OFDM based Foreign Agent for Communication between Wired and WIMAX Network

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ABSTRACT
In Wireless technologies are able to provide mobility and portability that makes it more attractive as compared to wired technologies. WIMAX (Worldwide Interoperability for Microwave Access) is a telecommunications protocol that provides fixed and fully mobile internet access. Wired network refers to interoperable implementations of the IEEE 802.3 and WIMAX which refers to interoperable implementations of the IEEE 802.16 wireless-networks standard. A LAN (wired) is a data transmission system designed to provide location dependent network access between computing devices by using a cable infrastructure. The radio range and data rate of WIMAX are much better then Wired network but, on the basis of cost WIMAX is expensive. Now this paper proposed a new hybrid network that is the communication between two different technologies on the basis of Foreign Agent (FA), Home Agent (HA) and Mobile Host (MH). Now the FA is worked as a interface in between wired and WIMAX network and FA is connected with wired network to synchronize the communication with WIMAX, first the request is goes to FA then to network. The combinations of these two technologies are not very expensive and also better than wired. In previous there is no such work done on Wired-WIMAX hybrid network. Their performance will be measure on the basis of performance metrics.

General Terms
Wired, WIMAX, Communication, hybrid network.

Keywords
Wired Network, WIMAX, MAC, MANET,MA, HA, FA

1. INTRODUCTION
Mobile Ad hoc network nodes are communicate with each other without any fixed infrastructure. These networks have no fixed routing nodes. All nodes are capable of movement and can be connected in any random manner. These networks are mainly used in disaster or emergency areas where no prior fixed infrastructure exits. One of the challenging aspects in these ad hoc networks is to find and develop routing protocols that can efficiently find routes between any two nodes. In The routing protocol should take into account the mobility factor in these networks and the topology being used. For this reason, performance evaluation of various protocols has been carried out by different authors. In [1], performance of Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV) has been considered. The performance is analyzed using various network load, mobility and network size. Highly Dynamic Destination-Sequenced

Distance-Vector Routing (DSDV) is another protocol which is a table-driven protocol used in wireless networks [2]. Various performance parameters for these protocols have been explored including packet fractional delay (PDF), average delay, throughput, and normalized routing load (NRL).

Today's broadband Internet connections are restricted to wire line infrastructure using DSL, T1 or cable-modem base connection. However, these wire line infrastructures are considerably more expensive and time consuming to deploy than a wireless one. Moreover, in rural areas and developing countries, providers are unwilling to install the necessary equipment (optical fiber or copper-wire or other infrastructures) for broadband services expecting low profit. Broadband Wireless Access (BWA) has emerged as a promising solution for "last mile" access technology to provide high speed connections. IEEE 802.16 standard for BWA and its associated industry consortium, Worldwide Interoperability for Microwave Access (WIMAX) forum promise to offer high data rate over large areas to a large number of users where broadband is unavailable. This is the first industry wide standard that can be used for fixed wireless access with substantially higher bandwidth than most cellular networks [4]. Development of this standard facilitates low cost equipment, ensure interoperability, and reduce investment risk for operators. In the recent years, IEEE 802.16 working group has developed a number of standards for WIMAX. The first standard IEEE 802.16 was published in 2001 and focused on the frequency range between 10 and 66 GHz and required line-of-sight (LOS) propagation between the sender and the receiver [9]. In this paper the Wired and WIMAX Communication has been done on the basis of FA. The foreign agent has work on the basis of both OFDM (Orthogonal Frequency Division Multiplexing) used in WIMAX and TDM (Time Division Multiplexing) used in Wired. The proposed algorithm are separated in the WIMAX communication were only mobile nodes are communicate but if mobile and wired nodes are communicate then in that case we presents a general frequency estimation on the basis of OFDM and FDM. Detailed description is explained in proposed work section.

