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OVERVIEW OF WiMAX TECHNOLOGY

Broad Band Access to the Last Mile

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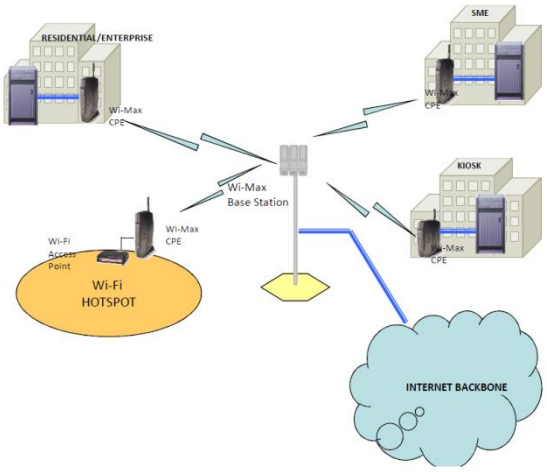
Abstract

WiMAX is a wireless communications standard designed to provide 30 to 40 megabit-per-sec data rates, with the 2011 update providing up to 1 Gbit/s for fixed stations. WiMAX can provide at-home or mobile internet access across whole cities or countries. In many cases this has resulted in competition in markets which typically only had access through an existing incumbent DSL (or similar) operator. Additionally, given the relatively low costs associated with the deployment of a WiMAX network (in comparison with 3G, HSDPA, Xdsl, HFC or FTTx), it is now economically viable to provide last-mile broadband Internet access in remote locations. Mobile WiMAX was a replacement candidate for a cellular phone technologies such as GSM,CDMA, or can be used as an overlay to increase capacity. Fixed WiMAX is also considered as a wireless backhaul technology for 2G,3G and 4G networks in both developed and developing countries. In this paper we will discuss about the features, working and technology aspects of WiMAX.

Keywords: ***CPE (Customer Premises Equipment) DSL (Digital Subscriber Line), Multiple-Input Multiple-Output.(MIMO),OFDMA(Orthogonal Frequency Division MultipleAccess)***

1. Introduction:

WiMAX (Worldwide Interoperability for microwave Access) technology is one of the hottest topic in wireless, based on the IEEE 802.16-2004 Air Interface Standard, is rapidly proving itself as a technology that will play a key role in the fixed broadband wireless metropolitan area networks, which is designed to provide 30 to 40 mbps data rates. The Institute of Electrical and Electronics Engineers (IEEE) 802 committee, which sets networking standards such as Ethernet (802.3) and Wi-Fi (802.11), has published a set of standards that define WiMAX. The name "WIMAX" was created by the **WiMAX Forum** which was formed in June 2001 is an industry body formed to perform interoperability of the IEEE 802.16 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". In December, 2005 the IEEE introduced the 802.16e which adds the features and attributes to the standard necessary to support mobility The WiMAX forum is now defining system performance and certification profiles based on the IEEE 802.16e Mobile Amendment and going beyond the air interface, the WiMAX Forum is defining the network architecture necessary for implementing an end-to-end Mobile WiMAX network.



Mobile WiMAX is a broadband wireless solution that enables convergence of mobile and fixed broadband radio access technology and flexible

network architecture. The Mobile WiMAX Air Interface adopts orthogonal frequency Division Multiple access (OFDMA) for improved multi-path performance in non-line-of-sight environments. Scalable OFDMA (SOFDMA) is introduced in the IEEE 802.16e support scalable channel bandwidths from 1.25 to 20 MHz The Mobile WiMAX System Profile enables mobile systems to be configured based on a common base feature set thus ensuring baseline functionality for terminals and base stations that are fully interoperable. Some elements of the base station profiles are specified as optional to provide additional flexibility for deployment based on specific deployment scenarios that may require different configurations that are either capacity-optimized or coverage optimized. Mobile WiMAX covers 5, 7, 8.75 and 10 MHz channel bandwidths for licensed worldwide spectrum allocations in the 2.3GHz, 2.5GHz, 3.3 GHz and 3.5GHz frequency bands.

