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Astonishing Performance of Indian Women in Sports

KEYWORDS

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ABSTRACT *This paper attempts to present the key technical features and applications of WiMAX, and illustrate them by providing examples of usage scenarios in which WiMAX would be the preferred solution. There are many usage scenarios that can be addressed by WiMAX; however, the limited length of this paper means that we cannot address all of them. The WiMAX agenda is revolutionizing the broadband wireless world, enabling the formation of a global mass-market wireless industry. Putting the WiMAX revolution in the bigger context of the wireless industry, this paper portrays the recent acceleration stage of the Broadband Wireless Access market. Today's operators require a smooth path to mobility; one that provides a future-proof solution, protects their investment and provides a sound business case. OFDM with sub channelization may be just the cost-effective solution they are after for their fixed to basic mobility business model. A solution that drives strong value differences in today's broadband mobility market The introduction of the WiMAX to ensure its success, will do much to encourage the growth of broadband wireless markets everywhere, benefiting everyone in the delivery chain from equipment vendors to carriers to end users*

Over the last 10 years, technology has changed the way the world works, plays,
communicates and shops.. The enormous growth of the Internet and the advances in both wired and wireless network technologies have boosted the emergence of advanced multimedia applications offered over distributed systems consisting of a heterogeneity of network technologies and information servers. On the business side, the market share of e-business is increasing, the telco market is becoming more competitive and the unbundling of the telecommunications world has become reality. In this context, network and service providers experience that it is becoming crucial to be able to offer customers high and predictable end-to-end Quality of Service (QoS) in a cost-effective manner.

A look at the past.
Obviously, the range of new types of tools and appliance available to the average

consumer has changed dramatically over the past 20 years. From microwaves to VCRs,

from DVDs to cordless phones, from CD music to satellite and cable TV. It's hard to remember what it was like to live in a world without these convenient and useful products. Even in poorer countries, these technologies are taken for granted. Take a taxi around a city in the former Eastern European block and you'll see small satellite TV dishes mounted on roof tops and balconies of almost every apartment block you pass. In fact, if you describe to your children how you lived as a child, you probably won't be believed. My teenagers certainly cannot imagine a world without color television, rental movies, microwaves and the not. Amusingly, they assume that their parents lived just like people in the 19th century. That is, they assume that if you didn't have computers and VCRs, you probably didn't have electricity either.

Rather than looking broadly at all technological advances, I'd like to focus the discussion: We want to consider those technologies and inventions that impact how people communicate, work, and learn. For these are the technologies that are available to governments and citizens to improve the communication between them, to improve transactions (of all types) among them, and are used to inform and educate. With this restriction, the major categories of inventions now include: Cell phones, Personal Computer, Networks, Wireless networks, Interactive Television, PDAs etc.

WIRELESS NETWORKS
One of the exciting new developments is the deployment of wireless networks. There are 2 main types of wireless networks today: Cellular and WIFI (also called 802.11a/b).

a. Cellular networks are used primarily for voice coverage along with very limited data capabilities. The main advantage of cellular technology is its long-range capability. In many parts of the world, (notably not including all of the United States), there is pervasive cellular connectivity available. In Europe and Asia in particular, users expect universal access to their cellular network. Users on some of the high-speed trains in Europe and Asia can even use their cell phones while travelling.
b. WIFI is based on existing wired computer network technology (LAN). It provides very high speed but with a much short range of service. It is available in limited locations (commonly called 'hot spots'.) It does not provide voice communication, just Internet access. Additionally, WIFI access requires a specific device or a special add on to other devices (laptop and PC). Today, only a relatively small number of users have appropriate devices. However, the expectation is that this technology will gain very rapid popularity

Both of these technologies have issues today:
1. Cellular. Obviously, great for voice communication. Very wide acceptance worldwide. Today, only very limited (i.e., slow) data capability. All of the major carriers are working on next generation cellular technology that will dramatically increase the data capabilities. They are several years away. (If you hear terms like 2.5G and 3G, this is what they are talking about. 3G refers to third generation cellular, while 2.5G is 'second and a half' generation. Technology guys have a sense of humor too!).

2. WIFI. Excellent for data communication. This issue today is availability and cost. As the availability increases, I expect the costs to drop dramatically. (For example, to use WIFI at Starbucks today costs $0.10 per minute or up to $39.99 per month.) I expect it to eventually reach, less than $9.99 per month for unlimited access)

Think about how you access the Internet today. There are basically three different options:
• **Broadband access -** In your home, you have either a DSL or cable modem. At the office, your company may be using a T1 or a T3 line.