Rest of the portion of paper is summarized as, section 2 presents the overview of WIMAX technology and section 3 is of related work. Routing procedure of AODV Protocol are described in Section 4. Section 5 and section 6 is of problem statement and proposed work. Conclusion and future work are be a part of section 7.

2. WIRED-WIMAX TECHNOLOGY
All Wired Local Area Networks make use of Ethernet cables and network adapters. Numerous computers can be wired to one another by using an Ethernet crossover cable. Wired LANs also need vital devices like hubs, switches, or routers to aid further computers.

- For dial-up connections to the Internet, the computer hosting the modem should administer Internet Connection Sharing or similar software to share the connection with every other computers on the network.
- Broadband routers permit easier sharing of cable modem or DSL Internet connections, furthermore they often include built-in firewall.
- Ethernet cables should proceed from each computer to a different computer or to the central device.
- The accurate cabling configuration for a wired LAN differs depending on the merge of devices, the form of Internet connection.
- Following hardware installation, the lasting steps in configuring either wired or wireless LANs do not contrast a great deal. Equally rely on standard Internet Protocol and network operating system configuration options.

All wired networks differ from each other. The most familiar type of wired network is an Ethernet network.

In wired networking cabling (wired Ethernet as defined by IEEE 802.3) consists of 4 pairs of copper cabling that can be utilized for both voice and data transmission. The use of two wires twisted together helps to reduce crosstalk and electromagnetic induction. The transmission speed ranges from 2 million bits per second to 10 billion bits per second. Twisted pair cabling comes in two forms: unshielded twisted pair (UTP) and shielded twisted-pair (STP). Each form comes in several category ratings, designed for use in various scenarios

In December, 2001, the Wireless MAN-SC [3] standard was established. This standard specifies the physical layer and multichannel techniques, including the single-carrier that can handle both TDD and FDD.

In 2003, WIMAX was consolidated under the IEEE 802.16a standard to support OFDM in the PHY layer. During this time substantial changes were made to the 802.16a standard, resulting in the 802.16c standard. The 802.16c standard is the basis of HIPERMAN (High Performance Metropolitan Area Network); and of 802.16e-2005, which specifies scalable OFDM for the PHY layer. As already mentioned, the WIMAX standard is divided into several sub-standards 802.16a and so on. The original standard which allows for a 70Mbps speed at distances of up to 30 miles using the 10GHz and 66GHz bands. 802.16e: This standard is the newest standard and employs the 2GHz and 6GHz bands. This standard allows mobile devices to use wireless technology. The 802.16e-2005 standard was developed under IEEE guidelines, but the implementation was left to private industry. The WIMAX Forum was created to solve interoperability problems and promote the standard itself [4].

WIMAX is the acronym for Worldwide Interoperability for Microwave Access and its architecture is based on broadband point-to-multipoint wireless access [5]. This standard was finally approved in June 2004 [14]. The 802.16 standard provides for fixed and mobile WIMAX in 802.16d and 802.16e, respectively. Some important characteristics of WIMAX include:

- Its use of the microwave frequency band for wireless data transmission
- Its high transmission speed over long distances.
- its use of OFDM (Orthogonal Frequency Division Multiplexing) to enable non-line-of sight communication.
- Its multi-channel support for TDD (Time Division Duplex) and FDD (Frequency Division Duplex)
- Its flexible handling of channels in the 3.5MHz, 5MHz and 10MHz frequencies. Some challenges for WIMAX include:
  - ✓ Reaching a coverage area of up to 10 miles.
  - ✓ Providing wireless broadband and dedicated links.
  - ✓ Making the technology more affordable.
  - ✓ Allowing access from more remote areas.

Although WIMAX technology is relatively new, its brief history and development consists of four phases [4].

Comparison of Wired-WIMAX network is shown in table 1. On the basis of following constraint WIMAX has definitely superior than wired. Due to the excellent performance WIMAX are also very costly and wired cost are not too much. So on the basis of cost and other constant their hybrid network are definitely show the good performance.

