Installation and Deployment of WiMAX for Campus Network

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Abstract

The necessary design steps for the implementation and deployment of WiMAX in a particular region have been discussed. At first, deployment technique and issues of WiMAX campus network are described. A model is proposed for fixed WiMAX connectivity using the WiMAX gateway as a backbone and modem for access purposes. The model is done under some real world application for the campus of University of Dhaka, Republic of Bangladesh. The benefit of WiMAX campus networking is compared with other options. As WiMAX is low cost for both implementation and ongoing charges, it will be the best candidate for Bangladesh to provide high speed Internet through wireless network.

Keywords: Fixed WiMAX, Installation of WiMAX, Terrain Type, WiMAX Base Station, WiMAX Gateway.

1. Introduction

WiMAX Technology is a great development in wireless technology offering long distance broadband access. It is a IEEE 802.16 standards-based products built upon the IEEE 802.16d-2004 and 802.16e-2005-air interface standard known as fixed and mobile WiMAX respectively. The implementation of IEEE 802.16 wireless networks can expand the wireless access coverage and improve the quality of service. It can provide enough bandwidth and a wireless alternative to cable and DSL for "last mile" broadband access, which will allow more convenient and secure roaming services. As a part of fourth generation (4G) of wireless technology, WiMAX delivers low-cost, open networks and is the first all IP mobile Internet solution enabling efficient and scalable networks for data, video, and voice. Now days, WiMAX assures interoperability and standard compliance of equipments from different vendors. This technology is a key success factor for any modern telecommunication technology providing a point to multipoint capability in the 2-11 GHz band[1].This paper describes the implementation of an WiMAX network to connect University of Dhaka (DU) campuses in the city of Dhaka, Bangladesh.

Single WiMAX main station can serve hundreds of users. In case of WiMAX technology, endpoints installation within days are possible instead of the weeks required for wired. This technology provides data rates as high as 280Mbps for distances over 30 miles**.** Due to this superiority of WiMAX, applicability of WiMAX is enhanced. At present WiMAX plays an important role in campus connectivity, banking, etc [2]. This paper is mainly dealt with point to multi-point broadband connections from a central location to a number of buildings or other locations within a particular ranges. In section 2, superiority of WiMAX connection for campus networking over other tecgniques are mentioned. For a campus network, WiMAX dep;oyment techniques and other WiMAX issues are discussed in section 3. Section 4 represents the steps of WiMAX campus installation and section 5 describes design parameters Our proposed model for WIMAX installation and deployment at University of Dhaka is also highlighted in this section.

2. Superiority of WiMAX for Campus Networking

Accesses to areas that are too remote, too difficult or too expensive to reach with traditional wired infrastructures (such as fiber) require new technologies and a different approach. The best solution varies based on usage models, time of deployment, geographic location, network application type (such as data-only, VoIP and video) and network needs of its users .In university campus; students often use wireless equipment like notebooks, handsets and Personal Digital Assistance (PDAs). This facility can be initiated by three options like WiFi as a Metro-Access Deployment Option, mesh connection, WiMAX metro access deployment.

WiMAX campus networking is often compared with other two wireless broadband technologies. WiMAX is merely a more robust version of WiFi and is superior due to its some special feature like cost, speed, distance, and cost effectiveness. This is designed for metropolitan area networking (MAN) instead of local area network (LAN) of WiFi to get access to the Internet. WiFi mesh-network topology is selected for Wireless coverage of LANs and blanketing large areas with hot-zone coverage. The limitations encountered with mesh networks are to cover larger areas, share bandwidth, latency problem, and proprietary implementation. Standardized WiFi mesh-network topology and QoS won't be available until the implementation of the 802.11s and 802.11e standard respectively. Here comes the superiority of WiMAX and the key benefits are built-in QoS, high performance, standards-based and smart antenna support [3].