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• **WiFi access -** In your home, you may have set up a WiFi router that lets you surf the Web while you lounge with your laptop. On the road, you can find WiFi hot spots in restaurants, hotels, coffee shops and libraries.

• **Dial-up access -** If you are still using dial-up, chances are that either broadband access is not available, or you think that broadband access is too expensive.

OFDM

Orthogonal frequency-division multiplexing (OFDM), also sometimes called discrete multitone modulation (DMT), is a transmission technique based upon the idea of frequency-division multiplexing (FDM).

OFDM is a multicarrier transmission technique that has been recently recognized as an excellent method for high speed bi-directional wireless data communication. It is based on frequency division multiplexing (FDM).

Why is OFDM so popular for new broadband systems?

- Most broadband systems are subject to multipath transmission
- Conventional solution to multipath is an equalizer in the receiver
- high data rates - equalizers too complicated
- With OFDM there is a simple way of dealing with multipath
- relatively simple DSP algorithms

Comparison to FDM

In FDM, multiple signals are sent out at the same time, but on different frequencies Most people are familiar with FDM from radio and television: normally,each station broadcasts on a particular frequency band (range of frequencies) or channel.

- OFDM takes this concept further: In OFDM, a single transmitter transmits on many different orthogonal (independent) frequencies (typically dozens to thousands). (Because the frequencies are so closely spaced, each one only has room for a Narrowband signal).
- This modulation technique coupled with the use of advanced modulation techniques on each component, results in a signal with high resistance to interference.

3.Applications of OFDM

1. ADSL
2. Digital radio and television
3. DVB-T's implementation of COFDM
4. DRM and Eureka-147's implementation of COFDM
5. Ultra wideband
6. Flash OFDM
7. BST OFDM
8. Hiperla
9. High speed data transmitted along existing telephone lines
10. Wireless technology(wimax)

WIMAX

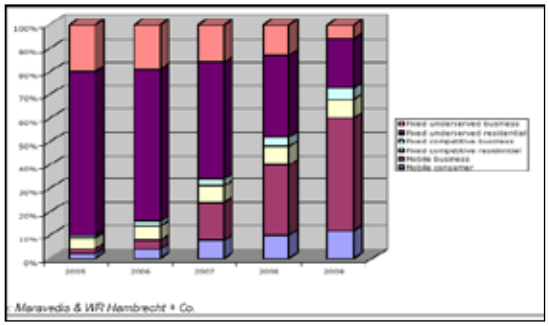
WiMAX, or Worldwide Interoperability of Microwave Access, is a wireless Internet service designed to cover wide geographical areas serving large numbers of users at low cost. WiMAX is a broadband wireless standard that enjoys widespread support from both the computer and telecom industries worldwide, making this technology particularly cost-effective. WiMAX is the synonym given to the IEEE 802.16 standard defining wide area wireless data networking.

WiMAX is the standard being adopted worldwide by manufacturers to insure inter-operability of equipment. WiMAX is considered one of the best solutions for "last mile" distribution. In contrast, wireless local area networks (WiLANs) are designed to provide network access within an office environment or a home once Internet service has been delivered to that point.

It is engineered to deliver significant business benefits to operators and users in diverse environments (enterprise, consumer, emerging, public service), geographies and demographies (urban, suburban, rural), both over the short and long terms.

The two driving forces of modern Internet are broadband, and wireless. The WiMax standard combines the two, delivering high-speed broadband Internet access over a wireless connection. Because it can be used over relatively long distances, it is an effective "last mile" solution for delivering broadband to the home, and for creating wireless "hot spots" in places like airports, college campuses, and small communities.Based on the IEEE 802.16 Air Interface Standard, WiMax delivers a point-to-multipoint architecture, making it an ideal method for carriers to deliver broadband to locations where wired connections would be difficult or costly. It may also provide a useful solution for delivering broadband to rural areas where high-speed lines have not yet become available. A WiMax connection can also be bridged or routed to a standard wired or wireless Local Area Network (LAN). The so-called "last mile" of broadband is the most expensive and most difficult for broadband providers, and WiMax provides an easy solution. Although it is a wireless technology, unlike some other wireless technologies, it doesn't require a direct line of sight between the source and endpoint, and it has a service range of 50 kilometers. It provides a shared data rate of up to 70Mbps, which is enough to service up to a thousand homes with high-speed access.CAN OFDM ENHANCEMENT DRIVE WIMAX MOBILITY FORWARD?

