Wireless Communication using WiMAX technology

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Abstract

WiMAX is a wireless digital communications system, also known as IEEE802.16 that is intended for wireless (Metropolitan area networks). WiMAX can provide Broadband Wireless Access (BWA) up to 50km for fixed stations and (5-15km) for mobile stations. In contrast, the Wi-Fi /802.11 wireless local area network standard is limited in most cases to only 100-300 feet (30-100m). With WiMAX, Wi-Fi like data rates are easily supported, but the issue of interference is lessened

The ability to provide these broadband connections wirelessly, without laying wire or cable in the ground, greatly lowers the cost to provide these services. WiMAX may change the economics for any place where the cost of laying or upgrading landlines to broadband capacity is prohibitively expensive, as in emerging countries. WiMAX is a second-generation protocol that allows for more efficient bandwidth use. Interference avoidance, and is intended to allow higher data rates over longer distances. The IEEE 802.16 standard defines the technical features of the communications protocol. The WiMAX forum offers a means of testing manufacturer's equipment for compatibility. The purpose of this paper is to design and configure a wireless networks for all colleges of university of Al-Mustansiriya using WiMAX technology, to get the advantages of this networks by any applications in these colleges with the head quarter of the university.

الخلاصـــــة

ان تقنية نقل المعلومات(WiMAX) والتي تدعى كذلك(IEEE 802.16) تعتبر من احدث التقنيان المستخدمة في نقل المعلومات بطريقة الوايرليس وهي تعتبر من تقنيات الشبكات الواسعة والتي قد تصل تغطيتها الى حدود 50 كم للمحطات الثابتة والى 15 كم في حالة محطات البث المتحركة وقد تم تطويرها بعد ان كانت التقنية القديمة المسماة (WiFi) لا تتعدى حدود التغطية فيها 100 متر, وكذلك ضعف معالجتها لتداخل الاشارات في الجو, وبصورة عامة ان حلول الوايرليس هي قليلة الكلفة بالمقارنة مع الحلول الاخرى لكن في حالة (WiMAX) هناك تقليل بالكلفة الى حد كبير جدا لقدرة هذه التقنية على التغطية الكبيرة وكذلك سرعة نقل المعلومات وسعة وتنوع هذه المعلومات. ان البروتوكل (IEEE 802.16) هو يرمز و يشير الى تقنية (WiMAX) ويحدد التفاصيل الفنية التي تعمل بها هذه التقنية وهذا البروتوكل هو نتاج جهد عدة شركات ومهتمين كان يطلق عليهم اسم منتدى (WiMAX), ان الهدف من هذا البحث هو تصميم وبناء وفحص شبكة وايرليس للجامعة المستنصرية وباستخدام تقنية (WiMAX) لتغطية مركز الجامعة وكذلك مجمعات الكليات التابعة لها بشبكة واحدة يمكن استخدامها في اي تطبق يخدم عمل الجامعة.

1. Introduction

WiMAX, the Worldwide Interoperability for Microwave Access, is a telecommunications technology aimed at providing wireless data over long distances in a variety of ways, from point-to-point links to full mobile cellular type access. It is based on the IEEE 802.16 standard,

WiMAX is an Institute of Electrical and Electronics Engineers (IEEE) standard designated 802.16-2004 (fixed wireless applications) and 802.16e-2005 (mobile wireless)**.**[1]

The name "WiMAX" was created by the WiMAX Forum, which was formed in June 2001 [2] to promote conformance and interoperability of the standard. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL. WiMAX has the potential to replace a number of existing telecommunications infrastructures. In a fixed wireless configuration it can replace the telephone company's copper wire networks, the cable TV's coaxial cable infrastructure while offering Internet Service Provider (ISP) services as in Figure (1). In its mobile variant, WiMAX has the potential to replace cellular networks.

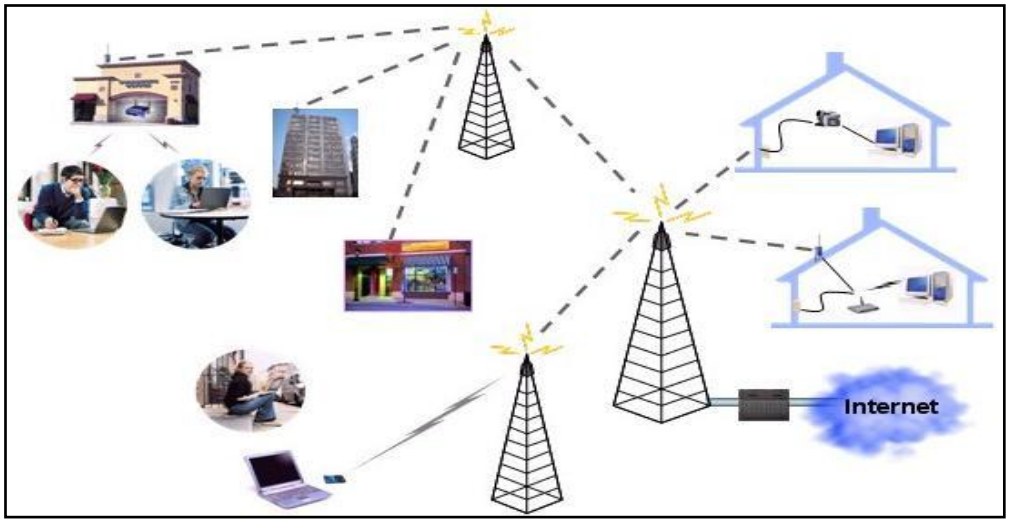


Figure (1) WiMAX network in variant way

2. Standards

The purpose of developing 802.16 standards is to help the industry to provide compatible and interoperable solutions across multiple broadband segments and to facilitate the commercialization of WiMAX products. Currently, WiMAX has two main variations: one is for fixed wireless applications (covered by IEEE 802.16-2004 standard) and another is for mobile wireless services (covered by IEEE 802.16e standard). Both of them are evolved from IEEE 802.16 and IEEE 802.16a, the earlier versions of WMAN standards.