Table 1. Wired and WIMAX comparison

Constraint	**Wired Network**	**WIMAX Network**
Installation	Moderate difficult	Easier, but beware interfaces
Cost	Less	More
Reliability	Moderate	Reasonably high
performance	Good	Very good
Security	Reasonably good	Reasonably good
Mobility	Limited	Outstanding

3. LITERATURE SUREY

On the basis of previous observations, no work is done on Wired-WIMAX hybrid network. The meaning of hybrid network is the combination of two different technologies. In hybrid network communication between the two different technologies are possible and also examine their performance that is given in result section.

There are no kind of work is done on Wired -WIMAX network but some work is done on WiFi-WIMAX network this section give details of that work.

A network infrastructure is based on multi-service implementation over convergence of network medium such as ISP, PSTN and GSM [19]. Therefore multi traffic in the network infrastructure has become more complicated to monitor and investigate [20]. Today sending and receiving information can be done through a variety of ways such as fix and mobile phones via the wireless, high speed networks, ISDN and DSL lines that are more prone to heterogeneous environment [21]. The main factor of network congestion is related to network design and bandwidth capacity [22]. Availability of various services has produced multi-traffic in network infrastructure [23]. Therefore, multi-traffic in the

network infrastructure has become more complex to observe and analyze [24], [25]. A novel approach for the measurement and estimation of aggregate traffic in Local Area Network environment has been discussed in [26]. The addition of a switch with a hub's network makes a network perform better in terms of throughput and delay characteristics [27].

IEEE 802.16(WIMAX) technology [6] has been proposed to overcome the critical problems of WLANs [7] and cellular networks. It provides greater coverage area and better mobility support while encouraging high transmission rate. In addition, it also supports heterogeneous traffic by means of various QoS scheduling. WIMAX also provides a solution for scenarios that are too remote to receive internet access via cable or DSL.

The WIMAX technology can be used for creating a wide-area wireless backhaul network. With the deployment of backhaul-based WIMAX many value added services can be provided to the service area.

To efficiently support the large number of customers in the WIMAX network, the network can be enabled with distributed services [9]. In other words, a customer can access the particular service from any of the servers in the network in which the servers are distributed to serve the entire metropolitan area. In this method, the customer does not specify the exact address of the server in the network which runs the particular service; whereas it only indicates the service it wants to access.

This article [28] has compared the use of OFDMA in WIMAX and LTE standards in detail. Both systems leverage many facets of OFDMA, including frequency diversity and frequency and time axes granularity. Subtle differences in exploiting different advantages of OFDMA in both systems are highlighted. Note that the physical layer overhead is higher for WIMAX systems than for LTE.

Previous work [10] has studied the performance of AODV and DSR in a variety of scenarios. This work showed that both AODV and DSR drop in performance at high velocities or when the number of connections is high. Based on the results, the authors proposed modifications to AODV that could improve the performance of each protocol. One specific proposal is the accumulation of the source route in request and reply packets during the route discovery process in AODV. By accumulating this information, nodes can learn an increased amount of routing information to different destinations. So the proposed modification should lead to a reduction in the routing load of AODV. To evaluate the new protocol, a detailed packet-level simulation comparing the performance of AODV with source route path accumulation to AODV is presented.

In [11], R. Bera et al. present a performance analysis of a university network combining the IEEE 802.11n standard and WIMAX technology. The paper describes the benefits of using these technologies in tandem, even when one of them is recently approved (WIMAX) for certifying purposes and the other is scarcely commercially available (802.11n). The document proposes possible solutions for problems related to the integration of these two technologies. However, the authors themselves recognize that security issues and the lack of availability of adequate equipment for testing the network's performance were significant limitations.