3. Deployment Realities of WiMAX

Campus networks carry a mix of voice, data and video. Campus systems require high data capacity, low latency, a large coverage footprint, and high security. Campus Connectivity means WiMAX networks to connect multiple locations, sites and offices within their campus. As for example we consider campus of University of Dhaka, Bangladesh. Mostly used wireless equipment by the students of University of Dhaka (DU) are 802.11wireless equipments such as notebooks, handsets and Personal Digital Assistants (PDAs). The students can use these equipments to access Internet or download the course materials from DU website through the 802.11 access points (APs) that are deployed in any DU building. However, there are some places such as like playground, vehicle that are far away from the building and there are no available network lines (e.g., Ethernet and fiber) to connect the APs to the campus backbone. In these areas without available network lines, we utilize WiMAX to extend wireless access coverage. The network architecture is illustrated in Fig.1. Radio Access Network (RAN) consists of WiMAX subscriber station (SS), base station (BS) and ASN-GW. In RAN, the 802.11 access points (APs) are connected to WiMAX base station through WiMAX SSs through a 10/100 Ethernet link. An SS may connect to more than one APs based on the RAN coverage. The SSs connect to DU campus backbone through a BS and a wireless gateway [4].The BS is deployed on the top of the teacher student center (TSC) building to serve the SSs through 802.16d wireless links. WiMAX base station consists of base station indoor unit, base station outdoor unit, antenna and Linux server [5]. WiMAX Gateway serves as backbone. WiMAX Gateway aggregates subscriber and control traffic from base stations within an access network. It provides subscriber management, network optimization and forwarding subscriber traffic [6]. The wireless gateway authenticates a user by using user name and password through the Authentication Authorization and Accounting (AAA) server and the LDAP server. The user name
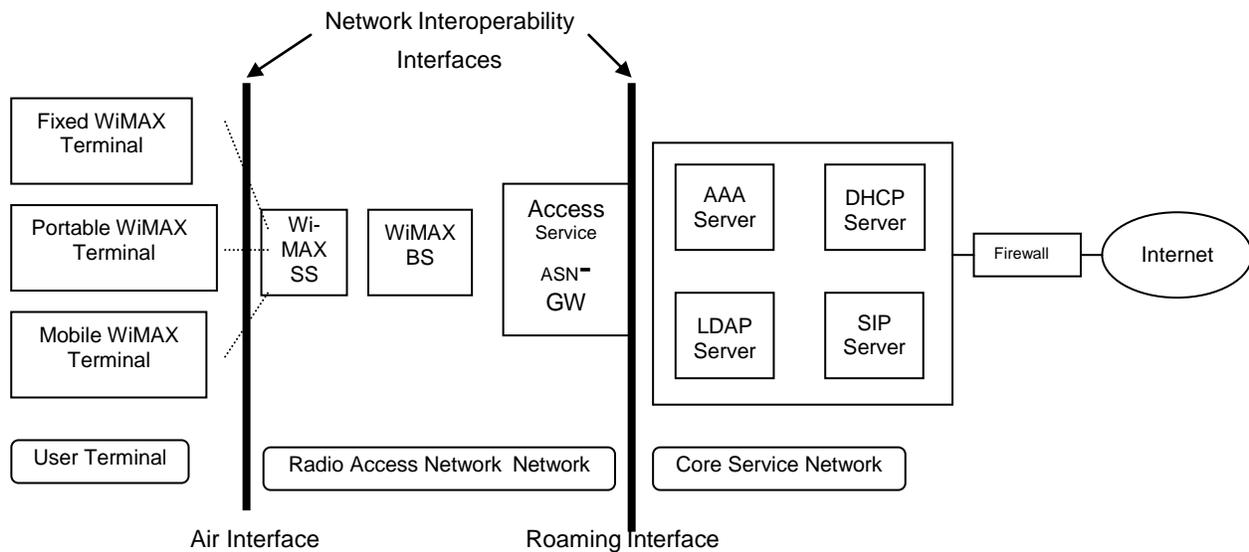
Fig. 1 The Network Architecture of DU WiMAX Deployment

(e.g., mahjabeen@du.edu.bd) consists of the user id (i.e.mahjabeen) and the host name (i.e.du.edu.bd), which identifies the user's home registrar. The AAA server forwards the authentication requests to the LDAP server for NIU users (i.e., the host name is du.edu.bd). Otherwise, the AAA server forwards the requests to the AAA servers based on the host name. After the authentication procedure, the user equipments can obtain an IP address from Dynamic Host Configuration Protocol (DHCP) server. Then the user can access Internet via firewall or SIP applications via the Session Initiation Protocol (SIP) server [4].