The 802.16 standards only specify the physical (PHY) layer and the media access control (MAC) layer of the air interface while the upper layers are not considered [3]. The first version of 802.16 family standards (published in April 2002). It specifies fixed broadband wireless systems operating in the 10–66 GHz licensed spectrum, which is expensive but there is less interference at the high-frequency band and more bandwidth is available. [3,4]

IEEE 802.16e-2005 is an amendment to IEEE 802.16-2004. Thus, the changes to the PHY layer introduced by IEEE 802.16e-2005[2]:

1. 802.16e operation is limited to licensed bands suitable for mobility below 6 GHz. This may introduce a compatibility problem between 802.16-2004 and 802.16e, since the available licensed spectrum may need to be split between the two technologies.
2. 802.16e defines a new PHY air interface, scalable-OFDMA (SOFDMA), besides those defined by 802.16-2004. S-OFDMA uses FFT size of 128, 512, 1024, or 2048 subcarriers. S-OFDMA uses this number of subcarriers to provide the ability to scale system bandwidth while at the same time the subcarrier separation and symbol duration remain constant as the bandwidth changes. Thus, the BS determines the subcarrier used to adapt to its devices' channel conditions.
3. The AAS, space time code, and closed-loop MIMO modes are enhanced in 802.16e to improve coverage and data transmission rate. Additionally, support for coordinated spatial division multiple access (SDMA).
4. 802.16e includes an additional advanced low complexity coding option method, low-density parity check (LDPC) to provide for more flexible encoding. LDPC codes 6 bits for every 5 data bits with

2.1 WiMAX and IEEE 802.16

The IEEE 802.16 group was formed in 1998 to develop an air-interface standard for wireless broadband. The group's initial focus was the development of a LOS-based point-to-multipoint wireless broadband system for operation in the 10GHz–66GHz millimeter wave band. The resulting standard—the original 802.16 standard, completed in December 2001—was based on a single-carrier physical (PHY) layer with a burst time division multiplexed (TDM) MAC layer. Many of the concepts related to the MAC layer were adapted for wireless from the popular cable modem DOCSIS (data over cable service interface specification) standard.[1]

The IEEE 802.16 group subsequently produced 802.16a, an amendment to the standard, to include NLOS applications in the 2GHz–11GHz band, using an orthogonal frequency division multiplexing (OFDM)-based physical layer.

Additions to the MAC layer, such as support for orthogonal frequency division multiple access (OFDMA), were also included. Further revisions resulted in a new standard in 2004, called IEEE 802.16-2004, which replaced all prior versions and formed the basis for the first WiMAX solution. These early WiMAX solutions based on IEEE 802.16-2004 targeted fixed applications, will refer to these as fixed WiMAX. In December 2005, the IEEE group completed and approved IFEEE 802.16e-2005, an amendment to the IEEE 802.16-2004 standard that added mobility support. The IEEE 802.16e-2005 forms the basis for the WiMAX solution for nomadic and mobile applications and is often referred to as mobile WiMAX[1]. Finally, one of the new task groups (IEEE 802.16f) is working on incorporating mesh networking capabilities into the standard. If it succeeds this could extend the range of networks by allowing each cell in the network to backhaul traffic from other cells, effectively routing around obstacles such as mountains [5].

2.2 WiMAX overlap with other technologies

One of the most interesting elements of WiMAX, and the technologies behind it, is how they overlap with many existing communication networks it terms of coverage and speed. First, WiMAX is seen as a competitor to fixed broadband connections such as digital subscriber lines (DSL), cable modem, and fiber optic technologies. WiMAX equipment will likely be able to provide fixed wireless access comparable to lower-speed DSL connections (e.g. 256 kbit/s) over a wide area. DSL, cable and fiber will be able to provide much faster connections when wired infrastructure is already in place but WiMAX equipment may still be competitive with lower-speed wired connections. The lower per-user speeds of WiMAX equipment will likely rule out WiMAX connections for high-bandwidth consumer applications such as High Definition Television (HDTV) transmission. WiMAX may also encroach on the mobile telephony and data markets that are currently serviced by mobile operators. WiMAX cells may be able to provide faster data connections to users than current 3G networks such as Wideband Code Division Multiple Access (WCDMA) and Code Division Multiple;

Finally, WiMAX will also be partially substitutable for Wi-Fi connections. Wi-Fi can support faster speeds to individual users on the network but users are limited to a typical range of 100 meters. The development of a mobile WiMAX will likely have implications on Wi-Fi hotspot providers. If a city has ubiquitous WiMAX connectivity, Wi-Fi operators may move towards a more specialized role of offering higher-speed data connections in small geographic areas. However, the fixed version of WiMAX will be a good candidate technology for Wi-Fi backhaul.[5]

Due to the ease and low cost with which Wi-Fi can be deployed, it is sometimes used to provide Internet access to third parties within a single room or building available to the provider, often informally, and sometimes as part of a business relationship.

For example, many coffee shops, hotels, and transportation hubs contain Wi-Fi access points providing access to the Internet for customers. Figure (2) show the different between WiMAX and Wi-Fi in a simple way.

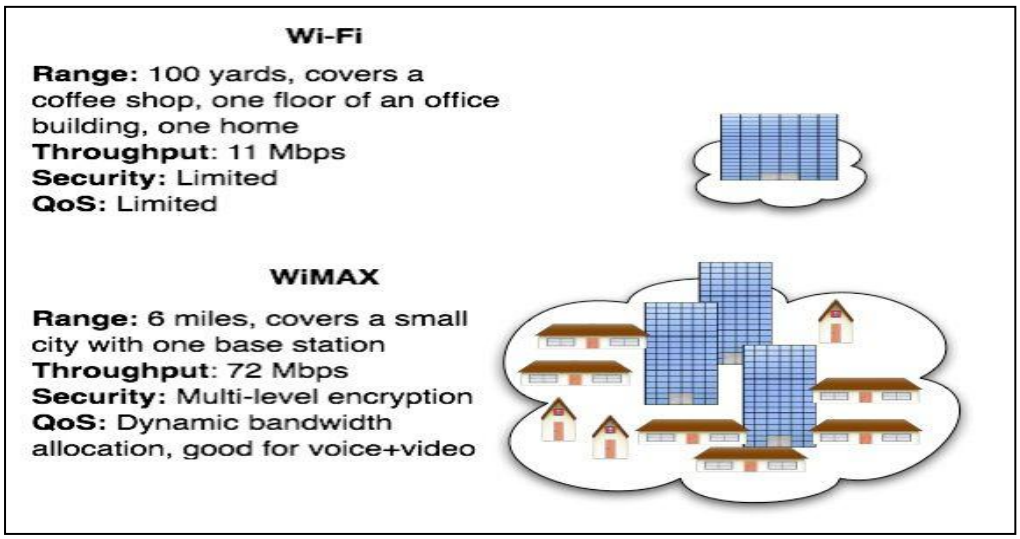


Figure (2) Difference between Wi-Fi and WiMAX

3. Practical design

3.1 Network design Overview:

Wireless communication is a wide technology with many advantages and experience especially in the WiMAX technology for what this project cover, giving this project more important is by making a design that give WiMAX technology more clarify.

