*Grenze International Journal of Engineering and Technology, Jan Issue*

# Low Cost Frame Work of E-Education with Special Reference to Rural Area using WiMAX

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***Abstract*—Mobile phones, internet, tablets, I Pads, their applications, social media, GPS guided travelling, You Tube guided cooking etc are part of our lives from the start to end of the day. Technology is now a part and parcel of the society and changing our life style dramatically. But there is one very important and indispensable part of the society, who are lagging from the use of various innovations on ICT, and also they are deprived from all modern education due to their low economic level. They cannot improve their status due to non availability of modern infrastructure in their areas. Only education can uplift the status of the urban people from their backwardness. Metro and City peoples somehow are managing their lifestyle with modern scientific amenities. So in this paper we tried to develop a low cost e-education framework for the people in village and urban areas. Thus they can be enriched with modern education. It is to be noted that E-education is the only simple solution to educate and uplift rural people without investing huge money like conventional education linked with costly infrastructure. Distant Education from anywhere, E-learning, E-Education clearly has a role to play in resolving the problem. Since conventional high speed telecom network installation in rural area have a very little ROI. The rural people could not effort for the technology like DSL, ISDN, FTH, 3G/4G/5G, where the installation cost is far more. The network using WiMAX technology is fit for low cost solution for end user student and teacher in deprived areas.**

***Index Terms*— WiMAX, PHY, SDH, NIB, MAC, DSL, ISDN, PSTN.**

## I. INTRODUCTION

India is a developing country with many young people. More than half of the country's population is under 25 years of age and every year 10 million people join the workforce. India already has one of the largest education systems in the world. The country has 1.5 million schools, 40,000 colleges, and nearly 1000 universities [1]. Right to Education is the primary right of every citizen of India, whether a child resides in a high profile society or in a far away not so developed secluded village, according to the Article 45 of Indian Constitution the basic elementary education must be provided to all the children up to the age of fourteen years. Even after 74 years of independence some States in India are still struggling to achieve quality education. There are more than one million rural schools among 6,38,000 villages in India[1]. E-learning is a combination of learning services and technology to provide high values in education. Internet plays a vital role in e-learning. E-learning is attaining significance in the world of internet. Due to many advantages in using internet, e-learning /e-education can be reached at anytime and anywhere to the learner [2]. We have seen in rural areas there are some good private tutors. Many of student in that village are taking tuition from these teacher and thus they carry out their day to

*Grenze ID: 01.GIJET.8.1.58*

day course works for their school syllabus. In this way they pass their school examinations without sufficient knowledge required for their future life. Our aim is to replace above conventional teaching and learning method by an efficient fruitful e-education frame work. E–Education is defined "as acquisition of knowledge and skill using electronic technologies such as computer and Internet based courseware. Like that tutor who is teaching many student of the village by making a tutorial class in his house with all student together. Here in E-Education, the tutor will teach from his house with the students residing their respective house using ICT. In this process the teacher can cover up more student in the village and also student will get quality education through some live example, models and some electronic teaching aids [2].

## II. WiMAX AND ITS APPLICATION

Now let us develop a frame work of e-education system which will use low cost transmission equipment having lower bandwidth to cope with the lower population density of a rural area. WiMAX is a very powerful wireless internet access technology. For an estimated Rs 100/- per month per student or a one-time cost of about Rs 3500/- (depending on population density), a tutor even a school can deploy a WiMAX network linking student mobile or laptops. There will be instructional software to run the both way teaching and learning process. This paper describe the opportunity for educators and vendors, for easy access to internet and give on line education to the students in particular rural area using low investment WiMAX Technology.

WiMAX is a last mile wireless broadband access as an alternative to cable/DSL/ISDN/FTH that provides fixed/portable/mobile non-line-of-sight from base station with a cell radius 6 miles, point-to-multipoint, non-line-of-sight. One of the major attractions to WiMAX is its cost per subscriber. Its cost relative to other technologies in terms of cost per home is less. This low cost per home brings it into the realm of possibilities for a school district to build its own private access network independent of commercial operator. These commercial operators are generally avoid rural belts due to low ROI. A comparative expenditure of the investment on different technology is given table 1 bellow[2].