2. Features of WiMAX technology

Some of the silent features supported by Mobile WiMAX are

i. ***High Data Rates***: The inclusion of MIMO antenna Techniques along with flexible sub-channelization schemes, advanced coding and modulation all enable the mobile WiMAX technology to support peak D/L data rates up to 63 Mbps per sector and peak U/L data rates up to 28 Mbps per sector in 10MHz channel.

ii. ***Quality of service (QoS)***: The fundamental premise of the IEEE 802.16 MAC architecture is QoS. It defines Service Flows which can map to Different Service code points or MPLS flow labels that enable end-to-end IP based QoS. Additionally, sub-channelization and MAP-based signaling schemes provide a flexible mechanism for optional scheduling of space, frequency and time recourse over the air interface on a frame-by-frame basis.

iii. ***Scalability***: Despite an increasingly globalized economy, spectrum resources for wireless broadband worldwide are still quite desperate in its allocations. Mobile WiMAX technology therefore, is designed to be able to scale to work in different channelization from 1.25MHz to 20MHz to comply with varied worldwide requirements as efforts proceed to achieve spectrum harmonization in the longer term. This also allows diverse economies to realize the multi-faceted benefits of the Mobile WiMAX technology for their specific geographic needs such as providing affordable internet access in rural settings versus enhancing the capacity of mobile broadband access in metro and suburban areas.

iv. ***Security***: The features provided for Mobile WiMAX security aspects are best in class with EAP-based authentication, AES-CCM-based authenticated encryption, and CMAC and HMAC based control message protection schemes. Support for a diverse det of users credentials exists including SIM/USIM cards, Smart Cards, Digital Certificates, and Username/Password schemes based on the relevant EAP methods for the credential type.

v. ***Mobility***: Mobile WiMAX supports optimized handover schemes with latencies less than 50 milliseconds to ensure real-time application such as VoIP perform without service degradation. Flexible key management schemes assure that security is maintained during handover.

3. Working of WiMAX

Now the next question arises is how WiMAX works..?? WiMAX is a telecommunication and mobile technology used for broadcasting of wireless data by use of a number of transmission methods. The working method of WiMAX is little different from Wi-Fi network because Wi-Fi computer can be connected via LAN card, router, or hotspot. While the connectivity of WiMAX network constitutes of two parts in which one is WiMAX Tower or booster also known as WiMAX base station and second is WiMAX receiver or WiMAX Customer Premises Equipment (WiMAX CPE).

The WiMAX network is just like a cell phone. When a user send data from a subscriber device to a base station then that base station broadcast the wireless signal into channel which is called uplink

and base station transmit the same or another user is called downlink. The base station of WiMAX has higher broadcasting power, antennas and enhanced additional algorithms.

WiMAX technology providers build a network with the help of towers that enable communication access over many miles. The broadband service of WiMAX technology is available in coverage areas. The coverage areas of WiMAX technology separated in series of over lied areas called channel.

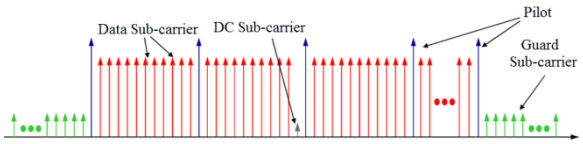
When a user sends data from one location to another the wireless connection is transferred from one cell to another cell. When signal transmit from user to WiMAX base station or base to user, the wireless channel faces many attenuation such as fraction, reflection, refraction, wall obstruction etc. These all attenuation may cause of distorted and split toward multipath. The target of WiMAX receiver is to rebuild the transmitted data perfectly to make possible reliable data transmission

4. Technology Aspects of WiMAX

The two main technology aspects which make WiMAX to provide larger band width through longer distance are OFDMA (Orthogonal Frequency Division Multiple Access) and MIMO (Multiple Output Multiple Output)

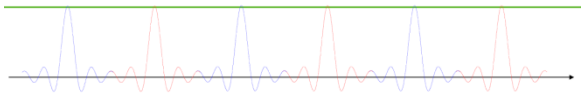
4.1OFDMA (Orthogonal Frequency Division Multiple Access)

Orthogonal Frequency Division Multiple Access utilizes a form of FDMA, TDMA, CDMA all together with the advantages of Orthogonal Frequency division Modulation (OFDM). In a classical parallel data system, total frequency band is divided into n non-overlapping frequency sub carriers. Each subcarrier is modulated with a separate symbol and then the N subcarriers are frequency-division-multiplexed (FDM). To provide a better interchannel interference, spectral overlap is not recommended to avoid high-speed equalization and to combat impulsive noise and multipath distortion. However, this leads to inefficient use of the available spectrum. To cope with this inefficiency, the ideas proposed from mid60s were to use parallel data FDM with overlapping sub channels as can be seen in figure. Overlapping technique would give 50% more subcarriers but reduce the different modulation carrier.