In [12], Shilpa et al. present a comparative study of emerging WIMAX, 3G, and WiFi wireless technologies. The authors describe the main characteristics of these technologies, as well as the advantages and disadvantage of each of them. Their paper, however, is theoretical in nature and does not provide quantitative results based on simulations. Currently, WiFi-WIMAX integration is based on the IEEE802.16d protocol, also known as Fixed WIMAX. The IEEE 802.16e standard has yet to be deployed because it is still undergoing the certification process. One of the greatest difficulties to be solved is how to deal with quickly changing network nodes that can cause breaks in the network connection. Consequently, any proposed routing algorithm must allow for highly dynamic nodes and network partitions. Quality of service (QoS) and mobility are the most common challenges, thus require specific protocols to integrate different types of wireless networks. The most significant problem in terms of QoS is the actual handoff, where nodes must pass information between cells [5].

An important aspect to consider is that the basic support for QoS differs significantly between WLAN and WMAN because of the different architectures, and more specifically, the specifications of their physical and MAC layers [5].

WIMAX technology supports both PMP and Mesh. A WIMAX PMP network provides last mile access to broadband Internet services by organizing the nodes in a manner that is similar to cell phone networks because it uses a BS. Meanwhile, in mesh topology, an ad hoc network functions independently of the BS. Each node can simultaneously transmit and receive information from neighbor nodes. Additionally, they can send information using a multihop strategy to communicate with nodes that are further away. [9].

The integration of WiFi-WIMAX has become increasingly common in urban areas where they work in tandem to provide mobile services and a variety of applications. Presently, several cities are attempting to become "wireless cities" in an effort to provide broadband wireless internet access throughout their entire metropolitan areas. WiFi and WIMAX are two options for internet access in metropolitan networks [9]. Presently, integrating WiFi and Fixed WIMAX is the most practical way to deploy large-scale wireless networks in cities that require wireless broadband connectivity [9]. The most famous Secure Wireless Cities (SWCs) projects include Wireless Philadelphia, the San Francisco Techconnect Project, and Google WiFi Mountain View [6, 7, and 8]. The purpose of the Wireless Philadelphia Project is to provide the Philadelphia metropolitan area with wireless services. Handled through Wireless Internet Partners (WIP), even though the entire city does not enjoy full coverage, the goals set by WIP will soon be reached. Although the WIP does not offer its services free of charge, there are some free zones located in public spaces like parks and gardens [6].

San Francisco Techconnect is an initiative for promoting internet services, training, and technical support for the citizens of San Francisco, California. This project places special emphasis on serving low income groups or people with special needs. An important goal of the San Francisco Techconnect project is to promote new applications, contribute to economic growth, and improve municipal services. [7]. The Google WiFi Mountain View project provides free internet to the city of Mountain View, California. The main goal is to provide city-wide service and uses mesh architecture to provide WiFi services [8]. Each project was motivated and developed for different reasons, but most of these projects remain true to offering free internet services to entire cities. The creation of a protocol which allows users access to both types of technologies without problems has great advantages for both users and service

providers. Offering integrated WLAN/WMAN services will provide users both performance and high speed data transmission [5]. Ali-Yahiya et al. propose an architecture where the WiFi and WIMAX networks and their traffic routes are separated by dedicated gateways to provide interconnectivity.

4. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL

Ad hoc On-Demand Distance Vector Routing Protocol (AODV) [13] is another reactive routing protocol, which perform the following procedures:

1. **Route discovery**: If the route is not available in the routing table towards the destination, a RREQ (Route Request) packet is broadcast throughout the MANET with a search ring technique. On receipt of RREQ, the node creates a reverse routing entry towards the originator of RREQ, which is used to forward replies later. The destination or the intermediate node, which has a valid route towards the destination, answers with a RREP (Route Reply) unicast packet. On receipt of RREP, the reverse routing entry towards the originator of RREP is also created, similar to the processing of RREQ. Associated with each routing entry is a so-called precursor list, which is created at the same time. The precursor list contains the upstream nodes which use the node itself towards the same destinations.
2. **Route maintenance:** Every node along an active route periodically broadcasts HELLO messages to its neighbours. If the node does not receive a HELLO message or a data packet from a neighbor for a while, the link between itself and the neighbor is considered to be broken. If the destination with this neighbour as the next hop is believed not to be far away (from the invalid routing entry), local repair mechanism may be launched to rebuild the route towards the destination; otherwise, a REER (Route Error) packet is sent to the neighbors in the precursor list associated with the routing entry to inform them of the link failure.
3. **Route table management**

