CHAPTER-8

Modulation of WiMAX

8.1 WiMAX Value Networks

A value network encompasses a series of industry participants into a vast series of symbiotic relationships. Telecommunications companies can be described as being "monolithic" in that they control every aspect of the service from the device in the customer's home or office, the means of access (copper, coaxial, or wireless) and all switching and application platforms.

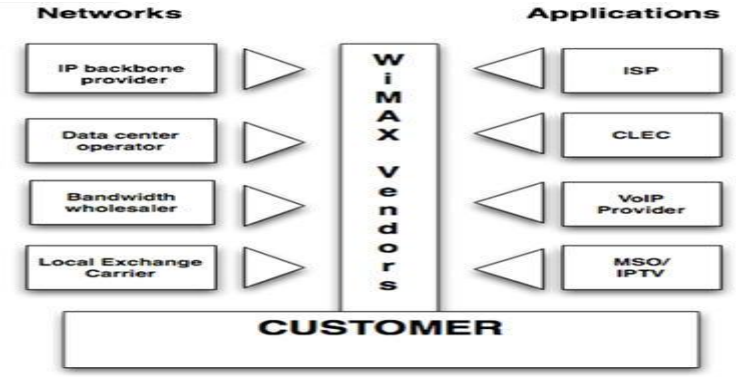

Figure :8.1 WiMAX creates a new value network in telecommunications

WiMAX is simply a means of access for customers. After access, the "internet model" kicks in where any variety of services (VoIP, IPTV, gaming, etc; remember, they are just applications) can be offered to the subscriber. In addition the WiMAX service requires access to IP backbones, which further expands the value network beyond a single monolithic service provider such as the traditional telephone company. The figure above illustrates the new telecommunications value network.

8.2 WiMAX - OFDM Basics

OFDM belongs to a family of transmission schemes called multicarrier modulation, which is based on the idea of dividing a given high-bit-rate data stream into several parallel lower bit-rate streams and modulating each stream on separate carriers. often called subcarriers, or tones.Therefore, in high-data-rate systems in which the symbol duration is small, being inversely proportional to the data rate, splitting the data stream into many parallel streams increases the symbol duration of each stream such that the delay spread is only a small fraction of the symbol duration.

OFDM is a spectrally efficient version of multicarrier modulation, where the subcarriers are selected such that they are all orthogonal to one another over the symbol duration, thereby avoiding the need to have nonoverlapping subcarrier channels to eliminate intercarrier interference.

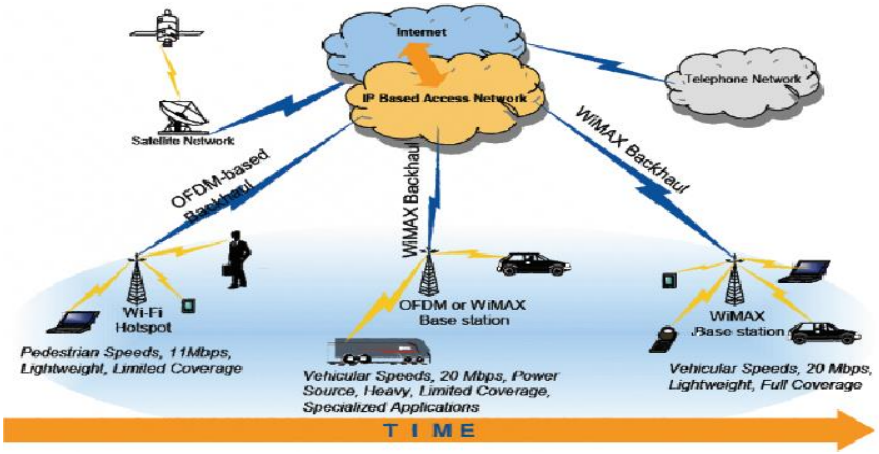

Fig:* 8.2 *Coverage to WiMAX area

8.3 Orthogonal Frequency Division Multiplexing (OFDM)

WiMAX uses Orthogonal Frequency Division Multiplexing (OFDM) to transmit information between a base station and multiple subscriber stations. OFDM offers a number of advantages that make it suitable for WiMAX deployment. OFDM is an extension of Frequency Division Multiplexing (FDM). FDM is a well understood technique and has been employed for decades to combine multiple signals onto a single medium. FDM works by separating frequencies, referred to as subcarriers, over a common transmission medium with guard bands between each frequency. The guard band ensures that signals do not overlap and that they can be easily understood at the receiver. Figure 1 shows a sample FDM system with eight subcarriers. Simply stated, FDM allows multiple frequencies to be carried over the same communications medium or system

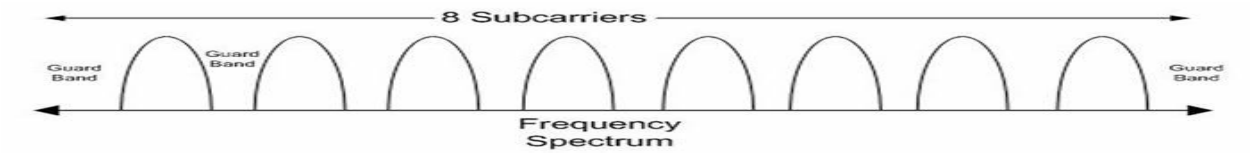

***Fig: 8.3*.a Sample FDM with 8 subcarriers.**

An FDM system is a cable television network. Each television channel operates at distinct 6 MHz channels along the coaxial cable path.