The main design set is the aim of WiMAX, is to connect a central base station with a specific substation to make one network for sharing information and other resources so that the entire network could share any information between the central station and the substations (clients); the base station will be far as non less than the required distance to the substation for a good signal received in any circumstance occur like bad environment, signal diffusion, non line of sight state and many other problem.

The main design work will focus on the hardware design and the devices that used for both the base station and substations; performance the configuration for the network connection and testing for guaranty the connection between all stations will be notified.

As mention that the WiMAX design will focus on making one wide network for sharing resources so for this; the main base station must have a public relationship with the connected substations (clients) so a main University and it's related college will be a good choice as important for the benefit of education and the needed of sharing resources; so for this reason, Al-Mustansiriya University as it is a main base station could be an excellent choice and their related college will be the substations.

For the devices that will used many company for the last few years are concentrate their work for improve the wireless communication and make it more flexible and efficiency especially in the WiMAX technology, either in the hardware work or software management. Figure (3) show the design map as the base station and the substations geographically shown.

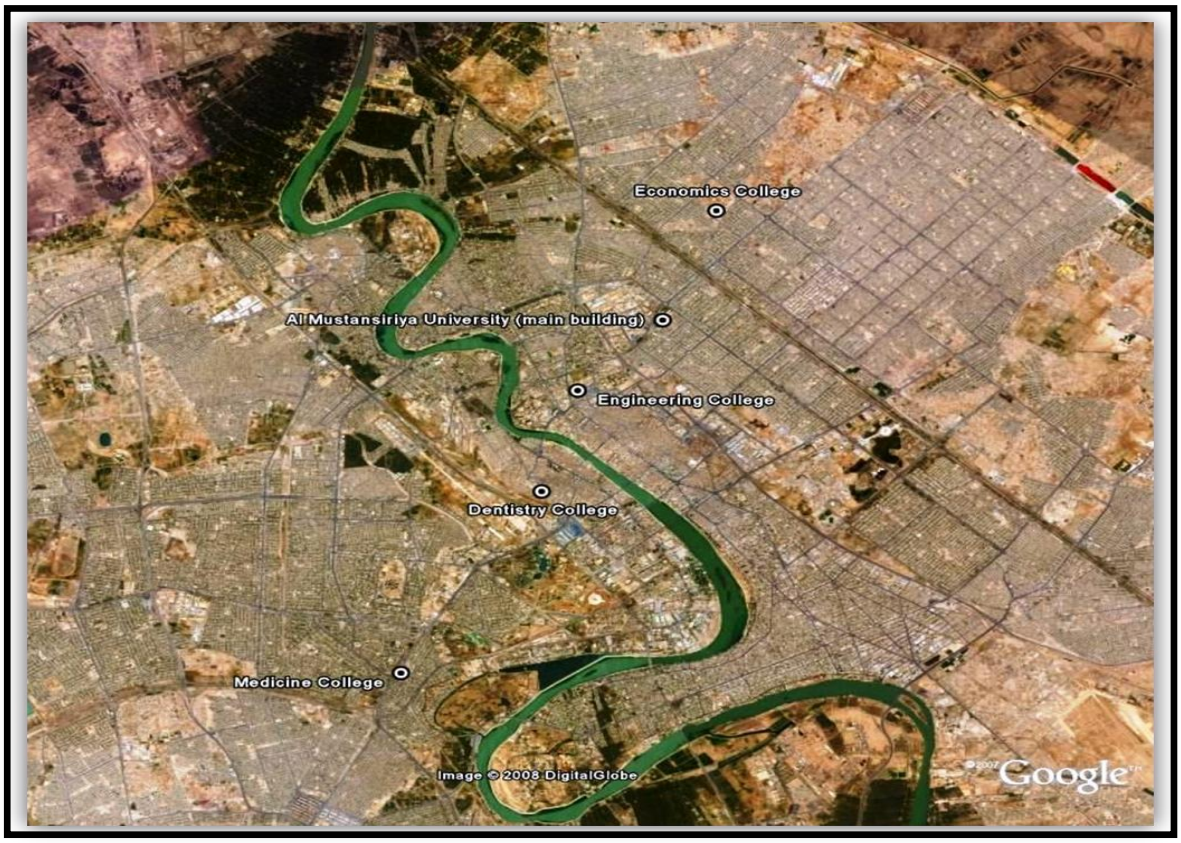


Figure (3): The design map

As see from figure (3), that the base station is not in central and that is not a problem as the WiMAX doesn't required that, as its cover a long distance signal transmission.

3.2 Workstation Characteristics

So before set the devise and other network character it's important to know the distant between the main base station and the substation, and guaranty that the signal range will cover all the colleges (clients).

Al-Mustansiriya University as it the main station the related college as the client is Engineering College, Dentistry College, Economic College, and Medicine College. Table (1) below show the GPS for each station and the distance from the main base station to the each substation.

Table (1): The GPS position and distant for the design work place.

Place	Latitude	Longitude	Distance
Al-Mustansiriya University	33°22'00.08"N	44°24'09.46"E	0.00 Km
Engineering College	33°21'07.99"N	44°23'10.29"E	2.22 Km
Economics College	33°23'21.91"N	44°24'47.38"E	2.71 Km
Dentistry College	33°19'46.21"N	44°22'59.93"E	4.51 Km
Medicine College	33°17'36.22"N	44°21'04.98"E	9.43 Km

From the table above it's clear that the farther distant is of the Medicine College (33°17'36.22"N, 44°21'04.98"E) and that 9.43 Km to the main station Al-Mustansiriya University (33°22'00.08"N, 44°24'09.46"E), and that in the range required to connect the station. [6]

3.3 Devices and Equipments System

3.3.1 WiMAX Equipments

After collecting information for each station location it's important to know the devices and equipment needed for the entire work either in the base station or substations, their manufacture, related product, the specification of each device and what the main design minimum required.

There are many company concerned with WiMAX technology especially communication and wireless company, the main company and as an example are; Adaptix a WiMAX compatible technologies, Agilent a Wireless communications, Alcatel a Fixed and mobile broadband networks, Clearwire a Wireless broadband Internet service, Intel Corporation a networking & communications, Redline Communications a Fixed wireless systems, Walbell a Fixed wireless broadband solutions and many more.

For the working design and from what it obviously that the leading one for a fixed wireless communication as it in the main design is the Redline Communications.