WiMAX covers a wide range of fixed and mobile applications. Analysts predict roughly 20 million subscribers for fixed services by 2009, while mobility figures vary between 15 and 40 million subscribers by the end of the decade. (Figure : 1)



The higher cost of first generation WiMAX products (due to relatively limited production and potential interoperability adjustments) mandates that early WiMAX applications will favor high revenue generating applications, as well as underserved service areas such as backhauls and rural DSL extension.

The 802.16 WiMAX fixed protocol was officially adopted in October of 2004. Since that time, attention has turnedto the development of the 802.16e WiMAX mobility protocol. This standard, which will include Orthogonal Frequency Division Modulation (OFDM) and OFDMA(also referred to as Multi-user OFDM), is expected to be completed in 2006. It will provide two primary areas of opportunity for the industry: basic, or urban mobility, which covers fixed to nomadic and portable applications; and full mobility which addresses the emerging broadband cellular market. For the purpose of this discussion, "fixed" is defined as a solution in which it is not possible to use the service from more than one location. "Mobility" covers different level of services including nomadicity (using a service in different locations), portability (basic mobility without soft handoff) and full mobility (high vehicular speed and seamless handoff between cells).WiMAX basic mobility is the natural evolution of 802.16-2004 (OFDM256). It adds subchannelization to improve indoor performance and subscriber coverage flexibility in terms of throughput versus distance.OFDM256 basic mobility targets simple

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standard profiles and low-cost terminals. Fast time to market and backward compatibility with fixed applications are also retained as key values. By comparison, WiMAX full mobility will follow a much more complex technical and challenging market path that may result in a larger market potential, but in the process puts it directly in the path of 3G. Based on scalable OFDMA (SOFDMA), WiMAX full mobility promises to deliver the performance and operational improvements required for cellular deployment, such as high-speed mobility and hand off, which would allow in-vehicle users to switch from one base station to another seamlessly.

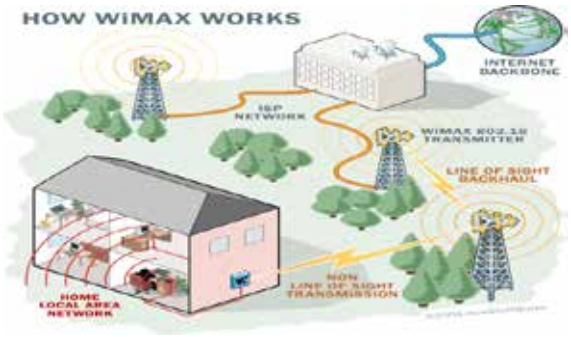
5.How WiMAX Works

In practical terms, WiMAX would operate similar to WiFi but at higher speeds, over greater distances and for a greater number of users. WiMAX could potentially erase the suburban and rural blackout areas that currently have no broadband Internet access because phone and cable companies have not yet run the necessary wires to those remote locations.

A WiMAX system consists of two parts:

- A WiMAX tower, similar in concept to a cell-phone tower - A single WiMAX tower can provide coverage to a very large area -- as big as 3,000 square miles (~8,000 square km).
- A WiMAX receiver - The receiver and antenna could be a small box or PCMCIA card, or they could be built into a laptop the way WiFi access is today.

WiMAX tower station can connect directly to the Internet using a high- bandwidth, wired connection (for example, a T3 line). It can also connect to another WiMAX tower using a line-of-sight, microwave link. This connection to a second tower (often referred to as a backhaul), along with the ability of a single tower to cover up to 3,000 square miles, is what allows WiMAX A to provide coverage to remote rural areas



What this points out is that WiMAX actually can provide two forms of wireless service:

There is the non-line-of-sight, WiFi sort of service, where a small antenna on your computer connects to the tower. In this mode, WiMAX uses a lower frequency range -- 2 GHz to 11 GHz (similar to WiFi). Lower-wavelength transmissions are not as easily disrupted by physical obstructions -- they are better able to diffract, or bend, around obstacles.

- There is line-of-sight service, where a fixed dish antenna points straight at the WiMAX tower from a rooftop or pole. The line-of-sight connection is stronger and more stable, so it's able to send a lot of data with fewer errors. Line-of-sight transmissions use higher frequencies, with ranges reaching a possible 66 GHz. At higher frequencies, there is less interference and lots more bandwidth.

