Emerging Trends in MIMO OFDM

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Abstract— Multiple-input multiple-output (MIMO) wireless technology together with orthogonal frequency-division multiplexing (MIMO-OFDM) is a horny air-interface solution for next-generation wireless native space networks (WLANs), wireless metropolitan space networks (WMANs), and fourth-generation mobile cellular wireless systems. this text investigates the impact of equal and unequal received powers on the performances of various MIMO-OFDM schemes for terrestrial digital TV.

More exactly, we tend to specialize in 3 kinds of nonorthogonal themes: the BLAST scheme, the Linear Dispersion (LD) code and therefore the Golden code, and that we compare their performances to that of Alamouti theme. using 2 receiving antennas, we tend to show that for moderate attenuation on the second antenna and high spectral potency, Golden code outperforms alternative schemes. However, Alamouti theme presents the most effective performance for low spectral potency and equal received powers or when one antenna is dramatically broken. when 3 antennas area unit used, we tend to show that Golden code offers the best lustiness to power unbalance at the receiving aspect.

Index Terms— OFDM, MIMO, Space Time codes.

I. INTRODUCTION

MIMO is the use of multiple antennas at each the transmitter and receiver to boost communication performance. The wireless system before MIMO is been forced by network capability that is said with channel quality and coverage. In wireless communication the propagation channel is characterized by multipath propagation thanks to scattering on completely different obstacle. The multipath drawback could be a typical issue in communication system with time variations and time unfold. For time variations the channel is attenuation and caused SNR variations. For time unfold, it becomes necessary for appropriate frequency property. With MIMO, the receiving end uses AN algorithmic rule or special signal process to mapped out the multiple signals to provide one signal that has the originally transmitted information

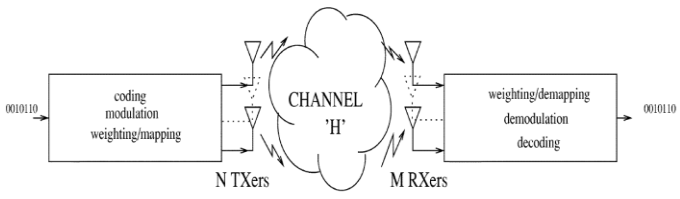
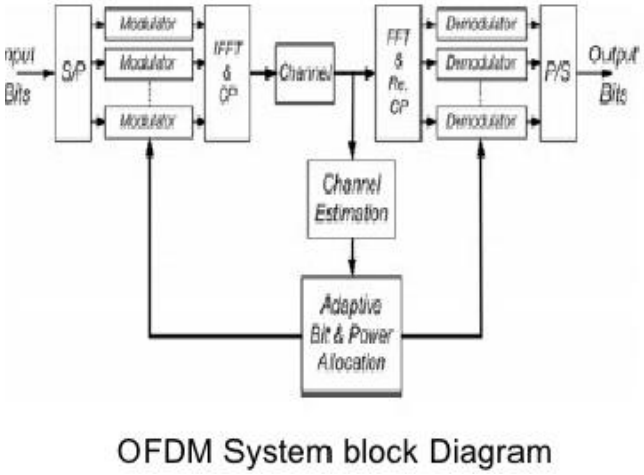


Fig:1 Basic of MIMO

Means that Multiple Input Multiple Output Orthogonal frequency-division multiplexing. Orthogonal frequency division multiplexing (OFDM) may be a methodology of encryption digital knowledge on multiple carrier frequencies. OFDM has developed into a preferred theme for broadband electronic communication, whether wireless or over copper wires, utilized in applications like digital TV and audio broadcasting, digital subscriber line net access, wireless networks, transmission line networks, and 4G mobile communications. OFDM is basically a dead ringer for coded OFDM (COFDM) and separate multi-tone modulation (DMT), and may be a frequency-division multiplexing (FDM) theme used as a digital multi-carrier modulation methodology.