Redline Communications is the leading provider of standards-based wireless broadband solutions. Redline's RedMAX™ WiMAX Forum Certified™ systems and award winning RedCONNEX™ family of broadband wireless infrastructure products enable service providers and other network operators to cost-effectively deliver high-bandwidth services including voice, video and data communications. Redline is committed to maintaining its wireless industry leadership with the continued development of WiMAX and other advanced wireless broadband products.

With more than 35,000 installations in 75 countries, and a global network of over 100 partners, Redline's experience and expertise helps service providers, enterprises and government organizations roll out the services and applications that drive their business forward. [7]

3.3.2 The RedMAX Base Station (AN-100U)

Redline communications offer many solution for WiMAX technology as in the base station its offer RedMAX Base Station (AN-100U) and it's shown in the figure (4) below.

Figure (4) the RedMAX Base Station (AN-100U)

RedMAX Base Station (AU-100U) is Redline's WiMAX Forum Certified™ broadband wireless solution capable of delivering high quality voice, video and data services and applications. Designed to meet WiMAX Forum specifications, the RedMAX AN-100U is completely interoperable with an emerging base of industry wide, WiMAX-compatible equipment.

Easy and economical to deploy, the RedMAX AN-100U facilitates the rapid provisioning of new, high margin and differentiated service offerings. It's very low latency ensures reliable delivery of delay-sensitive services in particular, including circuit switched voice traffic, Voice-Over-Internet Protocol (VoIP), video and prioritized data traffic. New subscribers can be provisioned dynamically while existing customers can have their contract changed 'on-the-fly' without affecting their current service.

Redline's carrier-class, PMP (Point-To-Multipoint) base station provides the ideal, scalable solution for any WiMAX access network. The RedMAX AN-100U can be deployed in clusters of up to six (60 degree) sectors to form high capacity, multi-sector cell deployments while its GPS time synchronization feature facilitates tight frequency reuse to make the most efficient use of available spectrum and channels, reducing interference when operating Time Division Duplexing (TDD) radios in close proximity.

The hardware is fully field upgradeable by software download to accommodate future enhancements including IPv6 support, scalability, additional classifiers, alternative encryption standards, and continued development of the 802.16 standard. Adherence to stringent carrier-class NEBS Level 3 design requirements provide high-reliability for mission critical deployments.

Like all of Redline's 802.16-2004 products, the RedMAX AN-100U base station addresses all of the relevant access frequency bands with ease and flexibility. [7]

3.3.3 The RedMAX Subscriber Unit (SU-O)

As the Redline communications offer a solution for the base station its offer for the substation the RedMAX Subscriber Unit (SU-O) and it's shown in the figure (5) below.

Figure (5): The RedMAX Subscriber Unit (SU-O)

The RedMAX SU-O is Redline's high performance, WiMAX Forum Certified™ outdoor broadband wireless product designed to WiMAX Forum standards. Certification ensures that the RedMAX SU-O seamlessly interoperates with emerging IEEE 802.16-2004-compatible Point-to-Multipoint (PMP) equipment.

The RedMAX SU-O is easy and economical to deploy, allowing service providers to quickly provision new service offerings with bandwidth comparable to or greater than xDSL and cable. This outdoor unit, available with fully integrated flat panel antenna, or optional standalone antenna, includes an audible antenna alignment indicator for quick and simple installation. The indoor Power-over-Ethernet (PoE) adapter provides power for the outdoor unit and the user's Ethernet network access port.

Operating in the several RF bands, Redline's built-in 3rd generation, Orthogonal Frequency Division Multiplexing (OFDM) Non Line Of Sight (NLOS) technology helps overcome typical urban obstacles such as trees and buildings while maintaining high reliability. Rugged design standards and sophisticated techniques, including advanced Forward Error Correction (FEC), combine to deliver wire line equivalent high availability.

The very low latency of Redline's RedMAX SU-O ensures reliable delivery of delay-sensitive services such as video, Voice-Over-IP (VoIP), and prioritized data traffic. The RedMAX SU-O supports VoIP interfaces to deliver toll-quality voice and data traffic with service level agreements and guaranteed QoS.

WiMAX-based compatibility, high performance, and ease of installation all combine to make the RedMAX SU-O the best choice for cost-effectively deploying wireless broadband to business and residential access markets. [8]

3.4 Proposed Design:

The proposed network design have the devices for the base station and substation as shown in Figure (6).