4. Steps of WiMAX Campus Installation

Campus connectivity means networks to connect multiple locations, sites and offices with high data capacity, low latency, a large coverage footprint, and high security within their campus. WiMAX is the most effective ways to interconnect campus buildings, as it does not require excavation and external construction [7]. To deploy WiMAX in the campus following steps [5] are maintained:

1.   Coverage Analysis and Site selection for outdoor unit
2.   Utilization of License Spectrum
3.   Identify Indoor equipment Location on campus
4.   Wiring and Installation of Pole
5.   Install base station indoor & outdoor unit
6.   Install AC feeds and DC power supplies
7.   Install antenna at outdoor site
8.   Install Ethernet Switch/Identify Existing Switch
9.   Install Linux Server & Software
10.   Connect Backbone Network

4.1 Coverage Analysis and Site selection for outdoor unit

Coverage analysis mainly consists of fixing terrain type and cell radius determination. It mainly depends on selection of propagation model. For fixed wireless access below 6 GHZ, IEEE propagation model namely extended version of the "HATA" model i.e. COST231 HATA model has been developed for higher frequency. For our calculation, we consider the location as University of Dhaka, Bangladesh. Dhaka is a flat land of intermediate path loss conditions. So it

is under terrain type B. According to the equation for fixed WiMAX and terrain type B, cell radius will be 6.75 km. So one WiMAX cell is enough to cover the campus of University of Dhaka [8].

An outdoor site should be identified on campus that based on the following requirements:

i. Antenna location should be to maximum range

ii. Safely and securely supporting a pole that mounts antenna and Base station outdoor unit

iii. Access to building ground for light Protection using heavy ground cable

iv. Access to indoor equipment room for power and optical fiber cables.

4.2 Utilization of License Spectrum

To deploy the WiMAX cells on Campus as a part of subleasing agreement, utilization of license spectrum is a vital factor. According to Bangladesh government regulatory rule, Bangladesh Telecommunication Commission issued three national licenses of 30 MHz each will be awarded, comprised of two licenses in the 2.3 GHz frequency, and one license in the 2.5 GHz band [9].

4.3 Identify Indoor Equipment Location on campus

An indoor unit should have equipment rack space to mount base station indoor unit and Linus servers. This site should access to outdoor site for power and fiber cables, to building ground, AC feeds and DC power supplies, available Ethernet switching capacity

4.4 Wiring and Installation of Pole

Different types of cable like heavy ground cable, DC power cable, dual optical fiber signal cable must be run at outdoor site and between the outdoor site and the indoor equipment room. The pole should be mounted in a position that optimizes the performance of the antenna of pole.

4.5 Install base station indoor & outdoor unit

Base station indoor unit (IDU) is mounted on the indoor equipment racks whereas the base station outdoor unit (ODU) is mounted outdoors, near the antenna. It connects to the antenna with a coaxial cable and connects to the indoor unit with a dual optical fiber cable.

4.6 Install AC feeds and DC power supplies

AC feeds are used for linux srevers, ethernet switch and DC power supplies and DC power supplies are for base station outdoor unit and base station indoor station unit and connect them to AC feeds.

4.7 Install antenna at outdoor site

For installation of WiMAX for campus networking dual-polarization, omnidirectional antenna is used. Antenna height is limited to 6 m above the roof of the building for aircraft safety. It is mounted so that significant portion of First Fresnel Zone is clear of obstructions. Ideally the antenna is mounted on the elevated structure providing clear line of sight to most of the intended coverage area.

