can be classified based on the network type available. 1. horizontal 2. Vertical handovers as an MT (mobile terminal) moves within or between different wireless overlay networks [1]. Horizontal handoff [2] or intra-system handoff is a handoff that occurs between the APs or BSs of the same network technology. In other words, a horizontal handoff occurs between the homogeneous cells of a wireless access system. Vertical handoff or inter-system handoff is a handoff that occurs between the different points of attachment belonging to different network technologies.

Handoff process is shown in Fig2 (a) and how handoff decision is shown in Fig2(b). Handoffs can be classified based on the number of available connections . They are classified as;

1. Soft
2. Hard

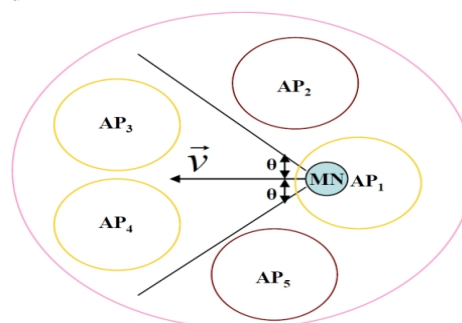


Figure 2 (a): Handoff process is shown

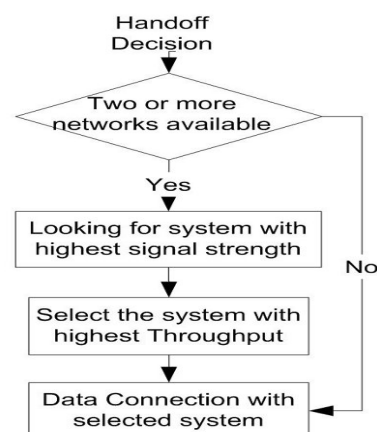


Figure 2(b): Handoff Decision Process

A handoff is Hard, when the MT (mobile terminal) is related to only one point of affiliation at a time. In other words, a MT may come upon a brand new affiliation at the purpose of target only once the previous affiliation has been abandon. "A make before break handoff", occurs if the MT can communicate with quite one point of attachment during

handoff. In this case, mobile terminal affiliation may be created at the target point of attachment before the previous point of affiliation is disconnected. For example, Mobile terminals are furnished multiple network interfaces can at same time hook up with multiple points of attachment in different networks during soft handoff.

Mobile ad-hoc networks are dynamic networks in which nodes are moving freely. A main performance constraint comes from path loss and multipath reduces. Many Mobile ad-hoc network routing protocols attempt multi-hop paths to route packets. Probability of successful packet transmission on a path is dependent on the reliability of the wireless channel on each hop. In this paper I assumed that all the nodes know their positions and velocities, and each and every node can measure the distance from AP and BS. And I assumed bandwidth with no of users. In my project, whenever number of user increases, then bandwidth will reduce. So I assumed maximum of 4 users, to avail maximum bandwidth within overlay networks, which means to provide Qos [7] to users.

#### A. WIMAX Network

The World wide Interoperability for Microwave Access (WIMAX) may be a third generation mobile cellular system for networks supported the GSM normal. WIMAX is anticipated to provide QOS to fixed, mobile, portable and, finally, mobile wireless broadband connectivity without the need for direct line-of-sight (LOS) with a base station.

#### B. WIFI Network

WIFI describes narrow range of connectivity to control Wireless Local Area network. Wi-Fi Networks use Radio Technology to transmit & receive data at high speed. To understand more about Wimax and Wifi consider Fig3.

WIFI Network are determined by IEEE 802.11 standards, where the fundamental access method is distributed coordination function (DCF) known as carrier sense multiple access with collision avoidance (CSMA/CA). Network allocation vector (NAV) is the main scheme used to avoid collision by setting a busy duration on hearing frame transmissions from other stations. Hence, the utilization of the WIFI channel is well reflected by NAV

The available bandwidth has been derived from NAV. This network enables me to access the Internet in localized hotspots via a WIFI access card and a PDA or laptop.