TABLE I. COMPETITIVE EXPENDITURE FOR DIFFERENT TECHNOLOGY

| TECHNOLOGY | CAPITAL EXPENDITURE | COST PER HOME |
|---|---|---|
| COPPER CABLE/ISDN/DSL | $270 billion (1) | $50 |
| Cable TV | $65billion (1) | $1200 |
| 3G/4G/5G Wireless | $405billion (3) | $50 |
| Fiber to Home FTH | $93billion (2) | $2000 |
| WiMAX | $3billion (4) | <$10 |

1) Hal Varian, University of California and Robert Litan of Brookings Institute (2004)
2) Wall Street Journal September, 2006
3) Morgan Stanley 2004
4) Business Week April 06, 2005 [3].

A school district-wide WiMAX network in support of a one-to-one computing initiative will inevitably require applications for instruction. These are the real power of the true value of the WiMAX network. A WiMAX network and one to one computing do little for a student's instruction in and of themselves. The power of the network lies in the applications residing on the school's intranet accessed by students through WiMAX network and the one-to-one computing program. In the present situation all the student remaining in their respective home can interact with his teacher either from school or from his residence. Thus investment for infrastructure of school can be reduced. Different classroom is not required in a school and the teacher can communicate to their student from his individual chamber. In this way schools may be constructed in each village panchayet area with a very low investment. Thus education can be distributed to each individuals of the village.

## III. WiMAX IN RURAL EDUCATION

There are many reasons for the barriers, why until now broadband ICT access was mainly deployed in developed countries and more precisely in metro and city areas in developing countries. In the same way, while developed countries and urban areas are requiring higher and higher bit rates for multimedia applications, rural areas in developing countries are still at first favoring voice communication with a slow evolution towards ICTs[4]. WiMAX stands for "World Interoperability for Microwave Access''. It is a broadband wireless technology that supports fixed, nomadic, portable and mobile access. WiMAX is widely supported by the computer and the telecommunications industry, cost-effective and standard base. It is engineered to deliver the latest type of

ubiquitous fixed and mobile services such as Voice over Internet Protocol (VoIP), Information Technology and Video at very low cost. WiMAX systems are able to cover a large geographical area, up to 50 km and to deliver significant bandwidth to end-users up to 72 Mbps. To meet the requirements of different types of access, two versions of WiMAX have been defined. The first is based on IEEE 802.16-2004 and is optimized for fixed and nomadic access. The initial WiMAX Forum certified products will be based on this version of WiMAX. The second version is designed to support portability and mobility, and will be based on the IEEE 802.16e amendment to the standard [5].

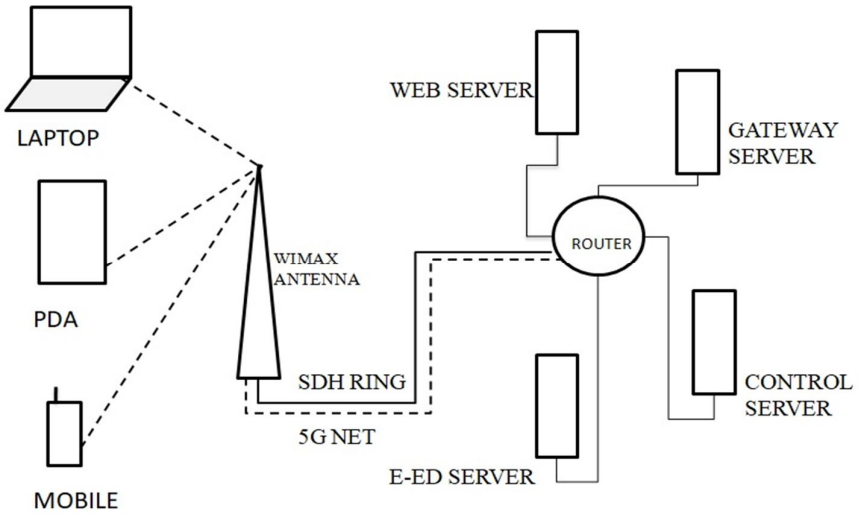


Fig 1 WIMAX for E-Education

The IEEE 802.16 standard which includes Medium Access Control (MAC) and physical (PHY) layer specifications, aims at supporting Internet services over wireless metropolitan area networks (WMAN). It is also an alternative to traditional wired networks, such as Asymmetric Digital Subscriber Line (ADSL) and cable-modem. There are two modes (two different air-interfaces) defined in WiMAX networks: Point-to-Multi-Point (PMP) and Mesh modes. In PMP mode, two SSs (Subscriber Stations) can only communicate through BS (Base Station), while in Mesh mode, two SSs can communicate directly [6].