II. MIMO OFDM

The quality of a wireless link is delineated by 3 basic parameters, particularly the transmission rate, the transmission vary and therefore the transmission dependableness. Conventionally, the transmission rate could also be augmented by reducing the transmission vary and dependableness. against this, the transmission vary could also be extended at the price of a lower transmission rate and dependableness, whereas the transmission dependableness could also be improved by reducing the transmission rate and vary. However, with the appearance of MIMO power-assisted OFDM systems, the above-named 3 parameters could also be at the same time improved. Initial field tests of broadband wireless MIMO OFDM communication systems have shown that AN augmented capability, coverage and dependableness is possible with the help of MIMO techniques. what is more, though MIMOs will doubtless be combined with any modulation or multiple access technique, recent analysis suggests that the implementation of MIMO-aided OFDM is a lot of economical, as a advantage of the simple algebra invoked for process the MIMO OFDM signals. MIMO OFDM, that is claimed to be fabricated by Air go Networks, has shaped the inspiration of all candidate standards planned for IEEE 802.11n. In recent years, this subject has attracted substantial analysis efforts, addressing varied aspects, like system capability, space/time/frequency committal to writing, peak-to-average power quantitative relation (PAPR) management, channel estimation, receiver style, etc. Recently, Paul dominion et al. and Stubbier et al. provided compelling overviews of MIMO OFDM communications. what is more, Nortel Networks has developed a MIMO OFDM epitome throughout late 2004, that demonstrates the prevalence of MIMO OFDM over today's networks in terms of the possible rate.



OFDM System block Diagram

Fig:2

III. SDMA-BASED MIMO OFDM SYSTEMS

As a taxon of MIMO arrangements, recently the SDMA based mostly techniques have attracted substantial interest. Collectively of the foremost promising techniques aiming at resolution the capability drawback of wireless communication systems, SDMA allows multiple users to at the same time share a similar information measure in several geographical locations. A lot of specifically, the exploitation of the abstraction dimension, particularly the questionable abstraction signature, makes it doable to spot the individual users, even after they square measure within the same time/frequency/code domains, so increasing the system's capability.

IV. GENERATION OF MIMO OFDM

Parallel information streams area unit used as inputs to Associate in Nursing IFFT IFFT output is add of signal samples IFFT will modulation and multiplexing in one step Filtering and D/A of samples leads to baseband signal OFDM during a multipath surroundings - impact on one subcarrier Received signal in one image amount isn't a sinusoid Causes lay to rest carrier interference (ICI) Cyclic Prefix cyclic prefix refers to the prefixing of an emblem with a repetition of the tip. though the receiver is often organized to discard the cyclic prefix samples, the cyclic prefix serves 2 functions.

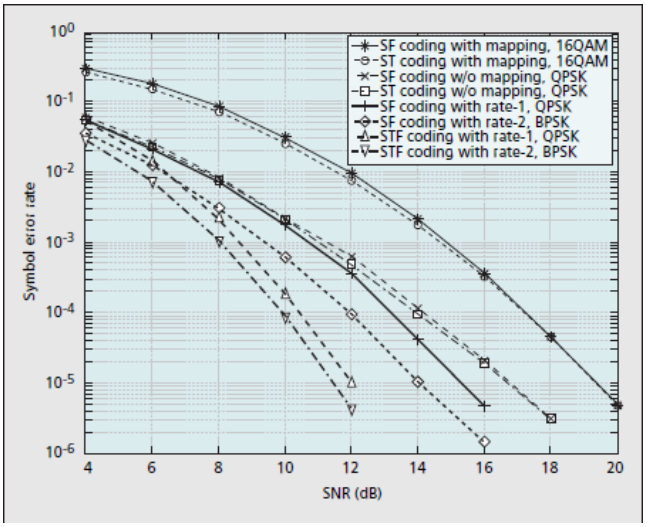


Fig:3 Symbol error rate performance comparison in a MIMO-OFDM system with 2 transmit antennas and 2 receive antennas

As a guard interval, it eliminates the lay to rest image interference from the previous image. As a repetition of the tip of the image Some loss in potency as cyclic prefix carries no new info during this paper MIMO-OFDM technique is studied for 4G wireless communication system. we tend to use Alamouti's house time cryptography. this method will offer high rate transmission while not increasing transmits power and increasing information measure.

V. PRINCIPLE OF OPERATION

A) ORTHOGONALITY

In OFDM, the sub-carrier frequencies square measure chosen in order that the sub-carriers square measure orthogonal to every alternative, which means that cross-talk between the sub-channels is eliminated and inter-carrier guard bands don't seem to be needed. This greatly simplifies the planning of each the transmitter and also the receiver; in contrast to standard FDM, a separate filter for every sub-channel isn't needed.