**Table 1:** Comparison between WIMAX and WIFI

	<i>WiMAX</i>	<i>WiFi</i>
Coverage	Vast, Broader Area	Small Limitd Arae
Spectrum	Licensed	Unlicenced
Mobility	Anywhere, Anytime	Limited to hotspot locations
Speed	Higher Speed	Limited speed
Quality of service	Support Multimedia Aplications	Unreliable, Does not support multimedia applications

### 3. Related Work

[1] In this paper, I expressed an summary of problems associated with horizontal and vertical handoffs and additionally mentioned the design of integrated wireless

local area network and WIMAX networks supported Mobile IPv6.

Pros and Cons:

The Overlay Networks are formed to boost the various characteristics of wireless access network technologies to satisfy anytime, anywhere, and any service wants of mobile users however I used the wide space access network during which fixing a network may be a fashionable and sophisticated and additionally the larger the network the dearer it's and therefore the Security could be a real issue.

[2] In this paper, I explicit economical handoff schemes to extend quality of service and supply flawless mobility and it presents different and new aspects of handoff and discusses handoff connected problems with fourth generation systems.

Pros and cons:

The classification of handoffs, handoffs in 4G heterogeneous networks, handoff method and vertical handoff decision functions are clearly explained

[3] In the paper, I presented a different end-to-end mobility management system for seamless and proactive roaming across heterogeneous wireless networks and this system integrates a connection manager that intelligently detects the condition of the wireless networks and a virtual connectivity-based mobility management scheme that maintains connection's continuity using the end-to-end principle.

Pros and Cons:

A Heterogeneous wireless network is proposed which has advantages like capable of reacting to roaming events proactively and accurately and maintaining the connection's continuity with small handoff delay but the technical details such as network bandwidth and delay estimation, as well as end-to-end mobility management were not fully addressed.

[4] In this paper, I analyzed the most recent research efforts in the area of handover management in integrated WIFI/Cellular networks, attempting to categorize and comment on the proposed solutions. The focus is placed mainly on the methods to integrate two different architectures and on the supported functionality of the integrated system.

Pros and Cons:

An integrated WIFI/cellular network is proposed to handle interference problems and also to increase the bandwidth in limited geographical areas but in this paper I used WIFIs and GPRS/WIMAX technology which has some drawbacks like speed, reliability and distance factor.

[5] In this paper, I analyzed the foremost recent research efforts in the area of handover management in integrated WIFI and wireless metropolitan area networks (WMANs). This integrated network can bring a synergetic improvement to the services provided to mobile users.

Pros and Cons:

An integrated WIFI and wireless metropolitan area network which considers the handover decision algorithm based on

MIH framework but it does not consider the packet delay and bandwidth while handoff is occurring.

[6] In this paper, I addressed an Movement-Aware Vertical (MAV) handover algorithm between WIFI and Mobile WIMAX for seamless ubiquitous access. MAV handover algorithm is proposed in this paper to exploit movement pattern for avoiding unnecessary handovers in the integrated WIFI and Mobile WIMAX networks.

Pros and Cons:

A novel MAV handover algorithm is proposed for interworking between WIFI and Mobile WIMAX to avoid Frequent handovers for a short time period of time and there is an higher chance of packet loss, delay are affecting the overall throughput but he considers only about the velocity of mobile station but not about the other factors.

[7] In this paper, I considered the quality-of-service oriented intersystem handover between the IEEE 802.11b network and the overlay network. I proposed the handover scheme and algorithm that guarantee to simultaneously meet the three key QoS values, that is, minimum data rate; the maximum data block delay and the maximum data error rate, for the number of uplink and down link multi service connections.

Pros and Cons:

A handover scheme and algorithm is proposed to ensure that to meet the three key QoS parameters as well as the maximum call-dropping probability and the maximum average number of ping-pong event constraints but When the number of fixed stations in the WIFI cell is high, station collision probability is also high and the QoS requirements of the mobile stations arriving at the WIFI cell cannot be satisfied at least for the real-time traffic.