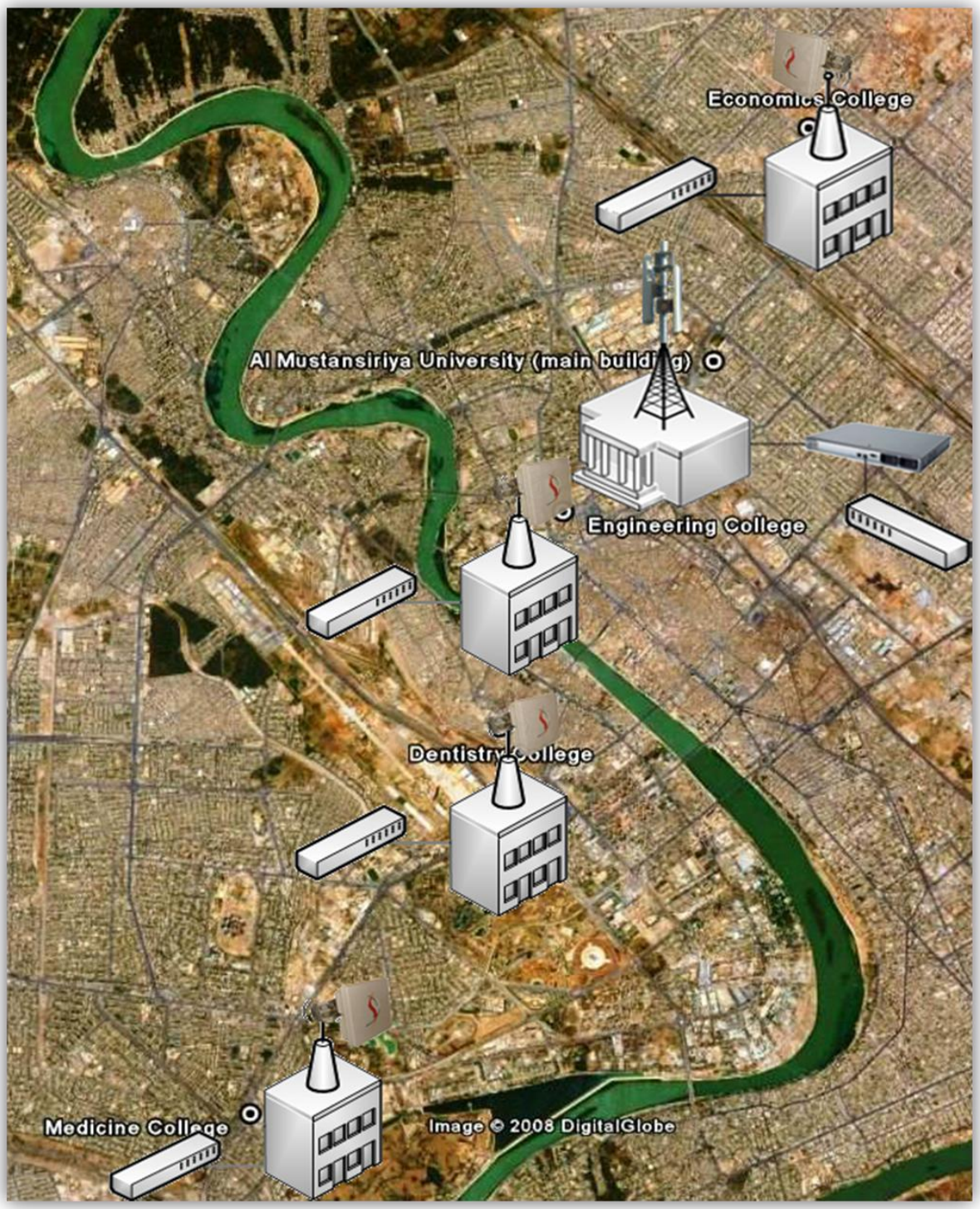


Figure (6) the proposal design as it's shown the location of the stations

It's well-known that for a good signal transmission is to tower up the antenna as high as needed; so at the base station at the main building of the Al-Mustansiriya University a tower with medium high is set up for antenna to set on it.

There are many types of antenna used, WiMAX antennas, just like the antennas for car radio, cell phone, FM radio, or TV, are designed to optimize performance for a given application. Figure (7) below illustrates the three main types of antennas used in WiMAX deployments. From top to bottom is an Omni directional, sector and panel antenna each has a

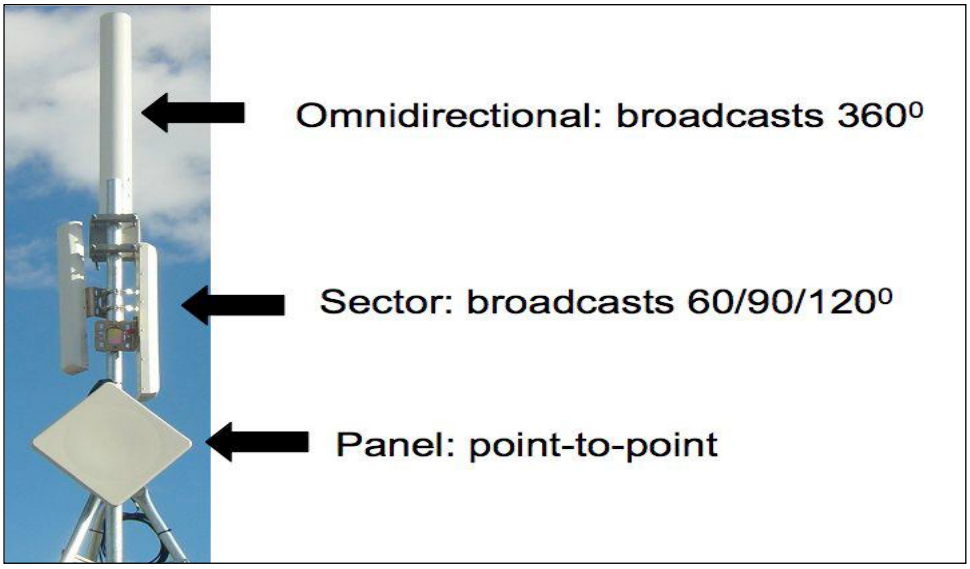


Figure (7): Different antenna types are designed for different applications.

As mention before that the RedMAX AN-100U can be deployed in clusters of up to six (60 degree) sectors, Figure (8) show the sector antenna and illustrate how it work.

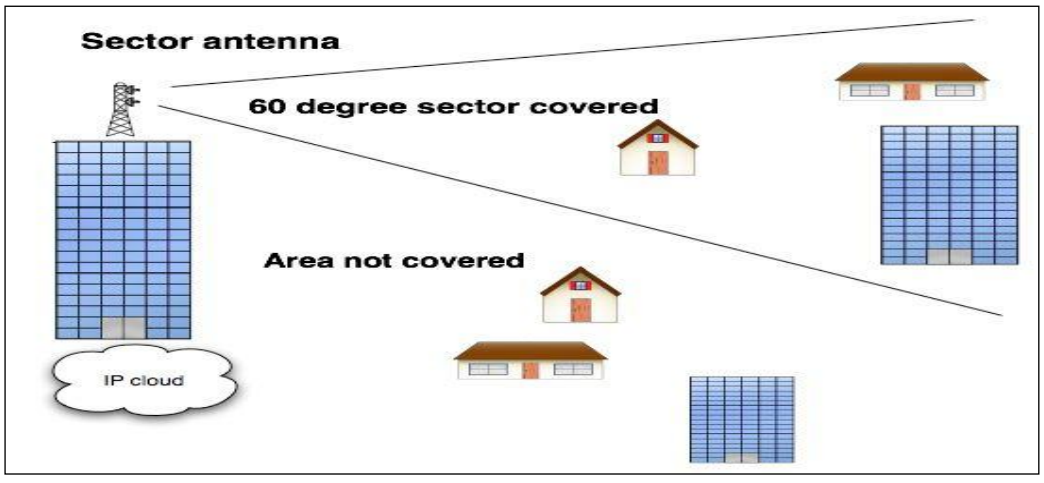


Figure (8): Sector antennas are focused on smaller sectors.

A sector antenna, by focusing the beam in a more focused area, offers greater range and throughput with less energy.

Many operators will use sector antennas to cover a 360- degree service area rather than use an Omni directional antenna due to the superior performance of sector antennas over an Omni directional antenna, so in this design a three-sector antenna is used with 120 degree each. Figure (9) show the three-sector antenna.