   AODV needs to keep track of the following information for each route table entry: x Destination IP Address: IP address for the destination node.

   - Destination Sequence Number: Sequence number for this destination.
   - Hop Count: Number of hops to the destination.
   - Next Hop: The neighbour, which has been designated to forward packets through intermediate nodes to the destination for this route entry.
   - Lifetime: The time for which the route is considered valid. Active neighbour are the nodes that are actively using this route entry.
   - Request buffer: Makes sure that a request is only processed once.

5. PROBLEM STATEMENT

The problem in WIMAX technology is range and in wired is not possible to provide connectivity in everywhere. WIMAX is also a wireless technology but it will be enhance in radio range and presence of OFDM as compare to wired. Wired WIMAX communication has no doubt provides better results but have some limitations that has tried to solve by combining Wired and WIMAX hybrid network.

6. PROPOSED METHODOLOGY

According to problem statement , very first we create mobile node and use routing protocol as AODV (ad-hoc on demand distance vector) routing and set channel type as wireless channel , prorogation type two ray ground wave because mobile node contain routing table and also node radio range is limited so our data transmitted from node to node after that we apply MAC (media access control technique) as 802.16 WIMAX that provides greater radio range as compare to 802.3 WLAN scheme our dissertation work proposed in WIMAX scheme so here we elaborate WIMAX network.

6.1 Algorithm for AODV Routing Discovery and Scenario Generation with WIMAX standard

```
Mobile node = N; // Number of mobile nodes
Sender node = S; // sub set of N i.e MH
Receiver Node = R; //sub Set of N i.e MH
Start simulation time = t0
Set routing protocol = AODV;
Set MAC = 802.16
Set radio range = rr; //initialize radio range
RREQ_B(S, R, rr)
{
If ((rr<=550) && (next hop >0))
{
Compute route ()
{
rtable->insert(rtable->rt_nexthop); // nexthop to RREQ source
rtable1->insert(rtable1->rt_nexthop); // nexthop to RREQ
destination
if (dest==true)
{ send ack to source node with rtable1;
Data_packet_send(s_no, nexthop, type)
}
 else {
destination not found;
                }
            }
else
{
destination  un-reachable ;
}
}
```

Communication of Wired with WIMAX on the basis of Foreign Agent

Frequency division multiplexing (FDM) is a technique by which the total bandwidth available in a communication medium in wired network at frequency of maximum 48 KHz. Multipath interference [11, 22] is a phenomenon used in OFDM (used by FA) in the technique of where a signals from a source travels to a detector via two or more paths and, under the right condition frequency of 3GHz

```
If( Frequency >48Khz )
```

{
Wired WIMAX communication is possible on the basis of channel estimation}
now channel estimation [11] calculation and channel equalization [11] on the basis of frequency. So calculate required frequency for communication in between Time Division Multiplexing (TDM) and OFDM
{Calculate required frequency = (difference of frequency of wired and WIMAX
Then
Calculate difference of the frequency range need for communication for WIMAX and maintain the synchronization in TDM wired and OFDM WIMAX
if (check frequency is = = possible communication means (3GH)}
then
data in the foam of signals passes to WIMAX Network
}
else
{no synchronization is possible on the basis of frequency in wired WIMAX)
}

The Wired WIMAX communication are shown in figure 1.This figure represents the one wired topology and one WIMAX mobile node topology. Here HA represents *Home Agent*, FA represents *Foreign Agent* in wired network and MH represents *Mobile Host* in wireless network. Basically the Home Agent functioning is only in wired network means all the HA are free to communicate in wired network without any Foreign Agent and Mobile Hosts are similarly free to do communication in between mobile nodes without any FA. The main function of FA is to do the communication in between wired network and WIMAX network. This node is working as a intermediate in between these two network means only FA having a capability to maintain synchronization in Hybrid Network because FA understands both network. The communication of FA with HA and to MH is based on OFDM and TDM.