[8] In this paper, I defined specific bandwidth- related metrics; focus on the scope and relevance of each. Particularly, he differentiates between the bandwidth of a link and the bandwidth of a sequence of successive links.

Pros and Cons:

A specific metrics, calculation techniques and tools are used to estimate available bandwidth and capacity of the links but didn't consider about the other factors like packet delay and bit rate.

[9] In this paper, author proposes a scheme, named Bandwidth Recycling, to recycle the unused bandwidth without changing the existing bandwidth reservation. The theme of the scheme is to allow other SSs to utilize the unused bandwidth when it is available

Pros and Cons:

An algorithm is proposed which considers about the subscriber stations to utilize the unused bandwidth and it shows that it can further improve the overall throughput .when the network is in the steady state but it is only for homogeneous network and a light overhead is present.

[10] In this paper, I proposed a handover scheme with geographic mobility awareness, which considers the

historical handover patterns of mobile devices. HGMA can conserve the energy of handover devices based on triggering of mobile devices from unnecessary handovers according to their received signal strength and moving speeds and it contains a handover [5] candidate selection method for mobile devices to intelligently select a subset of Wi-Fi access points or WIMAX relay stations to be scanned.

Pros and Cons:

A method is proposed to reduce the energy consumption of a handover operation and also to improve QoS satisfaction ratio to handover devices but in this paper I discussed only about the energy consumption but not about the remaining factors in taking handoff decision.

#### 4. Existing Technique

In previous QoS based VHO methods for overlay networks, Quality of service [7] parameters are considered in handoff decisions. However, the handover procedures are normally started when the stations move across the border of WIFIs. As a result, the fixed stations and the mobile stations within overlapped areas cannot benefit from VHOs. Authors proposed a tightly coupled interworking structure. Further, seamless and proactive [3] vertical handoff scheme is designed based on the architecture with aims to provide always the best quality of service for users.

#### Disadvantages

Due to the newly developed WIMAX, there have been some advantages, but still limited proposals made for VHOs in WIMAX/WIFI overlay networks. I proposed a scheme which can keep stations always being best connected. But when system is out of the range to all BS, then no communication is possible in the model.

#### 5. Proposed Technique

In my project I have implementing the ad- hoc technology of infrastructure system called as cognitive radio network. In proposed model, whenever MT is out of range to all the base station and AP, Then it can make the communication though the primary user when PU is free. In this model we are considering requesting device as the secondary device and which one is helping to make communication that is primary user.

**Cognitive radios** are cognizant of their surroundings and bandwidth availability and are able to dynamically tune the spectrum usage based on nearby radios, location, time of day and other parameters. This provides more efficient use of the spectrum and enabling high priority communications to take precedence if needed. Cognitive radio has two types of users such as primary and secondary user.

#### Advantage

Our proposed schemes can keep stations always being best connected, more than previous method, when it's in outside also.

## 6. Algorithm

In this paper, I have investigated the integration and VHO issues in WIMAX/WIFI overlay networks. And we present the theory implementation model as below.

Step1:

Initializing a mobile node it can access both WIMAX/WIFI.

Initialize WIMAX/ WIFI networks.

Step2:

Node will check the available networks.

Step3: If {network available} {

If {only one network} {

Get communication from that.

} else {

For {each network}

{Checks which are the best networks in terms of Bandwidth and packet delay

Theory of Bandwidth calculation for Wi-MAX is given as follows.

Bandwidth calculation for Wi-MAX

$$B_u = \left(1 - \frac{AAS_u}{s_u}\right) \frac{\delta_u s_u}{T_f}$$

$$B_d = \left(1 - \frac{AAS_d}{s_d}\right) \frac{\delta_d s_d}{T_f}$$

Delay calculation for Wimax

$$t = t_s + t_q + t_m + t_t$$

$$t_s = 0.5T_f + T_f = 1.5T_f.$$

Bandwidth for WIFI

$$BW = B_0 - L \frac{NAV}{T_n + \frac{1}{2}T_{n,c}(N-1)}$$

Delay calculation for WIFI

$$t = t_q + t_a = \frac{\lambda t_a^2}{1 - \lambda t_a} + t_a$$

}

Step4:

Mobile node compares both networks,

VHOM selects the best network.