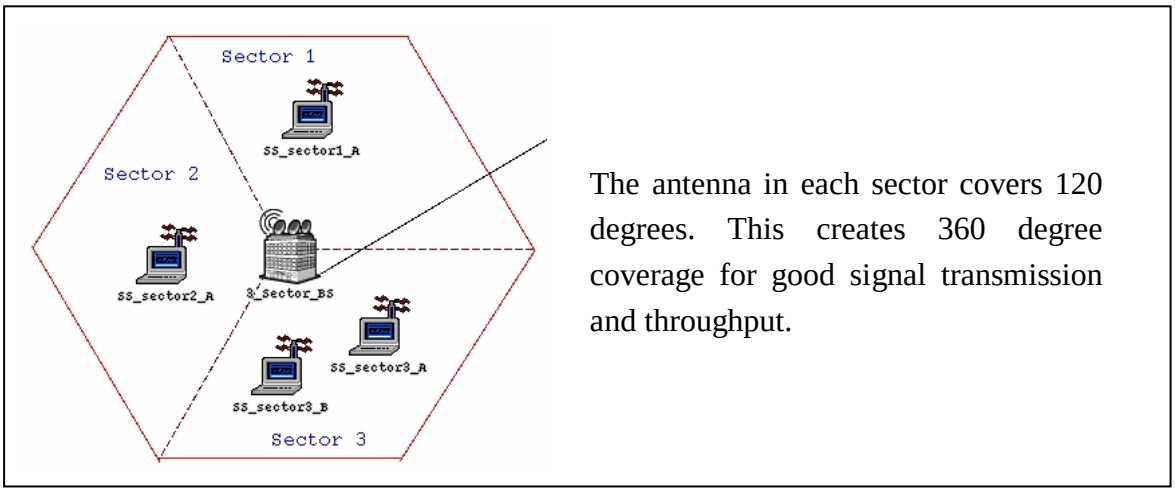


Figure (9): Sector Coverage for Three-Sector Base Stations.

For the Substations it's obviously from the RedMAX Subscriber Unit (SU-O) and mention before that this outdoor unit, available with fully integrated flat panel antenna, or optional standalone antenna, includes an audible antenna alignment indicator for quick and simple installation. The indoor Power-Over-Ethernet (PoE) adapter provides power for the outdoor unit and the user's Ethernet network access port, so it's that simple to just towering it up and start the connection. Figure (10) show as an example of how the Base station and Subscriber Unit setting up and that shown how it's fully integrated with a flat panel antenna.

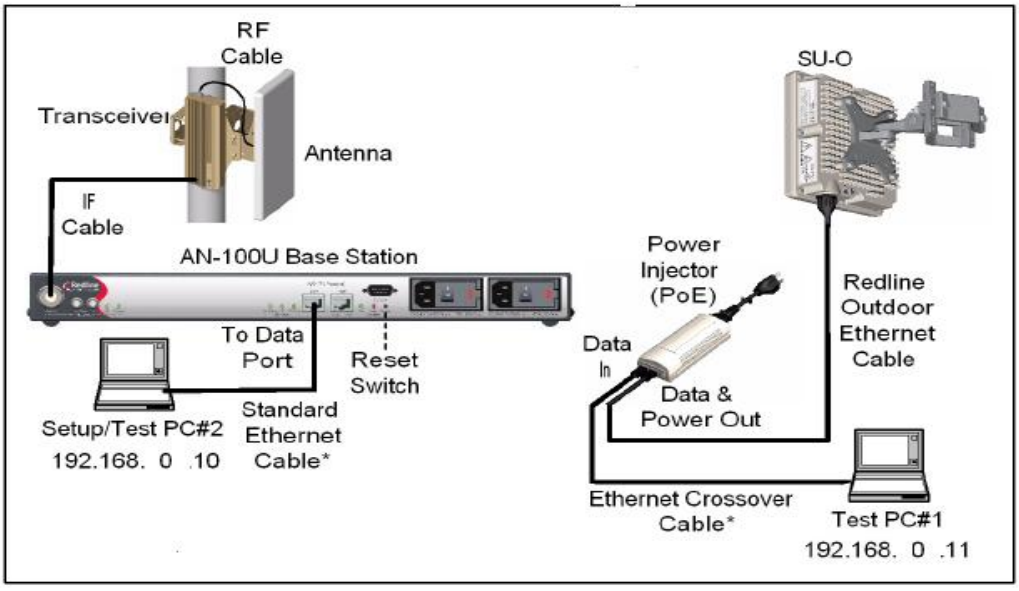


Figure (10): installation of RedMAX equipment

3.5 Initial configuration:

After setting up the antenna a CAT 5 (or better) Ethernet cable is used to linked to the RedMAX AN-100U it doesn't matter whether the cable is straight through or cross over – AN-100U support "Auto-Crossover" features, as it will recognize the polarity of the port of the Ethernet device is connected to and react accordingly, then connected to a laptop for configuration; the RedMAX AN-100U is fully field upgradeable by software download to accommodate future enhancements, so for the signal transmit:

- SSID named "**Al-Mustansiriya University"** is created for a signal name.
- Transmission will be transmit through **channel one**.
- Encryption is necessary for unauthorized connection to the network.
- DHCP is done for IP configuration.

Service Set Identifier (SSID) is the name of a wireless local area network (WLAN). All wireless devices on a WLAN must employ the same SSID in order to communicate with each other.

The SSID on wireless clients can be set either manually, by entering the SSID into the client network settings, or automatically, by leaving the SSID unspecified or blank. A network administrator often uses a public SSID, that is set on the access point and broadcast to all wireless devices in range.

SSIDs are case sensitive text strings. The SSID is a sequence of alphanumeric characters (letters or numbers). SSIDs have a maximum length of 32 characters. "Al-Mustansiriya University" is less than that.

Wireless can broadcast on several different channels, similar to the way radio stations use different channels. Just like you'll sometimes hear interference on one radio station while another is perfectly clear, sometimes one wireless channel is clearer than others. So channel one is a perfect choice for avoiding signal interfacing.

Dynamic Host Configuration Protocol (DHCP) was developed to automate the assignment of IP addresses, subnet masks, gateways, and other IP parameters. It allows for much capability, It saves the administrator the trouble of modifying IP information every time an implementation or upgrade is conducted.

As in the main base station the IP configuration as follow:

IP address: 192.168.0.10

Subnet mask: 255.255.0.0

Default gateway: 192.168.0.1

At the substation base, A laptop is connected to the antenna control unit using a web browser and Ethernet connection, searching for the signal is probably the first thing to do, even though, WiMAX doesn't need line-of sight to work, they have to turn it around to get the maximum signal strength. They said even the reflection of the single would also work. After a signal is found "Al-Mustansiriya University" a connection is provide with a key provided for authorized connection, and in each substation (client); an IP address is configuration for the first client:

IP address: 192.168.0.11

Subnet mask: 255.255.0.0

Default gateway: 192.168.0.1

After connection was made, DHCP will be available from the base station DHCP device because the link will be active between the base station and the client.