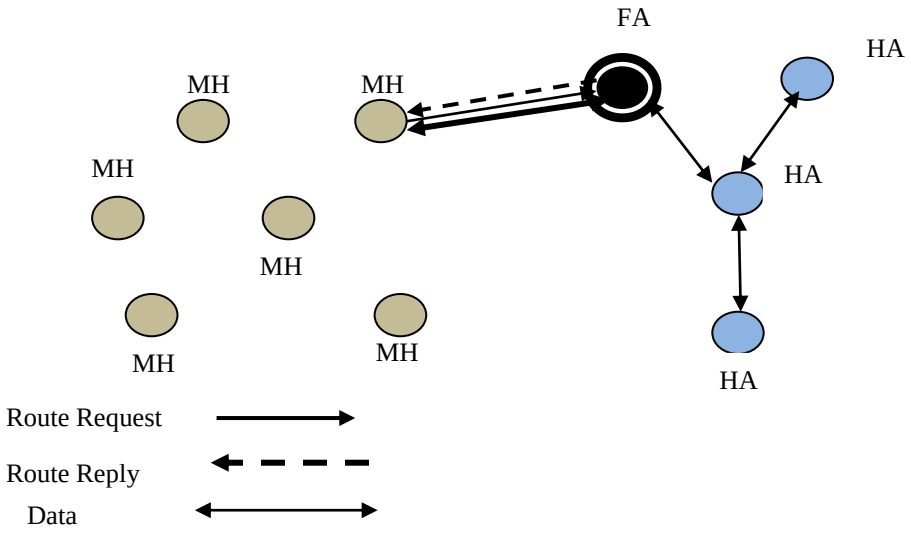

Fig 1: Wired WIMAX communication on the basis of Home agent and Foreign agent

7. SIMULATION ENVIRONMENT AND RESULTS

Simulation has been done in Network Simulator [15] (ns 2.31 version). Here the wired topology are consider three HA and single FA and connections are established in between MH to HA through FA i.e each MH are communicate with HA through FA. WIMAX wireless ad hoc parameters are shown in table 2.

Table 2. Simulation parameters

Simulator used	NS-2.31
Number of nodes (MH)	21
Dimensions of simulation area	800×800
Transmission range	250m
Network type	802.3 and 802.16
Routing protocol	AODV
Simulation Time	100sec.
Traffic Type (TCP and UDP)	CBR (3pkt/s)
Packet size	512bytes
Nodes Movements	Random
Number of HA and FA	3and 1

8. Results

This section represents the results of Wired WIMAX simulation on the basis of performance metrics and parameters that consider in this paper.

8.1.1 *WIMAX Network Scenario*

The simulation described in this project was tested using the ns-2 test-bed that allows users to create arbitrary network topologies. By changing the logical topology of the network, ns-2 users can conduct tests in an ad hoc network without having to physically move the nodes. NS-2 controls the test scenarios through a wired interface, while the ad hoc nodes communicate through a wireless interface. The topology shown in Figure 5.5 is used 25 mobile nodes to show

how the node senses the neighbor nodes and sends data to destination through shortest path.