Step5:

If no AP or BS detected,

[Checks whether any other mobile station available with AP or BS connection and having enough bandwidth limit. If Mobile Station is detected with enough bandwidth, then switch to Mobile Station communication]

Step 6:

Else

No communication.

We have divided our proposed system into small modules, they are given as below.

- Selection of Network
- Detection of Fading
- VHO between WI-MAX/WIFI
- Effective handoff

## 7. Performance Evaluation

For analyzing purpose I used the tool NS2. By using NS2 we are calculating the bandwidth and delay and showing the prototype model of VHO with enhancement such as ad-hoc property called cognitive radio technology. For simulations environment I consider table1 for better understanding purpose.

Table 2: Network Model Parameters

Parameters	Values
Wi-MAX nodes	1
WI-FI nodes	3
Mobile nodes	11
Routing protocol	AODV
WI-FI coverage	100m
Wi-MAX	400m (for testing only coverage)
Simulation time	10s

## 8. Simulation Results

Simulation results can be shown in two ways. They are: 1. NAM [Network animator] 2. Xgraphs

NAM:

In NAM simulations are shown in animation form by NS2.

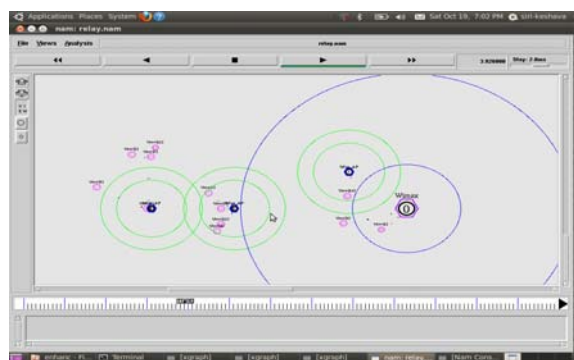


Figure 4: Nam Output for VHO model

The above Fig (4) indicates previous prototype model . In this model, if mobile terminals are out of the range of Wifi and Wimax mean it can't get communication.

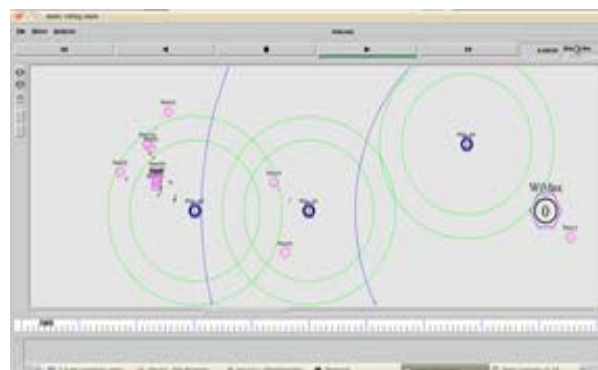


Figure 5: NAM output for VHO with Ad-hoc type

In my enhanced prototype model, I implemented VHO with ad-hoc property. So whenever node is not in the coverage of AP or BS then node can search for another mobile node which is having enough extra bandwidth. If mobile station

having extra bandwidth then that node going to act as a primary user and searching node is acting as secondary user which is shown in Fig(5). If primary user is detected by the secondary user mean secondary user can make communication through the primary user.

### X Graphs

In Xgraph simulations are shown in graphical form by NS2.

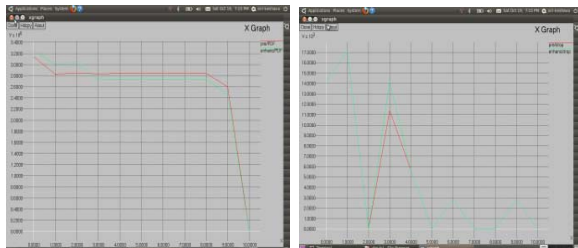


Figure 6: Xgraph output for (A)VHO and (B)VHO with ad-hoc

I analyzed performance through the x graph. From this graph the packet delivery function is high for VHO with ad-hoc network compare than normal VHO operation. There are the two x graphs shown in above Fig left (A), Right (B). “A” graph is for showing the quality of only VHO, “B” graph for VHO with Ad-hoc property. From that graph we can conclude “B” performance is higher than “A”. Here I Consider the following table [2] to plotting X graph for various simulation times to show that enhanced model is better than previous model of VHO.