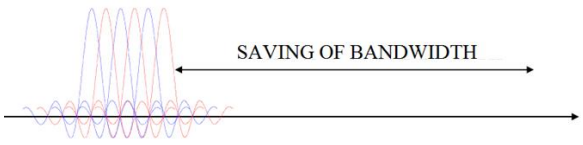


OFDM modulation creates a direct mathematical relationship between the frequencies of the carrier in the system so that the sidebands of individual carriers overlap and the signal is still received without adjacent carrier interference. Moreover, single high-rate bit stream is converted to low-rate *N* parallel bit streams where each can be modulated differently as seen in figure

The receiver in OFDM system acts as a bank of demodulators, translating each subcarrier down to DC, with the resulting signal integrated over a symbol period (T). If the carrier spacing is a multiple of 1/T then other subcarriers in time demine have cycles are linearly independent. Orthogonal frequency carriers are created by Discrete Fourier Transform (DFT). Figure shows the spectrum of the OFDM symbols and note that center frequency of each subcarrier shows no crosstalk from other channels. Using the DFT in the receiver and calculating the correlation values with the center frequency of each subcarrier can result in recover of the transmitted data. DFT-based technique achieves frequency division multiplexing by baseband processing not with band pass filtering as common for FDMA and others.



Ordinary FDMA



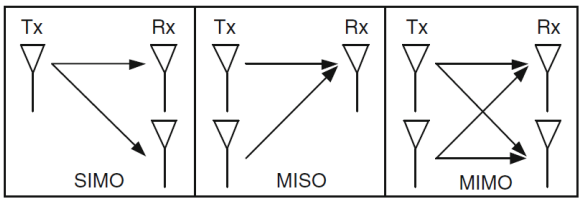
OFDMA

4.2 Multiple-Input Multiple-Output.(MIMO)

We know that higher data rates at better quality of service is challenged by scarce usable radio resource and time-varying radio environment affected by fading and multipath.

Utilizing multiple antennas at receiver and transmitter is widely touted as key technique that markedly improves the data rate on longer range without consuming extra bandwidth or transmitting power. This technology is also referred as Multiple-Input Multiple-Output.(MIMO) communication, which is now a well-mature technology.

Spatial diversity utilizes multiple antennas are transmitter and receiver with various configurations as illustrated in figure. Antennas are spatially separated with a fixed distance of separation depends on carries frequency and scattering environment.



Let us first consider a transmit antenna and two or more receive antennas; one can create two or more paths and combine the signals in receiver. This exploits receiver diversity and the scheme is now as single-input multiple-output.(SIMO) system. SIMO architecture collects more energy at receiver to improve the SNR as compared with SISO system

Now, consider two or more transmit antennas and one receiver antenna. One can create two or more paths easily is a fading environment. This is called transmit diversity and is known as multi-input-single-output (MISO) system. MISO achieves the same diversity gain as SIMO; nevertheless MISO can implement a different type of coding called space-time coding. Space-time transmitter encodes and modulates the information bits in space and time.

MIMO exploits multiple antennas at transmitter and receiver and inherits the benefits of SIMO and MIMO systems and introduces more. MIMO basically uses the degree of freedom of the channel to achieve greater performance as compared with SIMO and MISO. Also, MIMO opens up multiple independent data paths over a link. Space-time transmitter sends the signal, space receiver processes the signal received on each of the receiver antennas according to space-time transmitter's signaling strategy.

5. Conclusion

In this article we presented an overview of mobile WiMAX, a much-heralded technology for next-generation mobile broadband networks; WiMAX is an intricate system. We gave introduction to WiMAx technology, its features, working and the main technology aspects of WiMAX i.e. OFDMA and MIMO.

WiMAX's all-IP architecture lends itself well to high bandwidth multi-media applications, and with QoS which also support mobile voice and messaging service, re-using the mobile networks IP core systems. WiMAX appears to have what it needs for high speed wireless broadband.

6. REFERENCES

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