In the PHY layer, the IEEE 802.16 standard adopts the OFDM (orthogonal frequency division multiplexing), which is a multicarrier modulation scheme. The IEEE 802.16 standard has two OFDM-based modes: OFDM and OFDMA (orthogonal frequency division multiplexing access). Both of these technologies allow subcarriers to be adaptively modulated (e.g., QPSK, 16-QAM, and 64-QAM), depending on transmission distance and noise. Moreover, OFDMA has scalability to provide efficient use of bandwidth. The MAC layer of IEEE 802.16 standard was originally designed for the PMP mode [11]. On the later amendments of the IEEE 802.16a and the IEEE 802.16d, the mesh mode was included. The IEEE 802.16a adopts OFDM to provide greater spectral efficiency and to mitigate interference. IEEE 802.16d covers most of the QoS (quality of service) aspects. The IEEE 802.16e introduces scalable OFDMA into the standard, and supports mobile communications. With handover mechanisms, WiMAX is thus able to support mobile communications at vehicular speeds [7].

On July 2002, a study group called IEEE 802.16 Mobile Wireless MAN Task Group was initiated to produce an amendment covering the PHY and MAC layers for combined, fixed, and mobile operations in the licensed band range. The amendment was approved in December 2005 and the new standard called IEEE 802.16e-2005 was published in February 2006. The scope of this standard is to provide mobility enhancement support for SS moving at the vehicular speed [8].

## IV. WiMAX Performane

The first version of WiMAX standard was focused merely on the fixed subscriber application. The next generation mobile WiMAX technologies are designed enabling both fixed and mobile subscribers with various PDA, Tab, note book computer, mobiles, and other consumer electronic equipment. The air interface of mobile standard frequency band is varying from one geographical area to another. Hence the WiMAX interference and coexistence scenario in different area will not be identical [9].

In [10] various critical Quality of Service (QoS) parameters, including average jitter, average delay, packet loss, and throughput of a WIMAX network were evaluated. We found that the optimum value of QoS parameters could be obtained when the mobile nodes are increased. That means distance between should be as minimum as possible. The authors in [11] conducted a simulation study to determine the major factors affecting broadband wireless channels. They analyzed the bit error rate (BER) with SNR for multipath fading channels under different requirements and conditions recommended by the communication system. They evaluated WIMAX in various versions and compare it with other technologies available in the market. They also compared the initial 802.16, 802 .16a, mobile WIMAX, and fixed WIMAX by identifying the advantages of adaptive modulation. The OFDM is the most important distinction between 802.16 and 802.16a. In addition to discussing the MAC and PHY layers, the authors in [12] emphasized that the future versions of WIMAX provide better capacity and performance (QoS), WIMAX is generally more cost-effective and advantageous than other technologies in the market. The performance and QoS of WIMAX networks using different types of service classes to transfer VOIP traffic, was tested and evaluated in [13]. A new methodology was proposed by creating a WIMAX network using an OPNET modeler to explore the behavior of the traffic to and from the upper layers by analyzing the connection statistics (load and throughput) of WIMAX [14].
The use of the ertPS (performance analysis) scheduling class presented the advantage of giving back some of its reserved bandwidth when its bandwidth had no traffic to serve. The results indicated that the ertPS for delay-sensitive traffic oscillates beyond its nominal rate and that the performance for both voice and data application was similar. The author examined the performance of VOIP in a WIMAX network under different scheduling services (i.e., UGS, ertPS, rtPS, nrtPS, and BE) in terms of performance metric jitter, MOS, and end-to-end delay. The results indicated that UGS traffic had the least packet end-to-end delay, the lowest average jitter, and satisfactory MOS value [15]. In [16], the authors used an NS-2.33 simulator to evaluate the QoS performance of a mobile WIMAX under different propagation environments in terms of average throughput, average delay, and average jitter. The WIMAX networks in different areas were studied by [17]. The authors analyzed the performance under different modulations by simulating various parameters, such as SNR, BER, and path loss. Their simulation results revealed that 64-QAM had the highest bandwidth and SNR value, and that it demonstrated very good output.

