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Performance of Space Time Trellis Coded OFDM with antenna diversity

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Abstract*—Wireless communications have been developed widely and rapidly in the modern world especially during thelast decade. Recent advances in wireless communication systems have increased the throughput over wireless channels. The reliability of wireless communication has also been increased. But still the bandwidth and spectral availability demands are endless. The need to achieve reliable wireless systems with high spectral efficiency, low complexity and good error performance results in continued research in this field. The research in the field of space-time coding and multiple-input multiple-output systems has acquired a great interest in recent years.*

One of the major problems that wireless communication systems face is multipath fading. Diversity is often used to overcome this problem. There are three kinds of diversity - spatial, time and frequency diversity. Space-time trellis coding (STTC) is a technique that can be used to improve the performance of mobile communications systems over fading channels. It is a combination of space and time diversity. In this paper, we'll produce result of STTC OFDM using 4 PSK 4 States Modulation.

***Index Terms*—** Space Time Trellis Codes, Fading, Diversity

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I. INTRODUCTION

Now a day, third generation (3G) mobile communication systems have become popular all around the world. However, its services cannot provide a very big dynamic range of data rates, nor can it meet the requirements of a variety of business types. Besides, voice transportation in 3G still relies on circuit switching technology, which is the same method as used in second-generation (2G) communication systems, rather than pure Internet Protocol (IP) approach.

Thus, based on consideration listed above, many countries have already carried out research on the next completely evolutionary fourth generation (4G) communication systems which provide a comprehensive and secure IP solution where voice, data, and multimedia can be offered to users at "anytime, anywhere" with higher data rates than previous generations. Since bandwidth resource in 4G mobile communications is still scarce, in order to improve spectrum efficiency and achieve as high as 100Mbps wireless transmission rate, it requires more advanced techniques to be employed. The limitation of modulation schemes in existing communication systems has become an obstruction in further increasing the data rate. Hence, next generation mobile communication systems need more sophisticated modulation scheme and information transmission structure. Multiple input multiple output (MIMO) and orthogonal frequency division multiplexing (OFDM) have therefore been adopted due to their superior performance. They promise to become key high- speed wireless communication technologies and combining them can provide wireless industry evolution from 3G to 4G system.

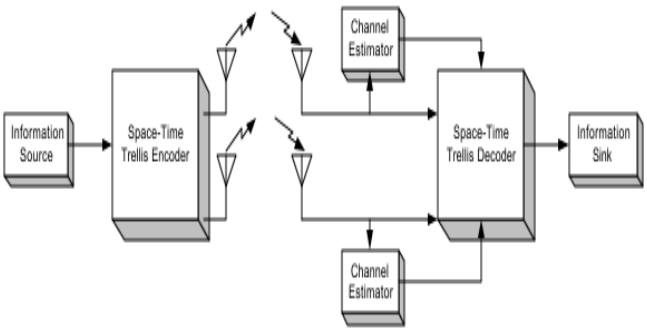
II. SPACE TIME TRELLIS CODED MODULATION Space-Time Trellis Codes (STTCs) were introduced in 1998

[1] as a high- data rate, bandwidth and power-efficient method of communication over wireless Rayleigh and Rician fading channels. STTCs can achieve a diversity advantage by placing the diversity burden on the base station, and hence leaving the mobile station to maintain its mobility and practicality [1].

STTCs are totally based on well defined trellis structures and hence they can be decoded using soft-decision decoding techniques at the receiver, such as Viterbi decoding. STTC modulation proposed a joint design of coding, modulation, and transmits diversity for flat Rayleigh fading channels.

Trellis coded modulation (TCM) is a technique that combines error-correcting coding and modulation in digital

communications [2].TCM gains noise immunity over un-coded transmission without any increase in the signal bandwidth or the transmission power. By partitioning signal set into groups,



TCM uses signal mapping to increase the Euclidean distance, rather than the Hamming distance, between codes [3],[4]. TCM systems use 2^{m+1} constellation points for transmitting m bits. In [5], a systematic approach to partition multidimensional signals is proposed. Since iterative error correction codes (ECCs) such as turbo codes [6] and low-density parity-check codes [7] are popular due to their near-Shannon limit decoding performance, TCM has the advantage of low decoding latency over these iterative codes. In this paper, an encoder and Viterbi decoder are implemented to simulate the performance of space time trellis coded modulation in a second order diversity (two transmit and one receive antennas).