3.6 Testing the network:

The test is done by the following instruction:

ipcofig; by checking the IP in each of the base station with itself and the client with their it's self and between the base station and each one of the clients.

After test of the IP address a packet delivery test is done by:

Ping instruction, ping command bounces a small packet off a domain or IP address to test network communications, and then tells how long the packet took to make the round trip. The Ping command is one of the most commonly used utilities on the network by both people and automated programs for conducting the most basic network test: can your computer reach another computer on the network,

The Internet Ping program works much like a sonar echo-location, sending a small packet of information containing an ICMP ECHO_REQUEST to a specified computer, which then sends an ECHO_REPLY packet in return. The IP address of each client is used for testing as for the first client 192.168.0.10 is set by convention to always indicate your own computer. Therefore, a ping to that address will always ping yourself and the delay should be very short. This provides the most basic test of your local communications.

Microsoft Windows contains a built-in ping utility for running ping tests, so to check connectivity by using the ping command, at the command prompt, type ping and the IP address you want to reach. Type ping-n and the IP address to determine the number of echo requests to send. The default is 4 requests.

In simple way try pinging the IP address of the target host to see if it responds, as follows:

Ping the loop back address to verify that TCP/IP is configured correctly on the local computer.

ping IP_address for local PC

Ping the IP address of the local computer to verify that it was added to the network correctly.

pingIP_address_of_local_host

Ping the IP address of the default gateway to verify that the default gateway is functioning and that you can communicate with a local host on the local network.

pingIP_address_of_default_gateway

Ping the IP address of a remote host to verify that you can communicate through a router.

pingIP_address_of_remote_host

After testing the connection and no problem found is clearly that a wide network is accomplishment between the college and the main University, and the network is ready for sharing resources.

4. Practical problems: [9]

For wireless networks, some problems will be appear in implementing such networks the main problems comes from channel like noise, interferences, frequency overlap and military channel effect etc, this networks solve many problems

4.1 NLOS Technology Solutions

WiMAX technology solves or mitigates the problems resulting from NLOS conditions by using:

- OFDM technology.
- Sub-Channelization.
- Directional antennas.
- Transmit and receive diversity.
- Error correction techniques.
- Power control.

4.1.1 OFDM Technology

Orthogonal frequency division multiplexing (OFDM) technology provides operators with an efficient means to overcome the challenges of NLOS propagation. The WiMAX OFDM waveform offers the advantage of being able to operate with the larger delay spread of the NLOS environment. By virtue of the OFDM symbol time and use of a cyclic prefix, the OFDM waveform eliminates the inter-symbol interference (ISI) problems and the complexities of adaptive equalization. Because the OFDM waveform is composed of multiple narrowband orthogonal carriers, selective fading is localized to a subset of carriers that are relatively easy to equalise. An example is shown in Figure (11) as a comparison between an OFDM signal and a single carrier signal, with the information being sent in parallel for OFDM and in series for single carrier.

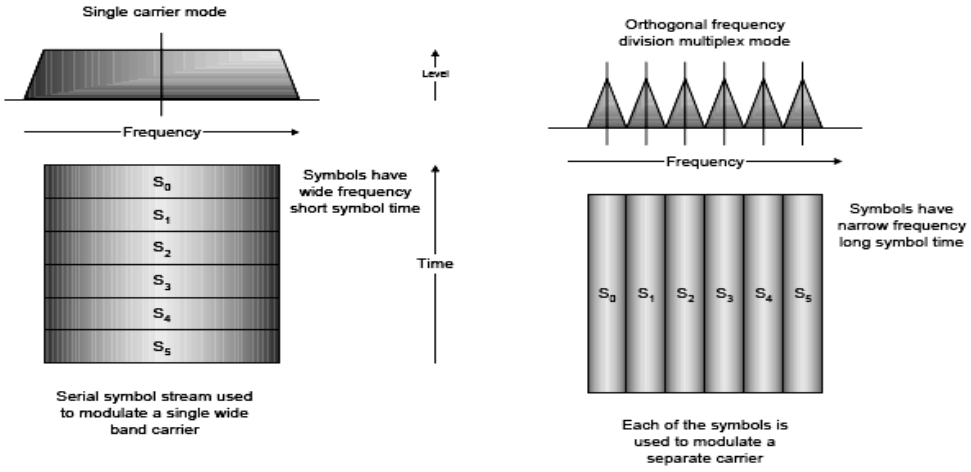
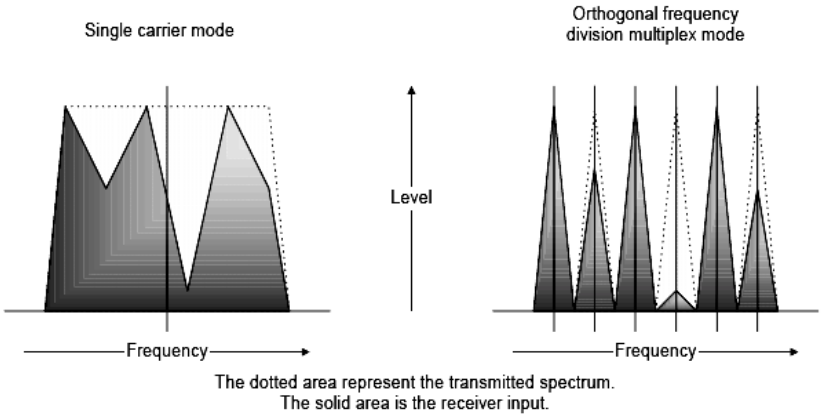


Figure (11): Single carrier and OFDM

The ability to overcome delay spread, multi-path, and ISI in an efficient manner allows for higher data rate throughput. Figure (12) showing an example it is easier to equalize the individual OFDM carriers than it is to equalize the broader single carrier signal.



Figure(12) Single carrier and OFDM received signals

For all of these reasons recent international standards such as those set by IEEE 802.16, have established OFDM as the preferred technology of choice.

4.1.2 Sub Channelization

Sub Channelization in the uplink is an option within WiMAX. Without sub channelization, regulatory restrictions and the need for cost effective Customer Premise Equipment CPEs, typically cause the link budget to be asymmetrical, this causes the system range to be up link limited. Sub channeling enables the link budget to be balanced such that the system gains are similar for both the up and down links.