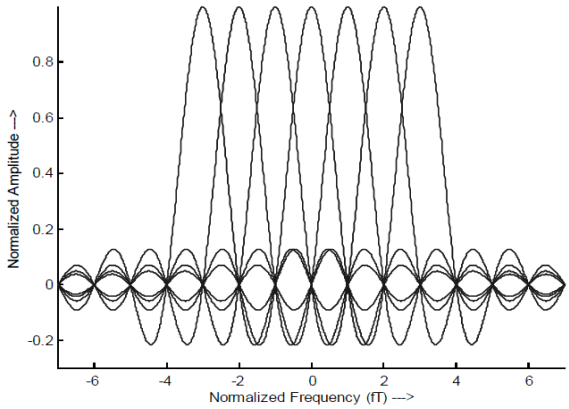


Fig:4 spectra of sub carriers

The orthogonality needs that the sub-carrier spacing is Hertz, wherever TU seconds is that the helpful image period (the receiver facet window size), and k may be a positive whole number, usually adequate to one. Therefore, with N sub-carriers, the overall passband information measure are B ≈ N•Δf (Hz).

The orthogonality additionally permits high spectral potency, with a complete image rate close to the Nyquist rate for the equivalent baseband signal (i.e. close to 0.5 the Nyquist rate for the double-side band physical passband signal). virtually the complete obtainable waveband are often utilised. OFDM typically includes a nearly 'white' spectrum, giving it benign magnetic force interference properties with regard to alternative co-channel users.

A simple example: A helpful image period TU = one ms would need a sub-carrier spacing of (or AN number multiple of that) for orthogonality. N = 1,000 sub-carriers would lead to a complete passband information measure of NΔf = one rate. For this image time, the specified information measure in theory consistent with Nyquist is N/2TU = zero.5 MHz (i.e., 1/2 the achieved information measure needed by our scheme). If a guard interval is applied (see below), Nyquist information measure demand would be even lower. The FFT would lead to N = one,000 samples per image. If no guard interval was applied, this might lead to a base band complicated valued signal with a sample rate of one rate, which might need a baseband information measure of zero.5 rate consistent with Nyquist. However, the passband RF signal is made by multiplying the baseband signal with a carrier wave shape (i.e., double-sideband construction amplitude-modulation) leading to a passband information measure of one rate. A single-side band (SSB) or undeveloped sideband (VSB) modulation theme would come through nearly [*fr1] that information measure for an equivalent image rate (i.e., doubly as high spectral potency for an equivalent image alphabet length). it's but additional sensitive to multipath interference.

B) IMPLEMENTATION USING THE FFT ALGORITHM

The orthogonality allows for efficient modulator and demodulator implementation using the FFT algorithm on the receiver side, and inverse FFT on the sender side. Although the principles and some of the benefits have been known since the 1960s, OFDM is popular for wideband communications today by way of low-cost digital signal processing components that can efficiently calculate the FFT. The time to compute the inverse-FFT or FFT transform has to take less than the time for each symbol.[6] Which for example for DVB-T (FFT 8k) means the computation has to be done in 896 µs or less.

C) OFDM EXTENDED WITH MULTIPLE ACCESS

OFDM in its primary form is considered as a digital modulation technique, and not a multi-user channel access method, since it is utilized for transferring one bit stream over one communication channel using one sequence of OFDM symbols. However, OFDM can be combined with multiple access using time, frequency or coding separation of the users.

In orthogonal frequency-division multiple access (OFDMA), frequency-division multiple access is achieved by assigning different OFDM sub-channels to different users. OFDMA supports differentiated quality of service by assigning different number of sub-carriers to different users in a similar fashion as in CDMA, and thus complex packet scheduling or Media Access Control schemes can be avoided. OFDMA is used in:

- The mobility mode of the IEEE 802.16 Wireless MAN standard, commonly referred to as WiMAX,
- The IEEE 802.20 mobile Wireless MAN standard, commonly referred to as MBWA,
- The 3GPP Long Term Evolution (LTE) fourth generation mobile broadband standard downlink. The radio interface was formerly named High Speed OFDM Packet Access (HSOPA), now named Evolved UMTS Terrestrial Radio Access (E-UTRA).
- The now defunct Qualcomm/3GPP2 Ultra Mobile Broadband (UMB) project, intended as a successor of CDMA2000, but replaced by LTE.
- OFDMA is also a candidate access method for the IEEE 802.22 Wireless Regional Area Networks (WRAN). The project aims at designing the first cognitive radio based standard operating in the VHF-low UHF spectrum (TV spectrum).