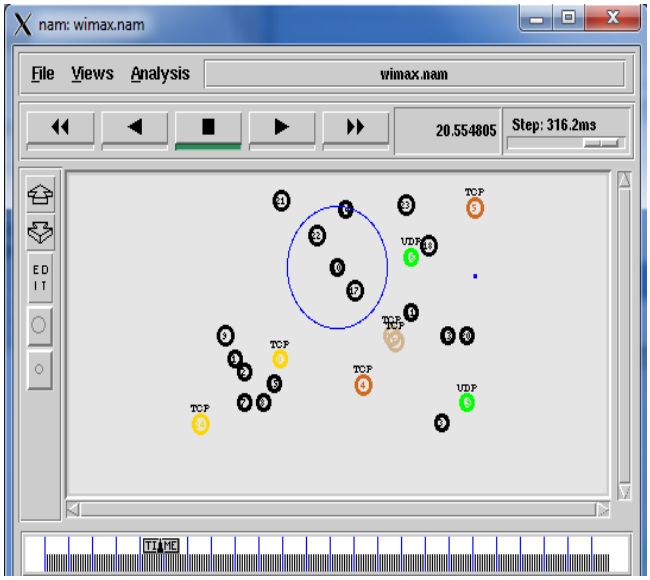

Fig 2: MANET with WIMAX Standard

8.1.2 *Wired-WIMAX Network Scenario*

Wired-WIMAX routing procedure was already discussed in proposed work section but this figure represents the NAM visualization of Wired-WIMAX communication. Here the four nodes are of wired connections and remaining are of wireless nodes. In wired network Foreign Agent are the mediators that do the interfacing in between wire and WIMAX. The rest of wireless nodes in the WIMAX network are work as a Mobile Host that are communicate with wired network through FA.

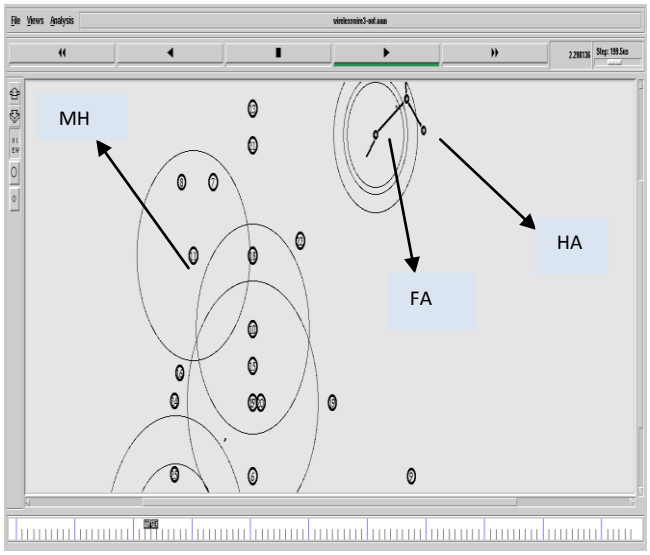

Fig 3: Wired-WIMAX Network Scenario

8.1.3 *Routing load analysis*

The routing load analysis of are clearly show that the performance of Wired-WIMAX communication as compare to individual WIMAX communication. Here we clearly show that at the time of WIMAX Communication about 1100 packets are delivered in the network between sender and receiver but in Wired-WIMAX communication only about 200 routing packets are deliver in between sender and receiver. It means this difference is about of 900 packets. The performance of WIMAX are definitely degrades due to mobile nature of mobile node as compare to Wired-WIMAX fixed FA based communication.