TABLE II. COMPARISON OF DEVICES WITH THEIR HANDOFF

| Mode | Devices Mode | Location /Speed | Handoffs |
|---|---|---|---|
| Fixed | Outdoor and indoor | Single Stationary | No |
| Nomadic access | Indoor CPEs, PCMCIA cards | Multiple Stationary | No |
| Portability | Laptop PCMCIA or Mini-cards | Multiple Walking Speed | Hard Handoff |
| Simple mobility | Laptop PCMCIA or Mini cards PDAs or smartphone | Multiple Low Speed Vehicle | Hard Handoff |
| Full mobility | Laptop PCMCIA or Mini cards PDAs or smartphone | Multiple High Speed Vehicle | Soft Handoff |

The mobile WiMAX PHY layer is based on OFDMA technology. The network is an IP end-to-end conventional architecture that provides high-speed broadband. With a modification from fixed WiMAX to mobile WiMAX, the PHY layer also supports BWs from 1.25 to 20 MHz. The standard is designed to accommodate either Time or Frequency Division Duplexing (TDD or FDD) deployments, allowing for both full- and half-duplex terminals in the FDD case [18].
Compared with other wired solution such as ADSL, or any other wireless or satellite system, WiMAX based access networks will enable operators and service providers to cost-effectively reach million of new potential customers providing them with broadband ICTs access. This is even true for developing countries and rural areas for which the cost/profitability and the demand factors are essential. This obviously includes adequate coverage, reliability, performances (throughput), capacity and applications[19]. Table 2 shows how WiMAX supports different types of access and their requirement. WiMAX technology benefits in a wide coverage and can be deployed as a Point-to-Multipoint “last mile’’ connection but also as part of the backhaul to the private switched telephone network (PSTN) and Internet access points [20].
Student laptops can be leased for approximately $32/month (on a 36 month lease). Coupled with WiMAX at $1/month/student the cost to the school district is $33/month/student. Allocation of tax money to public school ranges from $5,000 to $7,000 per student per year. Ergo, deploying a WiMAX network in this school district and providing a WiMAX-enabled laptop to each child would cost less than 10% of that district’s annual, tax dollar

per-student allocation. Another approach to financing a WiMAX network is substituting WiMAX for other expenses such as telecommunications and textbooks. Table 3 compares these expenses [21].

TABLE III. COMPARISON OF EXPENSES OF CONVENTIONAL AND WIMAX TECHNOLOGY

| Cost of Communication | Cost at present, with Conventional Technology | Cost Using WiMAX Technology |
|---|---|---|
| Using PSTN Telephone | Rs35000 per User | Interconnect Cost Nil |
| Cell Phone | Rs7000 per User | Interconnection Cost Negligible |
| VOIP | Rs3500 per User | No Phone Bill |
| Maintenance, Man Power | Rs14000 per Day | Only Terminal Maintenance |
| Text Book | Rs200 per Book | Text E-BooK Can be Freely Published |
| Insurance and Surveillance | Extra Expenditure | Low cost Surveillance |

The WiMAX role in an access network is illustrated in Figure 2. With potential range of 30 to 50 kilometers we can install WiMAX tower in line-of-site conditions between consecutive rural districts. WiMAX offer a huge improvement over all existing broadband wireless technology [9].

