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# PREAMBLE DETECTION IN WIMAX 802.16E USING OFDM WITH DIFFERENT CORRELATION METHOD SC, GM, MMSC AND ML

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## ABSTRACT

To meet out the high spectral efficiency and high data rate, an efficient modulation scheme is to be employed. The Wireless communication systems can be found all around the world today. WiMAX which represents World Interoperability for Microwave Access is a major part of broadband wireless network having IEEE 803.16 standard provides innovative fixed as well as mobile platform for broadband internet access anywhere in anytime. WiMAX works on high data rate and it is a wireless technique so fading and attenuation in the signals is presence due to noise, inter symbol interference, inter carrier interference etc. OFDM modulation technique is used to work on multicarrier. OFDM works on orthogonality so presence of ISI is neglected.

In this paper implement different convolution methods for detection of preamble. These methods comparative analysis is done by apply different lag factor and integration length. These methods are Schmidl and Cox maximum normalized correlation (SC), maximum normalized correlation using a geometric mean (GM), minimum mean squared error (MMSE), maximum likelihood (ML). Maximum Likelihood (ML) method is better than the other is shown by the results.In this preamble detection method we used communication channel AWGN channel, also used modulation techniques QAM with OFDM. The performance has been concluded based Sample versus Detection value and output through MATLAB-R3013a Simulation.

## INTRODUCTION FREQUENCY BAND DIFFERENCE OF WIMAX

The original WiMAX standard, IEEE 802.16, specifies WiMAX in the 10 to 66 GHz range. 802.16a added support for the 3 to 11 GHz range, of which most parts are already unlicensed internationally and only very few still require domestic licenses. There is a frequency band differences between two of them. WiMAX uses licensed spectrum whereas Wi-Fi uses unlicensed spectrum. WIMAX IEEE 802.16 WiMAX networks refer to broadband wireless networks that are based on the IEEE 802.16 standard, which ensures compatibility and interoperability between broadband wireless access equipment. The IEEE 802.16 standards define how wireless traffics move between subscriber equipment and core networks. WiMAX was designed for the transmission of multimedia services (voice, Internet, email, games and others) at high data rates.

### A. Analysis WiMAX Spectrum

Just as the in wireless technology Wi-Fi which also known as Wireless Local Area Network boom took off on the carrier of the IEEE 802.11 standard similarly an emerging Metropolitan Area Network (MAN) has launched Wireless Metropolitan Area Network standards which based on IEEE 802.16. In communication all over the worldwide many radio frequencies band varies by region. Many spectrum-governing authorities e.g. U.S Federal Communications Commission play an important role in determining and managing useable spectrum for various internet subscribers and competing services. To make the available portions of spectrum that may or may not in proportion with the rest of world by the government who have governing authorities. It is the case happens in the deployment of WiMAX. There is also a great deal of diversity in spectrum allocation and regulation.

## PREAMBLE

A problem encountered in the design of receivers for digital communication systems is the detection of data from noisy measurements of the transmitted signals. In any realistic scenario the receiver is, due to the noise, bound to make occasional errors. Therefore, designing a receiver which has the property that this probability of error is minimal is appealing, both from a practical and a theoretical point of view.Unfortunately, such designs tend to result in computationally complex receivers and for this reason they are often abandoned in favor of computationally simpler but suboptimal receivers. It is however well known that for many scenarios the gap in performance between suboptimal and the optimal receivers is substantial. This alone makes the optimal receivers interesting. Additionally, the decreasing cost of computation will result in computationally feasible optimal designs.

## SYNCHRONIZATION

Synchronization is used to find out the starting of the frame and received signal. Initial symbol timing is measured by the synchronization. Proper synchronization is useful for preparing the system that data is starting. Synchronization is done by the preamble. Normally synchronization is by adding stream of bits into the data. These bits increase the length of the data. These bits are known by the receiver.OFDM is a special case of multicarrier transmission, where a single data stream is transmitted over a number of lower-rate subcarriers. One of the main reasons to use OFDM is to increase robustness against frequency selective fading or narrowband interference. In a single-carrier system, a single fade or interferer can cause the entire link to fail, but in a multicarrier system, only a small percentage of the Subcarrier (SCs) will be affected. Error-correction coding can then be used to correct for the few erroneous SCs. The concept of using parallel-data transmission and frequency-division multiplexing was developed in the mid-1960s. Some early development is traced back to the 1950s. A U.S. patent was filed and issued in January 1970.