Table 2: Different Simulation times

Simulation time	Previous		Enhanced	
	Send pkts	Received pkts	Send pkts	Received pkts
10s	20052	20013	27540	27502
20s	57130	57050	80107	80028
30s	109046	108924	155523	155402
40s	174950	174786	252908	252745
50s	254848	254642	372309	372103
60s	348759	348510	513708	513459
70s	456661	456370	677104	676813
80s	578576	578242	862521	862187
90s	714482	714105	1069935	1069559
100s	864400	863980	1528759	1528299

Based on the above table, I calculated

### A. Throughput Performance

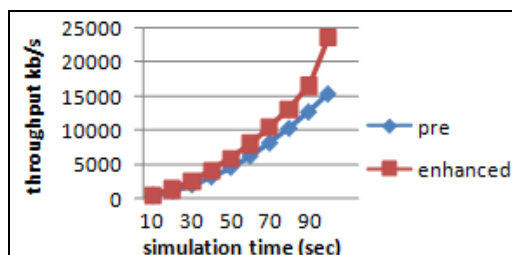


Figure 7: Throughput graph

In the above Fig7 pre-is consider as “previous model of VHO”, which is indicated by blue line. “Enhanced” means I consider that modified part of my paper as enhanced which is indicated as red. As result through put is more for enhanced VHO with ad-hoc mode.

### B. Packet delivery ratio

This is the ratio of total number of packets successfully received by the destination nodes to the number of packets sent by the source nodes throughout the simulation. Fig(8) indicates packet delivery ratio is more for VHO with ad-hoc mode.

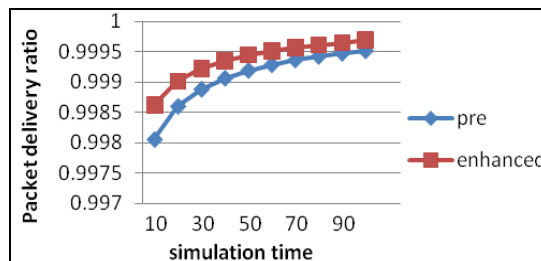


Figure 8: Packet delivery ratio for VHO and VHO with ad-hoc mode

### C. Average End-to-End delay

It is the average delay of all the packets while travelling from source node to destination node.

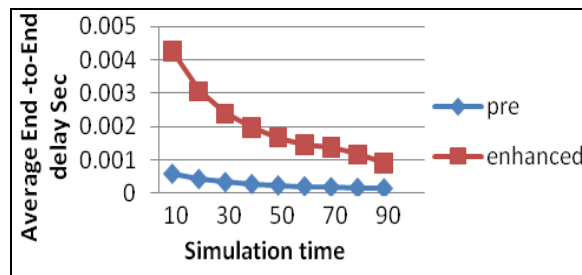


Figure 9: Average End-to-End delay for VHO and VHO with ad-hoc mode

Fig (9) shows that average End-to-End is more to VHO ad-hoc mode because during transmission of packets in ad-hoc mode takes time to send or receive by the intermediate nodes

### D. Packet loss Ratio

It is the ratio of number of lost packets to the sum of number of packets received and number of lost packets

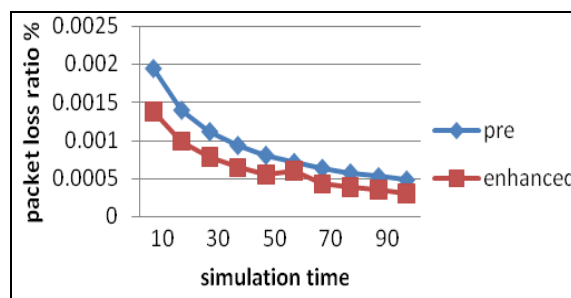


Figure 10: Packet loss ratio for VHO and VHO with ad-hoc mode

Fig (10) shows that packet loss ratio is less to VHO with ad-hoc mode because mobile terminals gets communication even when it is out of range of communication by PU to SU. Based on these calculations I showed that enhanced model which indicates ad-hoc network type is better than VHO that indicates with previous model.

