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Study of Performance of the combined MIM0 MMSE VBLAST-OFDM for Wi-Fi (802.11n)

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Abstract

Wireless technologies such as WiFi and Bluetooth have transformed the world of networks, and this technical revolution is still in its infancy. Wi-Fi (802.11b and g) now offers a limited range. It is also very susceptible to interference originating DECT phones and other wireless units. Finally, the Wi-Fi in its current version is much slower in terms of flows, the good old Ethernet. All this should change over to succeed the 802.11g. The 802.11n standard expected to provide data rates higher than an Ethernet connection and double the range. The use of combination VBLAST-MMSE-OFDM with MIMO (multiple input-multiple outputs) can leverage the advantage of both methods: the robustness of the link on frequency selective channels for OFDM and robustness of uncorrelated channels for MIMO space-coded. This article discusses the impact of technology (MIMO) wireless transmission of type Wi-Fi (802.11n), in a context-VBLAST MMSE-OFDM.

We will carry out a study of performance in terms of BER for a Rayleigh channel that characterizes most communication systems without son.

Key words: *Multi antenna systems, spatial diversity, MIMO- OFDM channel capacity, WIFI.*

1. INTRODUCTION

In recent decades, the applications for wireless local area networks called WLAN(Wireless Local Area Networks) have become increasingly numerous, hence the need for greater transmission rates. The diversity techniques and especially the spatial diversity techniques [1], [2] are very effective in reducing the impact of these problems on system performance. The fact received signal is affected by multiple channels, we assume uncorrelated, induces a gain of diversity, properly operated can improve system performance in terms of quality of service (QoS: Quality of service) and transmission rate.

The implementation of multiple antennas for transmission and reception is made possible by recent advances in wireless technologies. To eliminate the selectivity of the channel and combat fading and interference, and advanced modulation interference, technique OFDM is applied.

The combination of MIMO MMSE-VBLAST -OFDM is an optimal solution to increase the transmission rate and improve the performance of signals received. The aim of this paper is to study the performance of MIMO systems by combining the OFDM with MMSE-VBLAST coding in a Rayleigh channel that characterizes most wireless transmissions.

In Section 2, we present the MIMO technology. Section 3 concerns the channel model considered. In Section 4, we describe the MIMO-OFDM model adopted for this work. Section 5concern the OFDM transmission technique. Section 6, we discuss the simulation results of our study performance. We end our paper with a conclusion.

2. MIMO technology

In multi antenna systems, the capacity increases linearly with the number of transmitting antenna, exceeding the theoretical limit of Shannon. These systems have an advantage because they more resistant to fading and interference. MIMO systems are considered as technology that can solve the problems of congestion and capacity limitations of wireless broadband. Because of these properties, MIMO is an important part of modern standards of wireless communication such as IEEE 802.11n (Wi-Fi), 4G, 3GPP Long Term Evolution, WiMAX and HSPA + [3] [4]. Figure 1 shows the overall architecture of a MIMO system.

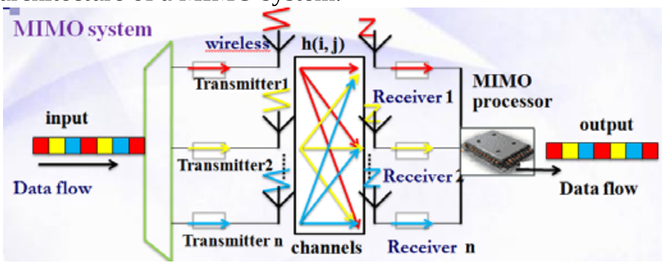

Fig.1: MIMO device

Channel capacity is given by:

$$C = \log_2 \det\left[I_N + \frac{\rho}{M} H.H^* \right] \quad (1)$$

H: the complex gain of the channel.
M: MIMO block size.
ρ: average SNR.
C: channel capacity in bps / Hz.