VI. SPECIFICATIONS

A lot of applications that use OFDM technology have spawned over the last few years. In this section, one such application will be described in detail, while a introduction to the other applications will be provided.

A) DIGITAL AUDIO BROADCASTING (DAB)

DAB is an European standard for digital broadcasting that is intended to replace the current analog technologies such as AM and FM. It was standardized by the European Telecommunications Institute (ETSI) in 1995. The DAB transmitted data consists of number of audio signals sampled at a rate of 48 kHz with a 22-bit resolution. This audio signal is then compressed at rates ranging from 32 to 384 kbps, depending upon the desired signal quality. The resulting digital data is then divided into frames of 24 ms. DAB uses differential QPSK modulation for the sub-carriers. A null-symbol (or a silence period that is slightly greater than the OFDM symbol length) is used to indicate the start of the frame. A reference OFDM symbol is then sent to serve as a starting point for the differential decoding of the QPSK subcarriers. Differential Modulation avoids the use of complicated phase-recovery schemes. DAB uses a rate ¼

convolutional code with a constraint length of 7 for error-correction.

The coding rate can also be increased using puncturing. Interleaving is used to separate the coded bits in the frequency domain as much as possible, which avoids large error bursts in the case of deep fades affecting a group of sub-carriers. DAB is designed to be a single frequency network, in which the user receives same signals from several different transmitters. This greatly enhance spectral efficiency. Even though there is a delay in the reception of signals from different transmitters, this situation can be considered as a multi-path situation and can be easily handled by selecting the guard interval properly. Further, this can be considered a form of transmit diversity, that the DAB receiver can take advantage of.

B) DIGITAL VIDEO BROADCASTING (DVB)

Digital Video Broadcasting (DVB) is a standard for broadcasting Digital Television over satellites, cables and thorough terrestrial (wireless) transmission. DVB was standardized by the ETSI in 1997. The following are some important parameters of DVB:

- DVB has two modes of operation: the 2k mode with 1705 sub-carriers and the 8k modes with 6817 sub-carriers.
- DVB uses QPSK, 16-QAM or 64-QAM sub-carrier modulation.
- DVB uses a Reed-Solomon outer code (204,188,t=8) and a inner convolution code with generator polynomials (177,133 octal) combined with two layers of interleaving for error-control.
- Pilot Sub-carriers are used to obtain reference amplitudes and phases for coherent demodulation. Two-dimensional channel estimation is performed using the pilot subcarriers, which aids in the reception of the OFDM signal.

C) WIRELESS LANS

Wireless LANs are one of the most important applications of OFDM. A lot of standards have been proposed for Wireless LANs during the past decade, most of then based on spread-spectrum schemes. In July 1998, IEEE Wireless LAN standardization group IEEE 802.11 standardized a scheme based on OFDM operating in the 5-GHz band. It is interesting to note that this standard is one of the first packet-based one to use OFDM. One of the main reasons for using OFDM for Wireless LANs is relatively small amount of delay spread encountered in such applications. In the case of indoor environments, the delay spread is still much less and the efficiency of OFDM in such environments is very high. In outdoor-environments however, directional antennas need to be employed if the same guard interval were used (to reduce the effect of delay spread).

D) OFDMA

Finally, it is also possible to use OFDM for multiple-access too. This technique is called OFDMA and is implemented by providing each user with a small number of sub-carriers. Even though this technique is similar to FDMA, it avoids the use of large guard bands that are used to prevent adjacent channel interference.

VII. FUTURE ASPECTS

Based on the solutions discussed throughout this paper, we demonstrated a number of significant benefits brought about by the GAs for wireless communications. It is worth pointing out that the proposed GAs may be further improved in various ways. For example, the value of the mutation probability can be adapted according to the number of users and/or the GA's generation index. exploiting RBF with or without the aid of EAs/GAs for employment in OFDM,MIMO-OFDM, and SDMA-OFDM systems constitutes a promising novel research area.

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