III. ORTHOGONAL FREQUENCY DIVISIONMULTIPLEXING

Orthogonal frequency division multiplexing (OFDM) is a popular technique for transmission of signals over wireless channels. OFDM has been adopted in several wirelessstandards such as digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a [8] local area network (LAN) standard and the IEEE 802.16a [9] metropolitan area network (MAN) standard. OFDM is also being pursued for dedicated short-range communications (DSRC) for road side to vehicle communications and as a potential candidate for fourth-generation (4G) mobile wireless systems. OFDM converts a frequency-selective channel into a parallel collection of frequency flat subchannels. The subcarriers have the minimum frequency separation required to maintain orthogonality of their corresponding time domain waveforms, yet the signal spectra corresponding to the different subcarriers overlap in frequency. Hence, the available bandwidth is used very efficiently. If knowledge of the channel is available at the transmitter, then the OFDM transmitter can adapt its signaling strategy to match the channel. Due to the fact that OFDM uses a large collection of narrowly spaced subchannels, these adaptive strategies can approach the ideal water pouring capacity of a frequency-selective channel. In practice this is achieved by using adaptive bit loading techniques, where different sized signal constellations are transmitted on the subcarriers.

OFDM is a block modulation scheme where a block of N information symbols is transmitted in parallel on N subcarriers. The time duration of an OFDM symbol is N times larger than that of a single-carrier system. An OFDM modulator can be implemented as an inverse discrete Fourier transform (IDFT) on a block of N information symbols followed by an analog-to-digital converter (ADC). To mitigate the effects of inter symbol interference (ISI) caused by channel time spread, each block of N IDFT coefficients is typically preceded by a cyclic prefix (CP) or a guard interval consisting of G samples, such that the length of the CP is at least equal to the channel length. Under this condition, a linear convolution of the transmitted sequence and the channel is converted to a circular convolution. As a result, the effects of the ISI are easily and completely eliminated. Moreover, the approach enables the receiver to use fast signal processing transforms such as a fast Fourier transform (FFT) for OFDM implementation [10]. Similar techniques can be employed in single-carrier systems as well, by preceding each transmitted data block of N length by a CP of length , while using frequency-domain equalization at the receiver.

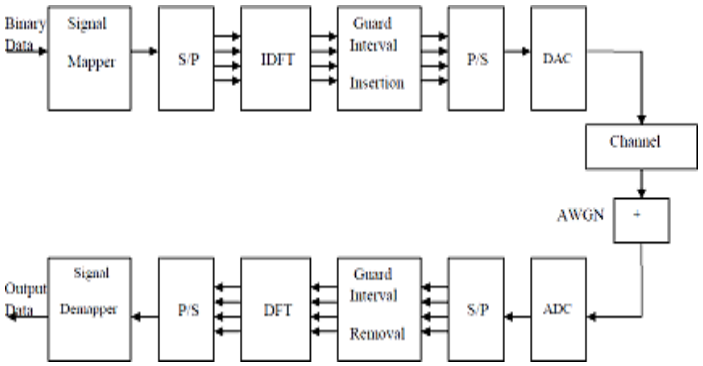


Fig. 1: The basic block diagram of an OFDM system inAWGN Channel

IV. PERFORMANCE ANALYSIS

In previous sections we have discussed the trellis coded modulation scheme and orthogonal frequency division multiplexing, now to analysis the performance of our desired system we have to combine both trellis codedmodulation and OFDM system to get our desired result.

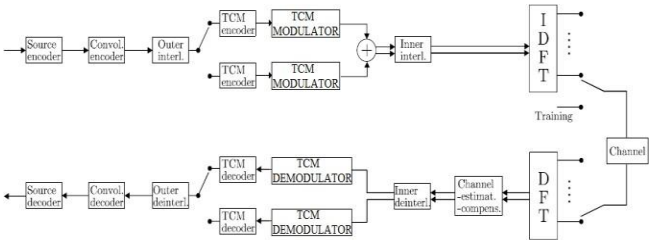


Fig. 2: OFDM Transmitter and Receiver with Trellis Coded Modulation

The basic aim of our work is to reduce the Bit error rate (BER). We are also trying to improve the signal- to-noise ratio in the proposed algorithm. The OFDM technology we changed was designed by m-PSK mapping for BER reduction and FFT/IFFT blocks. Implementation of the above OFDM transceiver designed for BER reduction carried out over MATLAB 7.8.0.Implementation details are first we randomly generate the data using ―randint‖ function provided in MATLAB for the random generation of data. Encoding of data is carried out by *"Trellis Encoding"*M-PSK modulation which is done with the help of 4 states. After the signal is trellis coded modulated followed by IFFT , we designed a channel for transmission, channel is prepared using *additive white Gaussian noise function. At the receiver side first we*take the FFT of noisy received signal followed by the decoding process, *Viterbi Detector* is used for this purpose.