3. CHANNEL MODEL CONSIDERED

There are a multitude of models of the propagation channel. In this study we focus on the following types of channels [3]:

3.1 Canal with additive white Gaussian Noise:
The channel model with additive white Gaussian noise (AWGN) is the simplest of models. The received signal r (t) is the result of the signal s (t) with the addition of noise n (t) modeled by a function of Gaussian probability density defined as:

$$f_x(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-u)^2/2\sigma^2} \quad (2)$$

With x: random variable, μ: mean, σ: variance.

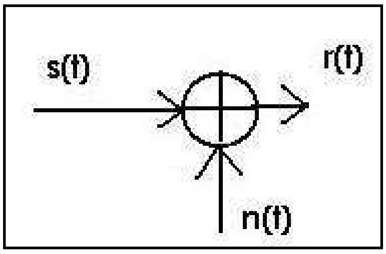

Fig.2: Model of a channel with white Gaussian noise

This channel is described by the equation:

$$r(t) = s(t) + n(t) \quad (3)$$

3.2 Channel with fading and additive white Gaussian noise (Rayleigh channel)

In this type of channel, which affect only the faint signals are taken into account. It is described by the equation:

$$r(t) = h(t, t_d) * s(t) + n(t) \quad (4)$$

The Rayleigh channel models both fading and AWGN is to say it includes the two channels described above. This channel can also theoretical model a frequency selective channel (and possibly time) for which we conducted a modulation / demodulation OFDM.

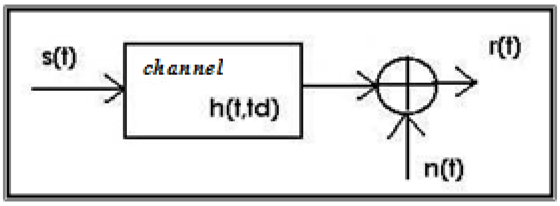

Fig.3: Model of a channel with fading and additive white Gaussian noise

Rayleigh fading:

If α i (t) have a Rayleigh probability density of type:

$$f_Z(Z) = (Z/\sigma^2)e^{-Z^2/2\sigma^2}U(Z) \quad (5)$$

With: α i (t): attenuation factor over time.
U (Z) is a random function.

σ^2 : Variance (α in this simulation).

4. Modeling of a MIMO-OFDM:

We consider a MIMO system using OFDM modulation, system using OFDM modulation, where the transmitter and receiver are provided respectively with Nt antennas and Nr. The antennas are disposed of the most commonly used, known in English Uniform Linear Array (ULA) [4], that is to say they are aligned and evenly spaced. The relative distance between two adjacent antennas is given by:

$$\Delta = 1 \ / \ 2\lambda \quad (6)$$

where λ is the wavelength.

Fig.4 describes the diagram of a MIMO / OFDM; in transmission we have the following stages:

- Serial parallel conversion of size P to obtain blocks of P symbols.
- Inverse Fourier transform of size P.
- Inserting a guard interval of size D at the beginning of the end block where the block is copied.

In reception, the dual operations are performed:

- Conversion parallel series.
- Conversion series parallel of size P to obtain blocks of P + Δ symbols.
- Remove the guard interval corresponding to the first samples of the block.
- Direct Fourier Transform of size P.
- Conversion parallel series.