Antenna installation should strictly follow the following issues:

Then Ethernet switch is installed or identified according to capacity. Finally Linux server including ASN-GW and software is used for final deployment configuration and connected to the backbone [5].

5. Design of Campus Network

For designing campus network at first we have to select the design parameters and then implement it accordingly.

A. *Design Parameters*

All the parameters are considered for better performance, from point of practical view, available for these areas and economical concept based on COST231 HATA model [8].

B. *Deployment*

WiMAX can be deployed in three significant ways like:

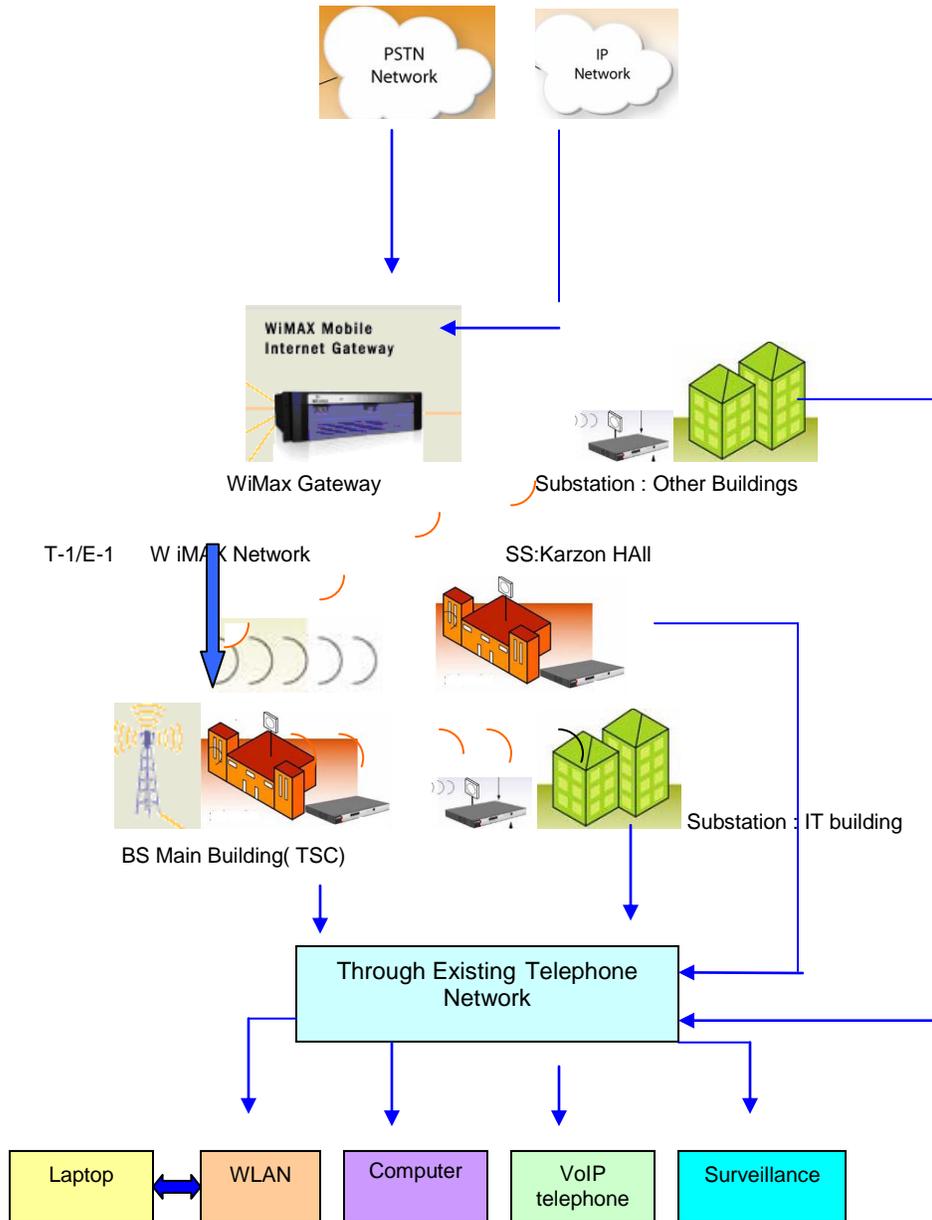i)   For incumbent mobile wireless providers as high speed data overlay for cellular networks