OFDM takes this FDM concept further by spacing the frequencies closer together. In OFDM, the subcarriers are orthogonally arranged to allow each subcarrier frequency to be detected without interference from neighboring subcarrier frequencies. This permits many more carriers on a transmission medium which in turn permits greater data rates. In effect, OFDM permits a much more efficient utilization of channel bandwidth. Figure 2 shows a sample OFDM system with eight subcarriers and guard bands between each group of subcarriers.

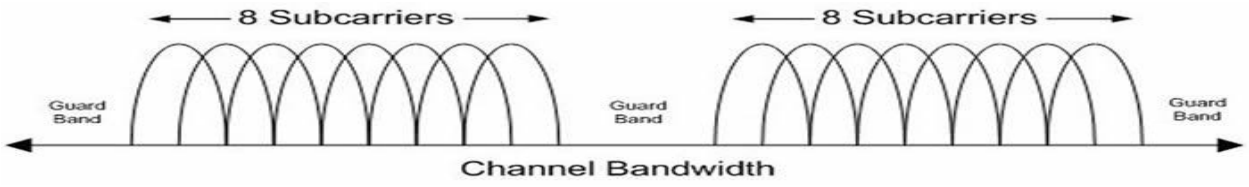

Fig: 8.3.b Sample OFDM system with 8 subcarriers and guard bands between each group of subcarriers.

Wireless environments can be hostile. Two issues that affect wireless system environments are time-selective interference and frequency-selective fading. Time-selective interference occurs when two signals arrive at the receiving antenna at separate times. Since signals arrive at different times there is a potential for signal interference. Multiple subcarriers, since they consist of many signals, allow OFDM to reconstruct the signal and compensate for interference. Frequency-selective fading occurs when waves destructively self-interfere as they propagate through the environment. Multiple subcarriers, which consist of many different frequencies, permit OFDM to compensate for frequency selective fading by ensuring the signal can be reconstructed.

8.4 Orthogonal Frequency Division Multiplexing Access (OFDMA)

Orthogonal Frequency Division Multiplexing Access (OFDMA) is a multiple access method based on OFDM and allows simultaneous transmissions to and from multiple users. In essence, OFDMA takes the subcarriers created with OFDM and assigns subcarriers to different subscribers. Further, OFDMA also schedules time slots when a subscriber can communicate with the base station. In effect, the base station simultaneously controls the time and frequency allocation for a subscriber. For example, Subscriber A may talk on subcarrier 1 at time slots 1, 3, 4, and 5. Subscriber B talks on subcarrier 2 at time slots 2, 6, 8, and 9.

OFDMA provides much greater granularity of the available bandwidth and allows multiple subscribers to connect to the WiMAX network. Since OFDMA efficiently uses the available spectrum, a large number of subscribers can be supported on the typical WiMAX network.

OFDM and OFDMA are generally used in fixed access networks such as back haul or dedicated point-to-point links. OFDMA can be utilized for mobile applications, however a technique called Scalable Orthogonal Frequency Division Multiplexing Access (SOFDMA) was developed to manage mobile connectivity similar to cellular networks

8.5 Adaptive Modulation and Coding in WiMAX:

WiMAX supports a variety of modulation and coding schemes and allows for the scheme to change on a burst-by-burst basis per link, depending on channel conditions. Using the channel- quality feedback indicator, the mobile can provide the base station with feedback on the downlink channel quality. For the uplink, the base station can estimate the channel quality, based on the received signal quality. The base station scheduler can take into account the channel quality of each user's uplink and downlink and assign a modulation and coding scheme that maximizes the throughput for the available signal-to-noise ratio. Adaptive modulation and coding significantly increases the overall system capacity.

8.6 Radio Conformance Test of WiMAX MIMO

The WiMAX Forum has a set of standardized conformance test procedures for PHY and MAC specification compliance called the Radio Conformance Test (RCT). Any technology aspect of a particular implementation of a radio interface must first undergo the RCT. Generally, any aspect of the IEEE 802.16 standard that does not have a test procedure in the RCT may be assumed to not yet be widely implemented.

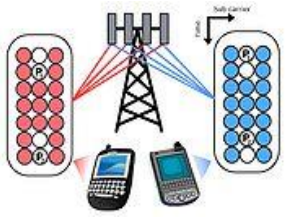

Fig: 8.6 Radio Conformance of WiMAX MIMO Simens Gigaset SE68