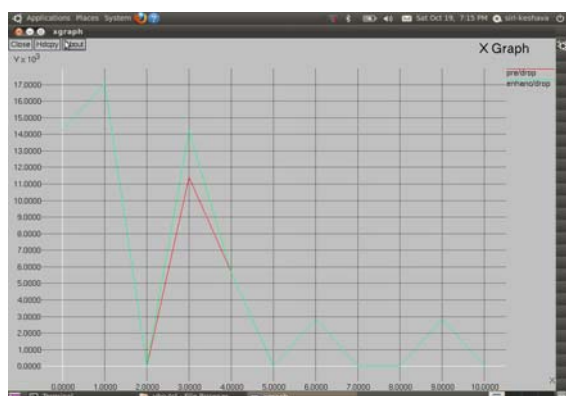


Figure 11: x-graph for packet loss

The graph shown in figure 11 shows that the packet loss for VHO with Ad hoc network is less when compared to VHO.

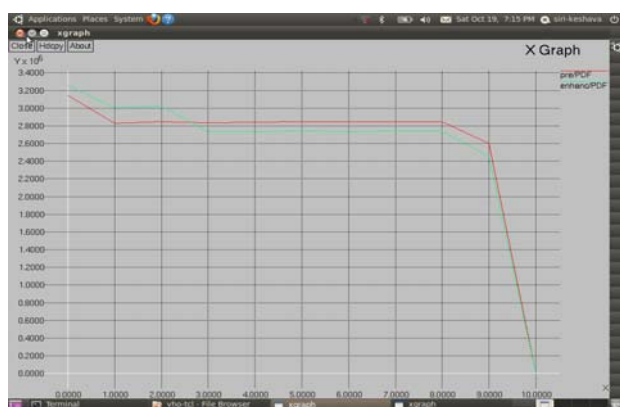


Figure 12: x-graph for packet overhead

In the on top of graph there are unit 2 lines, 1st line indicates packet overhead in VHO and second line indicates packet overhead in VHO with ad-hoc web work. The overhead in VHO is high compared to VHO with Ad-hoc network.

## 9. Conclusion

In this paper, I investigate several vital problems for the interworking of WiFi and WIMAX networks. I resolved a tightly coupled interworking design as the platform of my theme. And we improved efficiency of the network by including Ad-hoc property.

## 10. Future Work

The power consumption drawback for an MN is usually an important issue. In this paper the dual-interface of the MN is always on and might operate at constant time at the MAC level. This may waste energy when the MN is using one interface to transmit traffic and therefore the alternative interface continues to be in an exceedingly power on standing. However if we tend to power off the other interface, it leads to great handoff delay when the handoff is important .Thus a

way to realize a exchange between the ability of power consumption and good handoff performance ought to be studied within the future

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## Author Profile



**CH. SriLakshmi Prasanna**, received her B.Tech(CSE) Degree from G. Pullareddy College of Engineering, Kurnool, A.P, India in 2008 and pursuing M. Tech(CSE) degree in JNTUA College of Engineering, Pulivendula, A.P.



**Mrs. S. Jessica Saritha**, received her B. Tech (ECE) from JNTU Anantapur in 2000. She received her M. Tech from JNTU College of Engineering, Kakinada in 2005 and pursuing Ph. D in JNTU Hyderabad. She has total of 8 years of experience in teaching and currently working as Assistant Professor at JNTUA College of Engineering, Pulivendula, Y.S.R. Dist., A.P, India.