OFDM is used in many wireless applications today. Already it is used in different WLAN standards (e.g. HIPERLAN-3, IEEE 802.11a), Wireless Metropolitan Area Networks (WMAN), Digital Video Broadcasting (DVB), 3GPP-LTE, Asymmetric Digital Subscriber Line (ADSL) and power line communications [4].

## AWGN CHANNEL

The AWGN channel model is a simple but basic concept for modeling channel effects on electromagnetic signals in communication systems. The simplest channel model in wireless commutations is the well known Additive White Gaussian Noise (AWGN) model. The mathematical expression of the AWGN channel as follows

The AWGN channel adds white noise $n(t)$ to the signal $x(t)$:

$$y(t) = x(t) + n(t) \qquad (1)$$

The noise has a constant spectral density and the amplitudes are normal distributed with variance$\sigma^2 = N_0/2$. N0 is the single-sided noise spectral density.

White Noise is existent in all communication systems independent of their propagation and induced by many sources like thermal noise in electronic circuits, terrestrial noise, and cosmic noise.

Hence the AWGN channel model is essential but not sufficient to model terrestrial propagation effects. The terrestrial propagation faces further effects like multipath, slow and deep fading, which can affect the channel severe. To consider these, other channel models have to be used additionally. The Rayleigh and the Rician channel model are common representatives of these and described below.

If the average received power is $P'[W]$ and the noise power spectral density is $N_0$ [W/Hz], the AWGN channel capacity is:

$$c_{awgn} = W \log_2\left(1 + \frac{P'}{N_0 W}\right) \text{ Bit/Hz} \qquad (2)$$

Where $P'/NoW$ is the received signal-to-noise ratio (SNR).

When the SNR is large (SNR >> 0 dB), the capacity C≈ W $\log_3$ P'/$N_0$W is logarithmic in power and approximately linear in bandwidth. This is called the bandwidth-limited regime.

When the SNR is small (SNR << 0 dB), the capacity C≈ W $\log_3$ e is linear in power but insensitive to bandwidth. This is called the power-limited regime.

## OPTIMIZATION CRITERION (DETECTION)

Several types of optimization detection metrics have been developed: maximum correlation (MC), maximum normalized correlation (MNC), Schmidl and Cox maximum normalized correlation (SC), maximum normalized correlation using a geometric mean (GM), minimum mean squared error (MMSE), maximum likelihood (ML), and maximum normalized time reversed correlation (MTRC). The first six are functions of the same statistics, the correlation at lags equal to the Preamble's repetition period of the signal.

The delayed correlation is the autocorrelation of the received waveform evaluated at a specific lag d:

$$R_{yy}(n,d) = \frac{1}{M}\sum_{m=0}^{M-1} y(n+m)y^*(n+m+d) \qquad (3)$$

The power estimate is given by:

$$R_{yy}(n,0) = \frac{1}{M}\sum_{m=0}^{M-1} |y(n+m)|^2 \qquad (4)$$

Here *d* represents the correlation lag, and is fixed. The value of the lag is determined by the repetition period of the signal. The delay correlate computational burden is minimized by using an iterative moving average implementation:

$$R_{yy}(n+1,d) = R_{yy}(n.d) + y^*(n+d)y(n+d+M) - y^*(n)y(n+M) \qquad (5)$$

where*N* is the FFT size, *Ng* is the cyclic Prefix length, and *M* is the correlation integration length.