The main problems with broadband access are that it is pretty expensive and it doesn't reach all areas. The main problem with WiFi access is that hot spots are very small, so coverage is sparse. What if there were a new technology that solved all of these problems? This new technology would provide:

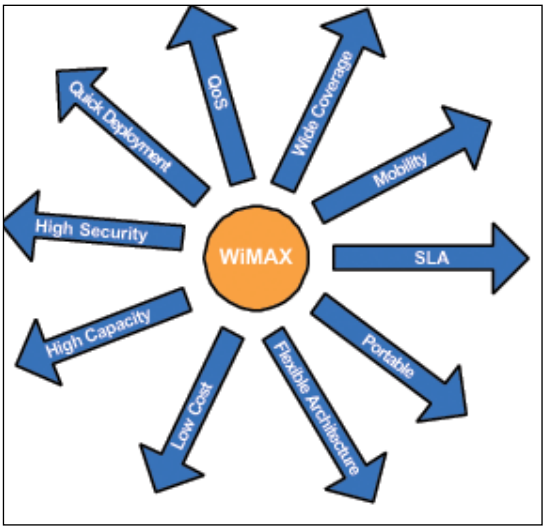
- The high speed of broadband service
- Wireless rather than wired access, so it would be a lot less expensive than cable or DSL and much easier to extend to suburban and rural areas
- Broad coverage like the cell phone network instead of small WiFi hotspots

This system is actually coming into being right now, and it is called WiMAX. WiMAX is short for Worldwide Interoperability for Microwave Access, and it also goes by the IEEE name 802.16.

WiMAX has the potential to do to broadband Internet access what cell phones have done to phone access. In the same way that many people have given up their "land lines" in favor of cell phones, WiMAX could replace cable and DSL services, providing universal Internet access just about anywhere you go. WiMAX will also be as painless as WiFi -- turning your computer on will automatically connect you to the closest available WiMAX antenna.

WiMAX Technology

The WiMAX standard has been developed with many objectives in mind. These are summarized below:



- **Flexible Architecture:**

WiMAX supports several system architectures, including Point-to-Point, Point-to-Multipoint, and ubiquitous coverage. The WiMAX MAC (Media Access Control) supports Point-to-Multipoint and ubiquitous service by scheduling a time slot for each Subscriber Station (SS). If there is only one SS in the network, the WiMAX Base Station (BS) will communicate with the SS on a Point-to-Point basis. A BS in a Point-to-Point configuration may use a narrower beam antenna to cover longer distances.

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- **High Security:**

WiMAX supports AES (Advanced Encryption Standard) and 3DES (Triple DES, where DES is the Data Encryption Standard). By encrypting the links between the BS and the SS, WiMAX provides subscribers with privacy (against eavesdropping) and security across the broadband wireless interface. Security also

provides operators with strong protection against theft of service. WiMAX also has built-in VLAN support, which provides protection for data that is being transmitted by different users on the same BS.

- **WiMAX QoS:**

WiMAX can be dynamically optimized for the mix of traffic that is being carried. Four types of service are supported:

- **Quick Deployment:**

Compared with the deployment of wired solutions, WiMAX requires little or no external plant construction. For example, excavation to support the trenching of cables is not required. Operators that have obtained licenses to use one of the licensed bands, or that plan to use one of the unlicensed bands, do not need to submit further applications to the Government. Once the antenna and equipment

are installed and powered, WiMAX is ready for service. In most cases, deployment of WiMAX can be completed in a matter of hours, compared with months for other solutions.

- **Multi-Level Service:**

The manner in which QoS is delivered is generally based on the Service Level Agreement (SLA) between the service provider and the end-user. Further, one service provider can offer different SLAs to different subscribers, or even to different users on the same SS.

- **Interoperability:**

WiMAX is based on international, vendor-neutral standards, which make it easier for end-users to transport and use their SS at different locations, or with different service providers. Interoperability protects the early investment of an operator since it can select equipment from different equipment vendors, and it will continue to drive the costs of equipment down as a result of mass adoption.

- **Portability:**

As with current cellular systems, once the WiMAX SS is powered up, it identifies itself, determines the characteristics of the link with the BS, as long as the SS is registered in the system database, and then negotiates its transmission characteristics accordingly.

- **Mobility**

The IEEE 802.16e amendment has added key features in support of mobility. Improvements have been made to the OFDM and OFDMA physical layers to support devices and services in a mobile environment. These improvements, which include Scaleable OFDMA, MIMO, and support for idle/sleep mode and hand-off, will allow full mobility at speeds up to 160 km/hr. The WiMAX Forum-supported standard has inherited OFDM's superior NLOS (Non-Line Of Sight) performance and multipath-resistant operation, making it highly suitable for the mobile environment.