Sub channeling concentrates the transmit power into fewer OFDM carriers; this is what increases the system gain that can either be used to extend the reach of the system, overcome the building penetration losses, and or reduce the power consumption of the CPE. The use of sub channeling is further expanded in orthogonal frequency division multiple access (OFDMA) to enable a more flexible use of resources that can support nomadic or mobile operation as shown on Figure (13).

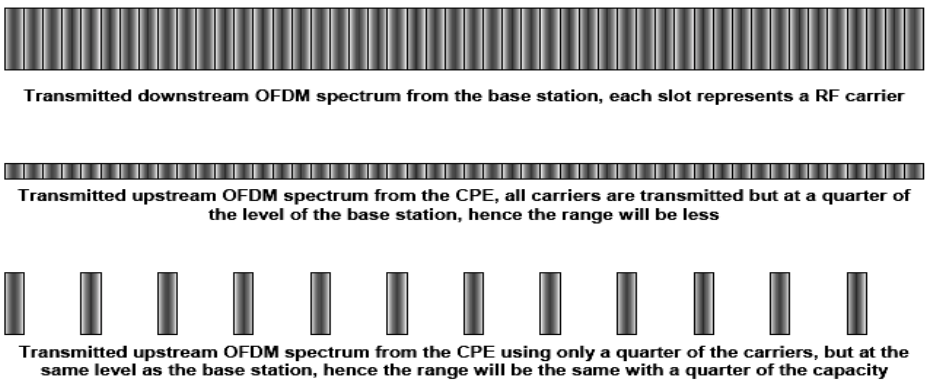


Figure (13) The effect of sub-channelization

4.1.3 Antennas for Fixed Wireless Applications

Directional antennas increase the fade margin by adding more gain. This increases the link availability as shown by K-factor comparisons between directional and omni-directional antennas. Delay spread is further reduced by directional antennas at both the Base Station and CPE. The antenna pattern suppresses any multi-path signals that arrive in the side lobes and back lobes. The effectiveness of these methods has been proven and demonstrated in successful deployments, in which the service operates under significant NLOS fading.

Adaptive antenna systems (AAS) are an optional part of the 802.16 standard. These have beam forming properties that can steer their focus to a particular direction or directions. This means that while transmitting, the signal can be limited to the required direction of the receiver; like a spotlight. Conversely when receiving, the AAS can be made to focus only in the direction from where the desired signal is coming from. They also have the property of suppressing co-channel interference from other locations. AASs are considered to be future developments that could eventually improve the spectrum re-use and capacity of a WiMAX network.

4.1.4 Transmit and Receive Diversity

Diversity schemes are used to take advantage of multi-path and reflections signals that occur in NLOS conditions. Diversity is an optional feature in WiMAX. The diversity algorithms offered by WiMAX in both the transmitter and receiver increase the system availability. The WiMAX transmit diversity option uses space time coding to provide transmit source independence; this reduces the fade margin requirement and combats interference. For receive diversity, various combining techniques are exist to improve the availability of the system. For instance, maximum ratio combining (MRC) takes advantage of two separate receive chains to help overcome fading and

4.1.5 Error Correction Techniques

Error correction techniques have been incorporated into WiMAX to reduce the system signal to noise ratio requirements. Strong Reed Solomon FEC, convolution encoding, and interleaving algorithms are used to detect and correct errors to improve throughput. These robust error correction techniques help to recover errored frames that may have been lost due to frequency selective fading or burst errors. Automatic repeat request (ARQ) is used to correct errors that cannot be corrected by the FEC, by having the errored information resent. This significantly improves the bit error rate (BER) performance for a similar threshold level.

4.1.6 Power Control

Power control algorithms are used to improve the overall performance of the system, it is implemented by the base station sending power control information to each of the CPEs to regulate the transmit power level so that the level received at the base station is at a pre-determined level.

In a dynamical changing fading environment this pre-determined performance level means that the CPE only transmits enough power to meet this requirement. The converse would be that the CPE transmit level is based on worst-case conditions. The power control

4.2 WiMAX Coverage Range

The two likely types of base stations and their capabilities. A standard base station with;

- Basic WiMAX implementation (mandatory capabilities only).
- Standard RF output power for a lower cost base station (vendor specific).

A full featured base station with :

- Higher RF output power than standard base station (vendor specific).
- Tx/Rx diversity combined with space-time coding and MRC reception.
- Sub-channeling.
- ARQ.

Both the standard and full-featured base stations can be WiMAX compliant, however the performance that can be achieved by each is quite different. Table 1 shows the amount of differentiation between the two different types, for a reference system configuration. It is important to understand that there are a number of options within WiMAX that give operators and vendors the ability to build networks that best fit their application and business case. *The uplink maximum throughput in Table 1 assumes that a single subchannel is used to extend the cell edge as far as possible.

Assumptions	Frequency: 3.5 GHz Bandwidth: 3.5 MHz Per 60^0 sector		Full featured		Standard	
			From	To	From	To
Cell radius (km)	LOS		30	50	10	16
	NLOS(Erceg-Flat)		4	9	1	2
	Indoor self-install CPE		1	2	0.3	0.5
Maximum throughput per sector (Mbps)		Downlink	11.3	8	11.3	8
		Uplink	11.3	8	11.3	8
Maximum throughput per CPE at cell edge (Mbps)		Downlink	11.3	2.8	11.3	2.8
		Uplink	0.7	0.175*	11.3	2.8
Maximum number of subscribers			More		Less	

5. Conclusions:

1. WiMAX has the potential to replace a number of existing telecommunications infrastructures.
2. Mobile WiMAX is based upon IEEE Standard 802.16e-2005.
3. Fixed WiMAX is based upon IEEE Standard 802.16-2004.
4. WiMAX coverage limitation is maximum range (50 km), Wi-Fi coverage limitation is a hundred of meters.
5. From the present work the WiMAX could cover a far distance, like a city.
6. Many company of wireless communication is making progress in wireless world the most leading one is Readline communications.
7. Sector antenna offers greater range and throughput with less energy.
8. Many operators will use sector antennas to cover a 360- degree service area rather than use an Omni directional antenna due to the superior performance of sector antennas over an Omni directional antenna.
9. As in the signal transmission channel 1, 6, 11 are the best for what technology that avoiding signals interfacing.
10. For unauthorized used and eavesdropping hacking an encryption must achieved for security.
11. For IP configuration for many clients network; DHCP is make it easy to link between clients.
12. On basis of the result, WiMAX technology can offer many connection solutions for sharing resources.

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