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**A. Schmidl and Cox maximum normalized correlation (SC)**

The simplest detection metric is the un-normalized maximum correlation metric. This approach is problematic for determining a threshold that will work well under a varied channel conditions. A normalized version of this idea was developed by Schmidl and Cox:

$$M_{SC}(n) = \frac{|R_{yy}(n,L)|^2}{R_{yy}^2(n,0)} \quad (6)$$

**B. Maximum Likelihood (ML)**

Maximum likelihood methods is modified by MINN using the Schmidl metrics denominator to average all the signal samples used in the calculation of $Ryy(n, d)$:

$$M_{M,L}(n) = \frac{2|R_{yy}(n,L)|^2}{(R_{yy}(n,0)+R_{yy}(n+L,0))^2} \quad (7)$$

**C. Minimum Mean Squared Error (MMSE)**

Minimum mean squared error method is modified by MINN and also added a length $Ng + 1$ smoothing filter to remove the plateau, reducing the variance of the timing estimates.

$$M_{Minn}(n) = \frac{1}{N_g+1}\sum_{k=0}^{N_g} M_{M,L}(n-k) \quad (8)$$

At high SNR this has a clearly defined peak, Figure 4. MINN describes another metric that takes advantage of additional redundancy present in preambles that have 4, 8, and 16 repeated sections. In the next section it will be clear that this concept, with 3 sections, applies to WiMAX preambles. Applying MINN's second metric for a preamble with 3 repeated sections the resulting metric is given by:

$$M_{Minn2}(n) = \frac{|R_{yy}(n,L)+R_{yy}(n+L,L)|^2}{\left(\frac{1}{2}R_{yy}(n,0)+\frac{1}{2}R_{yy}(n+L,0)\right)^2} \quad (9)$$

where $M = L = \left\lfloor \frac{N}{3} \right\rfloor$

**D. Maximum Normalized Correlation using a Geometric Mean (GM)**

Another approach to normalize the metric uses the geometric mean of two delayed power estimates to normalize the metric:

$$M_{GM}(n) = \frac{|R_{yy}(n,L)|}{\sqrt{R_{yy}(n,0)R_{yy}(n+L,0)}} \quad (10)$$

The square root can be avoided by squaring the metric. This metric performs well at higher SNR. At low SNR the performance falls off. The minimum mean squared error (MMSE) criterion has been shown to be equivalent to the MINN metric. Maximum likelihood (ML) techniques based on the CP have been developed. The ML detector is essentially the MMSE metric with a threshold that is a function of the SNR.

## SIMULATION RESULTS

***Table: 1 Simulation Parameter***

| | |
|---|---|
| Subcarrier spacing | 15 kHz |
| System bandwidth t | 5 MHz |
| Number of subcarriers | 68 |
| FFT size | 64, 128, 256 etc |
| Sampling frequency | 7.68 MHz |
| Symbol period | 66.7 µs |
| Carrier frequency | 2.5 GHz |
| Delay Time | 15s |
| Cyclic Prefix | ¼ |
| Channel | AWGN, Rayleigh |
| Modulation | BPSK, QPSK |
| Preamble Techniques | MSC, MGM, ML, MINN |

**A. Preamble detection in SNR at 0dB**

In the simulation result we are used in table 1 parameters. In this correlation of preamble detection (maximum normalized correlation (MNC or MINN), Schmidl and Cox maximum normalized correlation (SC or MSC), maximum normalized correlation using a geometric mean (GM or MGM), maximum likelihood (ML or MML)

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method are comparison on OFDM using AWGN Channel. In this model we have used QAM (Quadrature Amplitude Modulation) in modulation technique, and required SNR value is 0dB and the performance done by used MATLAB R2013a version.