- **Cost-effective:**

WiMAX is based on an open, international standard. Mass adoption of the standard, and the use of low-cost, mass-produced chipsets, will drive costs down dramatically, and the resultant competitive pricing will provide considerable

cost savings for service providers and end-users.

- **Wider Coverage:**

WiMAX dynamically supports multiple modulation levels, including BPSK, QPSK, 16-QAM, and 64-QAM. When equipped with a high-power amplifier and operating with a low-level modulation (BPSK or QPSK, for example), WiMAX systems are able to cover a large geographic area when the path between the BS and the SS is unobstructed.

- **Non-Line-of-Sight Operation:**

NLOS usually refers to a radio path with its first Fresnel zone completely blocked. WiMAX is based on OFDM technology, which has the inherent capability of handling NLOS environments. This capability helps WiMAX products deliver broad bandwidth in a NLOS environment, which other wireless product cannot do.

- **High Capacity:**

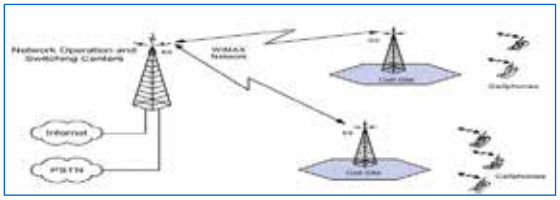
Using higher modulation (64-QAM) and channel bandwidth (currently 7 MHz, with planned evolution towards the full bandwidth specified in the associated IEEE and ETSI standards), WiMAX systems can provide significant bandwidth to end-users.

Uses for WiMAX

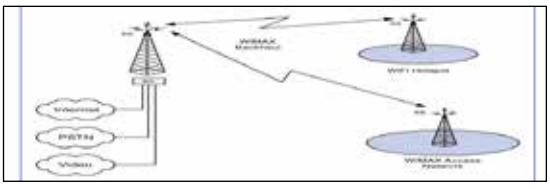
WiMAX is a wireless metropolitan area network (MAN) technology that can connect IEEE 802.11 (Wi-Fi) hotspots with each other and to other parts of the Internet and provide a wireless alternative to cable and DSL for last mile (last km) broadband access. IEEE 802.16 provides up to 50 km (31 miles) of linear service area range and allows connectivity between users without a direct line of sight. Note that this should not be taken to mean that users 50 km (31 miles) away without line of sight will have connectivity. Practical limits from real world tests seem to be around "3 to 5 miles" (5 to 8 kilometers). The technology has been claimed to provide shared data rates up to 70 Mbit/s, which, according to WiMAX proponents, is enough bandwidth to simultaneously support more than 60 businesses with T1-type connectivity and well over a thousand homes at 1Mbit/s DSL-level connectivity. Real world tests, however, show practical maximum data rates between 500kbit/s and 2 Mbit/s, depending on conditions at a given site.

WiMAX technology will revolutionize the way we communicate. It will provide total freedom to people who are highly mobile, allowing them to stay connected with voice, data and video services. WiMAX will allow people to go from their homes to their cars, and then travel to their offices or anywhere in the world, all seamlessly. To illustrate the ability of WiMAX to address the applications outlined in the preceding section, several representative usage scenarios, grouped into two broad categories – private and public networks – are outlined in the following sections.

Cellular Backhaul:-



Wireless Service Provider Backhaul:-



Campus Connectivity
Theme Parks
Banking Networks
Education Networks
Public Safety
Public Networks:-

In public network, resources are accessed and shared by different users, including both businesses and private individu-

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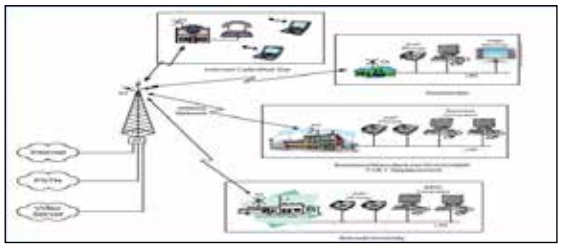
als. Public networks generally require a cost-effective means of providing ubiquitous coverage, since the location of the users is neither predictable nor fixed. The main applications of public networks are voice and data communication, although video communication is becoming increasingly popular. Security is a critical requirement, since many users share the network. Built-in VLAN support and data encryption address these concerns. Several usage scenarios involving public networks are shown below.