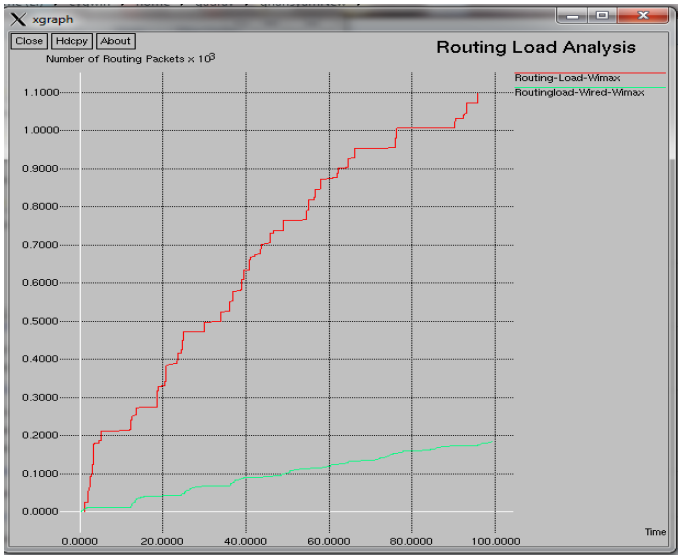

Fig 4: Routing Load Analysis

8.1.4 *PDR Analysis*

Packet delivery ratio is one of the important parameter to measure the performance of WIMAX and Wired-WIMAX network. Here we clearly show that the performances of proposed method is definitely improves the network performance as compare to WIMAX communication. In WIMAX network the maximum value of PDR is about 97% but in Wired-WIMAX network the PDR is 100%. Means on a single packet is drop in a network due to any reason. Wired-WIMAX communication is also cost effective as compare to WIMAX communication with improved performance.

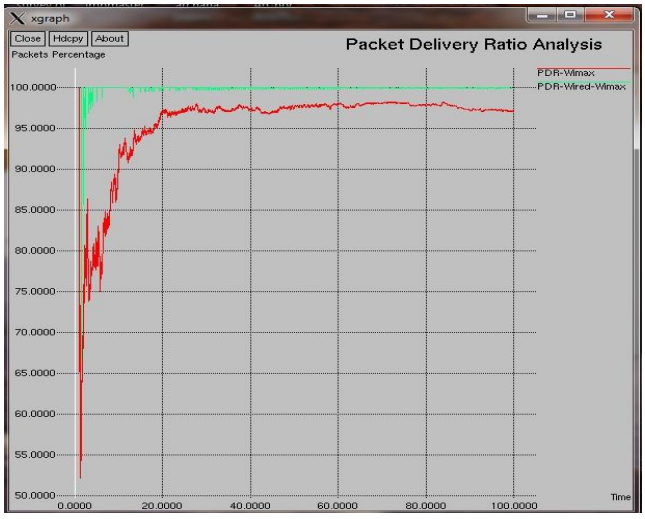

Fig 5: PDR Analyses

8.1.5 *Over summery of WIMAX and Wired-WIMAX Network*

Here table 3 represents the overall summery of performance metrics of both the technologies. Here we clearly visualized the performance of Wired-WIMAX network as compare to WIMAX Communication.

Table 3. Overall Analyses

Parameters	WIMAX	Wired-WIMAX
Packets Send	5963	1806
Packets Received	5793	1806
Routing Packets	1097	50
NRL	.19	.02
PDF	97.15	100.00
Packets Loss	168	00

9. CONCLUSION & FUTURE WORK

Theoretically Wired network support up to 11 Mbps data rate but in real world it has the data capability of 4 Mbps or little less than this. The most notable disadvantage of Wired is its range and WIMAX has a very robust and flexible air interface.

MH and HA are no problem to communication in own network but for communication in between FA is necessary. By comparing the performance of WIMAX and Wired technology FA is really a superior interface in between both technologies. Results are clearly shows that the wired WIMAX communication is better than WIMAX. It will also resolve some of the technical difficulties of Cellular network. Moreover it is highly flexible and spectrally efficient. It is not far away where everybody will be able to access the high speed internet connectivity at any time at any place like the mobile phone we use today.

Performances of WIMAX-Wired hybrid network are better than the WIMAX, if here we consider single FA. Now in future we also observe the performance of WIMAX in case of more than two FA and also with heavy congestion and try to do work in image encryption and decryption in MANET with WIMAX Technology.

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