Fig. 2: Proposed Model for WiMAX connectivity in Campus

ii)   For fixed wireless infrastructure providers as a standards-based interoperable network for undeserved areas.

iii.   A central office bypass to avoid using existing wired infrastructure [10,11].

We have chosen the second one, as it is interoperable with the prevailing one. So it will be simple and cheap. As shown in Fig.2, the connectivity starts from WiMAX Gateway. WiMAX Gateway serves as backbone. Next to gateway is WiMAX base station (BS) related by T-1/E-1.

BS consists of WiMAX tower, WiMAX access module/modem, and transceiver. For our real world application, TSC area, the center of University of Dhaka is considered as Base station. WiMAX access Module is connected to one of the port of multiple ports of existing service provider. Simply access network is divided into two segments:

i)   From central office or base station or equivalent to customer premises

ii)   From the premises edge to destination user devices like PCS, laptop, DVRs etc [10].

The base station maintains transmission and reception of information to substations like Carzon Hall, Arts building, other buildings etc. Access modules also exist in substations. Different types of access modules are available in market. Appropriate one should be chosen as per frequency and power requirements like Redmax_an100u BS module. The output of base station can be connected to either Wired IP network or modem through Ethernet to fiber ring. The cross campus connection is shown in Fig.3.

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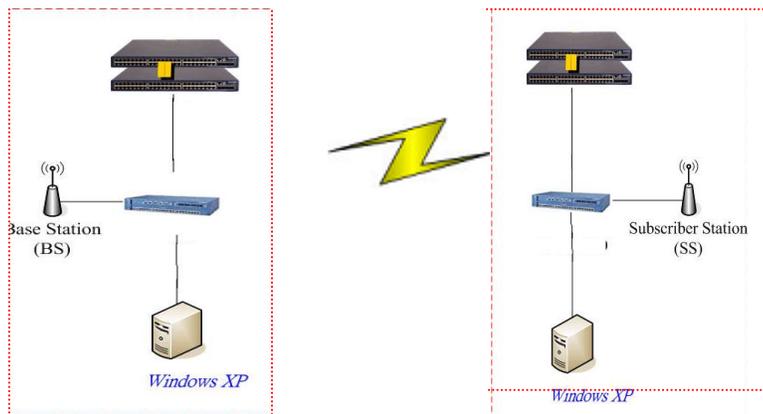

Fig. 3: Cross Campus WiMAX Network

Traditionally, the premises LAN are exclusively wired. LAN cable can be separated by the following ways [10]:

i.   Phone line networking-through existing home phone line networking

ii.   Power line networking – through existing electrical wirings and outlets

iii.   Wireless – through the WiFi 802.11 standard

        In this model, first one is considered because   it already exists and will be cheap.

Conclusion

The design of fixed WiMAX implementation and installation for a particular region is presented. As different ways of WiMAX deployment are available, we consider this one with respect to practical view and financial concept. Modem is used in every substation according to the license spectrum. WiFi mesh networks are driving the demand for WiMAX by increasing the proliferation of wireless access, increasing the need for cost-effective backhaul solutions and faster last-mile performance. WiMAX can be used to aggregate WiFi networks (such as mesh-network topologies and hotspots) and WiFi users to the backend. Each wireless metro-access solution has common and unique benefits. Today, a WiFi mesh-network offers mobility, while WiMAX offers a long-distance backhaul and last-mile solution. The best solution would be a combination of the two.

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