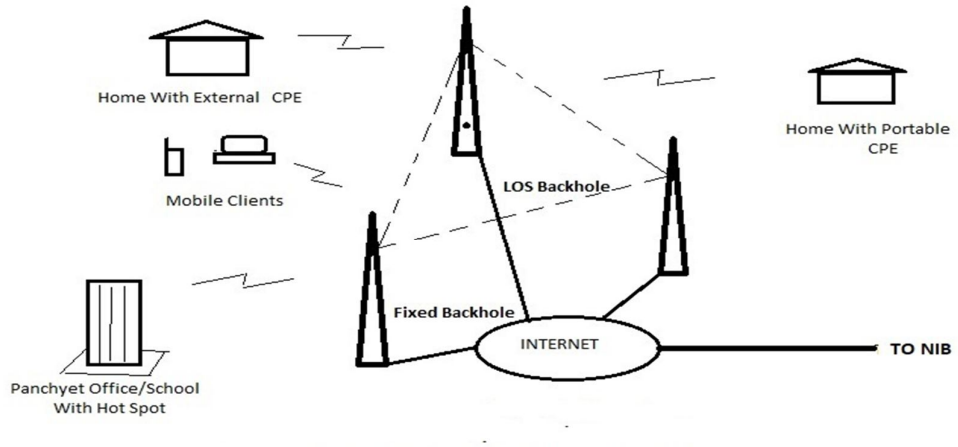


Fig 2 WiMAX Model in side by side Villages

Indian corporate sector have hold on the tech world such as Intel, Qualcomm and Tata are also making strides in this direction. Intel recently launched 'Digital Skills for India' initiative under which it introduced Digital Skills Training Application that is comprised of modules on Digital Literacy, Financial Inclusion, Healthcare and Cleanliness in five Indian languages. Qualcomm has launched Play 'n' Learn program for school children ages 5-8. It is providing 3G tablets under the Qualcomm wireless Reach initiative. Similarly, Samsung recently started on a Smart Learning initiative to provide interactive study materials to students.

Likewise, Tata, Reliance and BSNL are among the prominent Indian names that are going big on this sector. While Tata is expanding its school education solution, 'Classedg', Reliance has picked up over 38.5 per cent stake in digital education company, Extra marks Education Private Limited, through its subsidiary, Infotel Broadband Services Limited. Government owned enterprise BSNL has tied up with Grey cell 18 Media Private Limited, to launch its online education service 'Topper Education'. Other noteworthy names in this segment include the likes of Data Wind, Merit nation, and Class teacher. Even some of the e-commerce players have expressed their willingness in this segment. Needless to say, if the e-learning/education market takes root in the country, it will definitely improve the education scenario which desperately needs a shakeup.

Even the government is in strong supporter of e learning and the Department of Electronics and Information Technology (Deity) has been actively developing tools and technologies to promote it, what we need is more devices and an ecosystem. There is a need for a greater participation from the industry and stakeholders. For this to happen, the tech companies have to take the lead and help enable a strong ecosystem. We also need more applications and services to strengthen the ecosystem. The developers and content providers are going to be encouraged only when there is a plenty of devices, more importantly interest of tech companies. Apparently, there is a huge opportunity yet to be tapped, even as infrastructure and regulation issues might be slowing down the otherwise accelerating education space in India. Digital India (DI) program is a GoI initiative to electronically integrate the government departments and the people of India. This move aims at ensuring that

government services are made available to citizens electronically. It also includes a massive plan to connect rural areas with high-speed internet networks. Digital India has three core components. These include: Digital infrastructure, Digital service delivery and Digital literacy [22].

## V. Rural Network Design

Recently UGC and HRD jointly integrated all the major University in a common University network, where all the university can exchange their curriculum and syllabus to make a uniform course of education for all the students of the country. Similarly all the school board may be integrated in a common network so that any student anywhere from India can select his secondary/Sr Secondary board as per his choice. And thus he can continue his education with his own language also, irrespective of where he is. These frame work may be applicable to rural belt for getting student education in low cost. Framework will have a capacity to select any teacher of his own mother tong, even if he resides in any other local language area. The following fig 3 describes the concept.