Wireless Service Provider Access Network:-

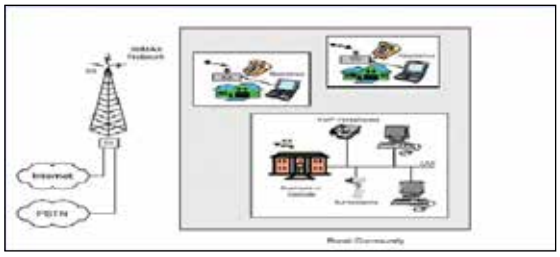


Wireless Service Providers (WSPs) use WiMAX networks to provide connectivity to both residential (voice, data and video) and business (primarily voice and Internet) customers, illustrated as follow:

The WSP could be a CLEC (Competitive Local Exchange Carriers) that is starting its business with little or no installed infrastructure. Since WiMAX is easy to deploy, the CLEC can quickly install its network and be in position to compete with the ILEC (Incumbent Local Exchange Carrier). The WiMAX built-in QoS mechanism is highly suited for the mix of traffic carried by the CLEC. The Quos MAC also offers multi-level service to address the variety of customer service needs. A common network platform, offering voice, data and video, is highly attractive to end customers, because it presents a one-stop shop and a single monthly bill. Support for multiple service types allows different revenue streams, yet it reduces customer acquisition cost, and increases ARPU (Average Revenue per User). The WSP needs only one billing system and one customer database. Cellular operators may also be interested in applying WiMAX in their networks. These operators already have towers, billing infrastructure and a customer base in place, but the deployment of a WiMAX solution will expand their market presence in their service area. All of the wired solutions, including fiber, DSL, and cable, require substantial up-front costs for implementing the wired infrastructure. In particular, wired solutions are not suited for markets in developing countries, where there is very little infrastructure, or in the less-populated areas of developed countries, such as rural areas, small towns or the suburban edges of major centers.

Rural Connectivity:-

Service providers use WiMAX networks to deliver service to underserved markets in rural areas and the suburban outskirts of cities, as shown below:



The delivery of rural connectivity is critical in many developing countries and

underserved areas of developed countries, where little or no infrastructure is available. Rural connectivity delivers much-needed voice telephony and Internet service. Since the WiMAX solution provides extended coverage, it is a much more cost-effective solution than wired technology in areas with lower population densities. WiMAX solutions can be deployed quickly, providing communication links to these underserved areas, providing a more secure environment, and helping to improve their local economies.

ADVANTAGES AND DISADVANTAGES

WHAT ARE THE ADVANTAGES?

- A single WiMAX main station can serve hundreds of users.
- Endpoints install within days instead of the weeks required for wired connections.
- Data rates as high as 280Mbps and distances of 30 miles are possible.
- Users can operate mobile within 3-5 miles of a base station at data rates up to 75Mbps.
- No FCC radio licensing is required.

WHAT ARE THE DISADVANTAGES?

- Line-of-sight (LOS) is required for long distance (5-30 mile) connections
- Heavy rains can disrupt the service.
- Other wireless electronics in the vicinity can interfere with the WiMAX connection and cause a reduction in data throughput or even a total disconnect.

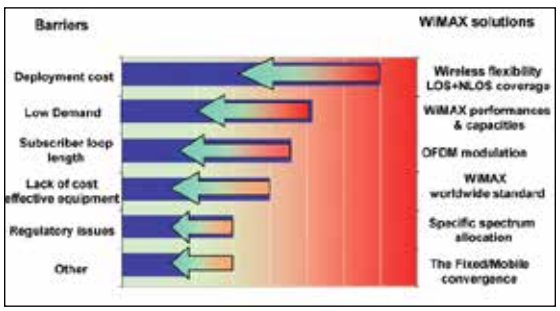
On the WiLAN side, security has been a major concern, though this has been addressed through developments in encryption technology and authentication systems. A typical access point covers an area 300 feet in diameter, but this distance can be impacted by structures within the building such as walls, furnishings etc.

WHAT ARE THE COSTS?

Adding users to a WiMAX system is less expensive than DSL or coaxial cable once a threshold level of users is reached. The cost of a base station can vary widely from $10,000 to over $100,000. A typical end point will cost $300-$500.

Conclusions

As shown in the preceding sections, WiMAX technology and products are poised to address a wide range of applications and usage scenarios, over a broad range of markets and geographies. The above usage scenarios should be considered representative, not comprehensive.



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