Finally we'll calculate the bit error rate by comparing the transmitted bits and the received bits.

V. SIMULATION RESULT

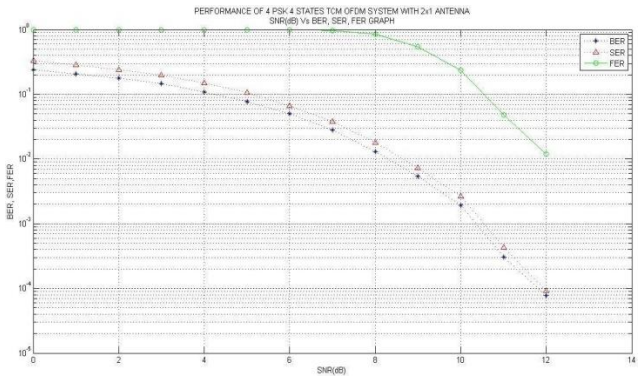


Fig. 3 B.E.R., S.E.R. & F.E.R. Graph of STTC 4 PSK 4 States Modulation with OFDM using 2x1 Antenna

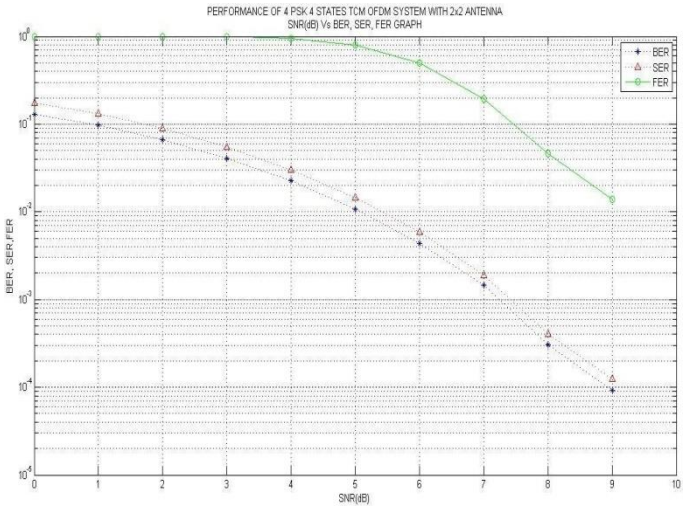


Fig .4 B.E.R., S.E.R. & F.E.R. Graph of STTC 4 PSK 4 States Modulation with OFDM using 2x2 Antenna

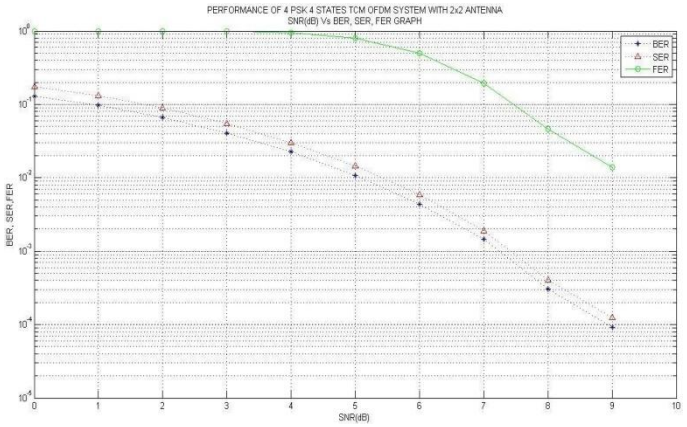


Fig .5 B.E.R., S.E.R. & F.E.R. Graph of ST TC 4 PSK 4 States Modulation with OFDM using 2x3 Antenna

The above diagram shows the BER, SER & FER Graph of STTC 4 PSK 4 States Modulation with OFDM using 2x1Antenna, 2x2Antenna ,2x3 Antenna where we are getting the satisfactory result as per ourpaper.

VI. CONCLUSIONS

In our paper we combined the trellis coded modulation and OFDM system having two transmitters and one receiver and analysed the performance of system using 4 PSK 4 States modulation which gives the satisfactory result of reduction in bit error rate.

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