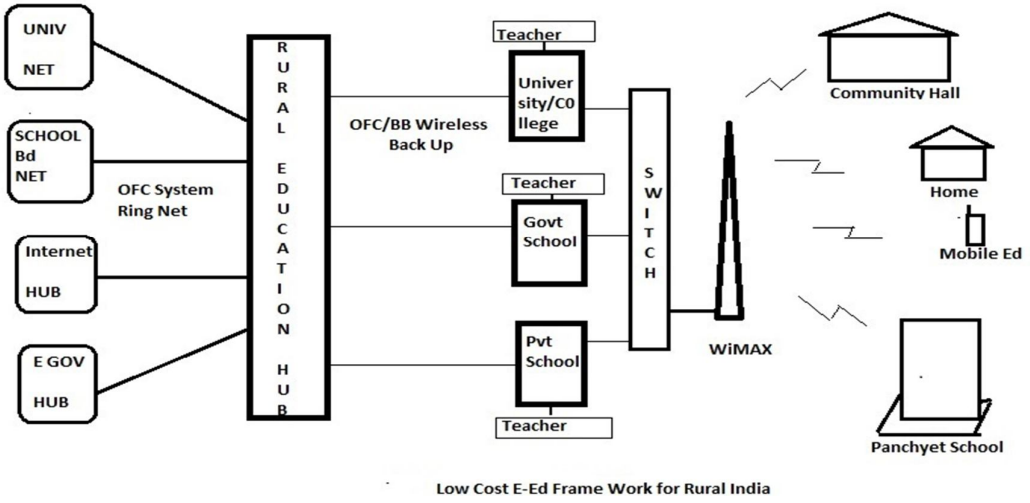


Fig 3

Here University NET, School Board and Internet hub is connected with the rural education hub by ring structure OFC links. Ring structure OFC cable system is made for system redundancy, ie when one side of the ring is failure due to cable cut, the system will run through other side of the ring. It is also connected with the E-Gov net to control over the uniform education policy to public. This rural Hub is connected with individual local teaching server organized by a team of expert teacher of the Universities directly from University net. Any teacher can intervene to his student for their problems like admission, examination, difficulty in learning etc including their day to day distant teaching and training. Student can get education with other than local language directly through education board hubs. For example, if a school student want to contact his nearest school teacher with his own language, the student will search the option of teacher of his choice. The network will guide him to select teacher from nearest school board hub to communicate with that student. Of course student had to register himself online first with a very nominal fees. All types of education contents including different teaching aids will be available from central hub of school boards and universities. Any teacher not only give lecture, but he can use proper audio video contents required for his lessons including extra curricular activities.

## VI. Challenges

1. A significant proportion of the rural population ccontinues to fall short of the required internet bandwidth and knowledge to recognize devices and digital terminologies.
2. Lack of awareness about E-learning material usage and services offered.
3. Problem in finding willing skilled manpower to training illiterate rural areas of India. Literate people generally migrated to nearest city area.
4. No computer based courses / skills taught to students in primary schools to increase their knowledge about ICT importance in rural development.

5. Gender Inequalities: The penetration of online learning amongst the female population in the rural parts of India is even more taxing. Just like most domains, the availability of internet and literacy in rural India is primarily available to men.
6. Language Barrier: Almost 85% of the population living in India does not speak English. The lack of access to standardized content in Hindi and other regional languages causes a slow rate of further online course adoption.
7. Another major issue involves the absence of supporting infrastructural facilities such as a stable flow of electricity and unavailability of high-speed internet [3].

The above challenges can be solved by proper policy and planning in Government level. That policy should be unanimously support by all political party. We have to promise first to educate all the people irrespective of religion cast race and other political differences. A good proportion of the yearly budget is to be provided for universal education and its infrastructure, to benefit every Indian. There should not be any compromise for this issue. It is to be mentioned that GOI already have taken some step to penetrate high speed internet and steady electricity to the rural belt.

## VII. Conclusion

India is a poor country and its main problem is to motivate people in education. Generally low income group spend more time for running their livelihood. So food and stay in home condition is to be improved and assured first by giving free aids. Then they have to be motivated for low cost or no cost basic education. Development of any society depends on its access to information and the same is essentially applicable to rural India too. E learning can work wonders in this direction and help the socially marginalized community to attain their entitlements. Launch of Digital India Program is a welcome step in this direction. The above discussed frame work with low cost WiMAX distributed network at the primary access point is the best solution for rural and deprived people. It is anticipated that with dedicated leadership, willpower and control will open a new horizon in education. An integrated framework comprising of the government, technology industry and society, with E-learning interventions in the rural areas will undoubtedly improve the true education (not a degree production only) environment.

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