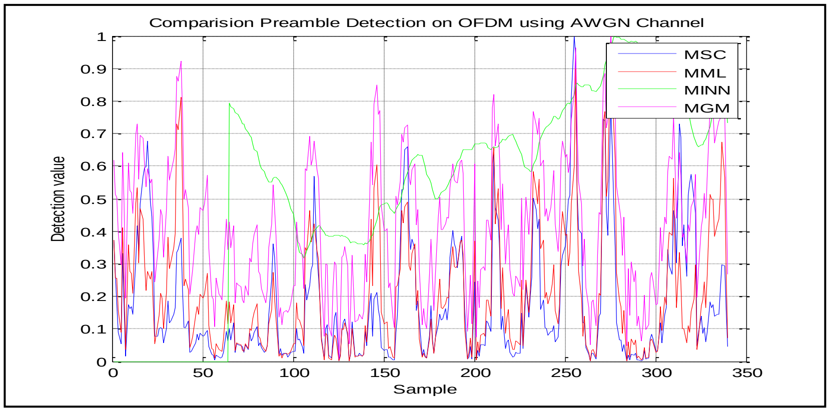


*Fig 1 Correlation between Different signals at SNR=0 dB*

### B. Preamble detection in SNR at 20dB

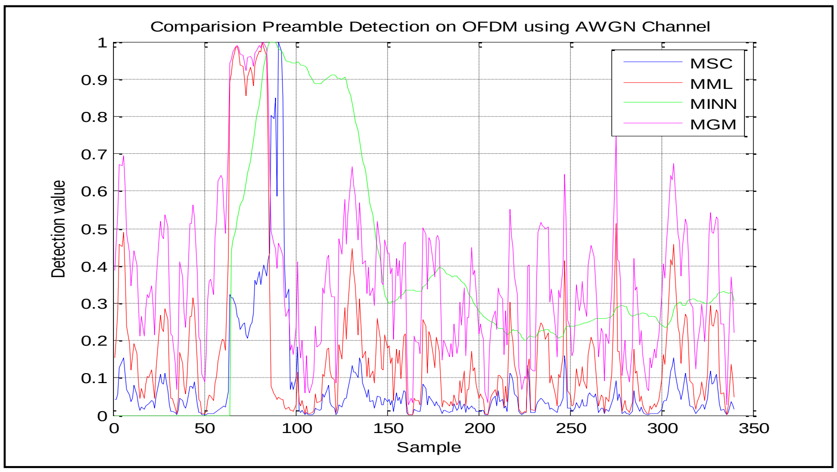


*Fig 2 Correlation between Different signals at SNR=20 dB*

### C. Preamble detection in SNR at 30dB and SNR at 50dB

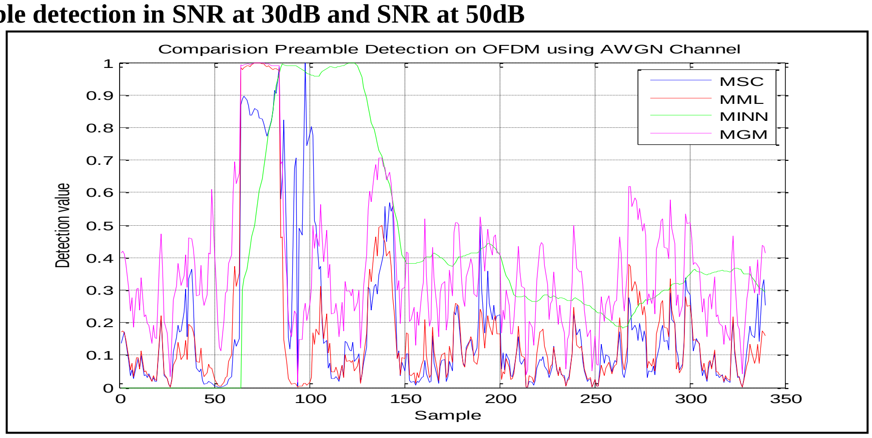


*Fig 3 Correlation between Different signals at SNR=30 dB*

## CONCLUSION

An above result we analysis all preamble technique (MSC, MML, MSC and MGM) at different SNR value (0dB, 20dB and 30dB). In the SNR at 30dB have best performance is obtain in MML and MGM but some time both result suddenly down over performance. But in the MINN techniques has batter than all techniques because its performance is smoothly down and rise at all point so that MINN is batter techniques.

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