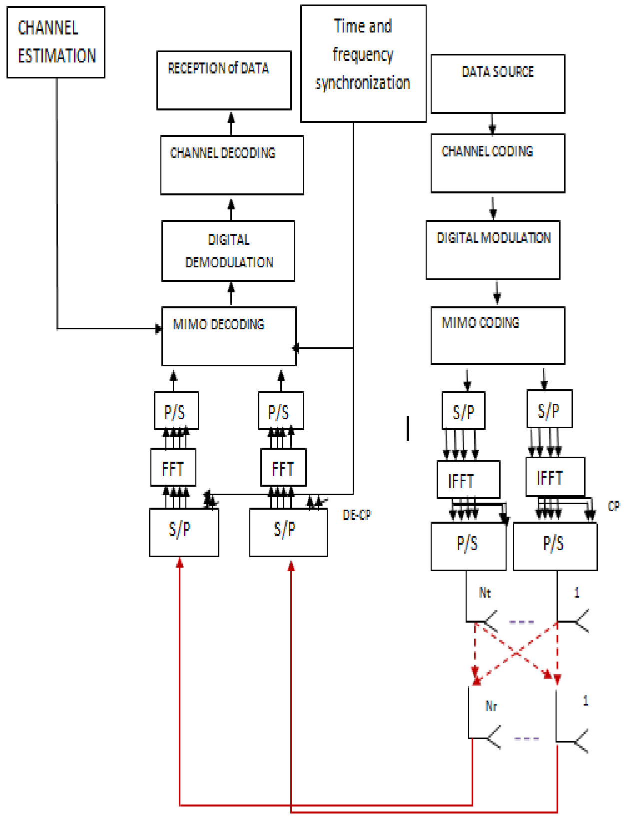

Fig.4: Model of MIMO-OFDM (Nt*Nr) system

5. OFDM modulation and demodulation

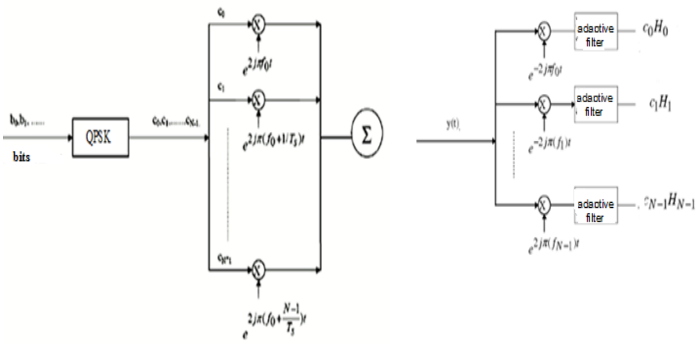

Fig.5: Diagram of OFDM modulation and demodulation

To distribute the data to be transmitted on the N carriers, symbols are grouped in bundles of N.

The complex numbers c_k are defined **[5]** from the bits by a constellation often QAM and PSK:

$$c_K e^{j2\pi f_K t} \qquad (7)$$

The total signal s(t) is the set of N symbols reassembled in an OFDM symbol:

$$S(t) = \sum_{K=0}^{N-1} c_K e^{j2\pi f_K t} \qquad (8)$$

The received signal is written over symbol duration T_s :

$$y(t) = \sum_{K=0}^{N-1} c_K H_K(t) e^{2j\pi(f_0 + K/Ts)} \qquad (9)$$

$H_K(t)$ Is the channel transfer function around the frequency and time.

6. VBLAST-OFDM coding

The coding principle VBLAST is to transmit each Nt time [5].

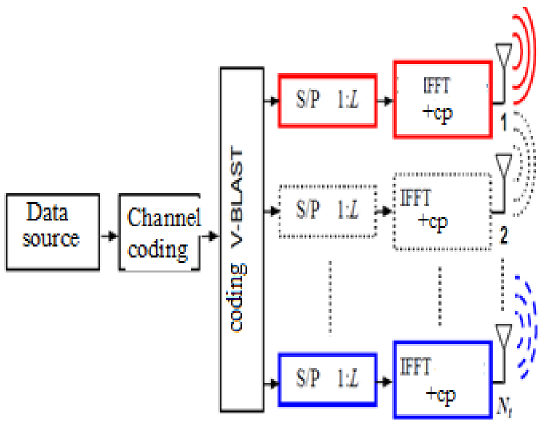

Fig.6: VBLAST-OFDM Transmitter

7. VBLAST-OFDM decoding

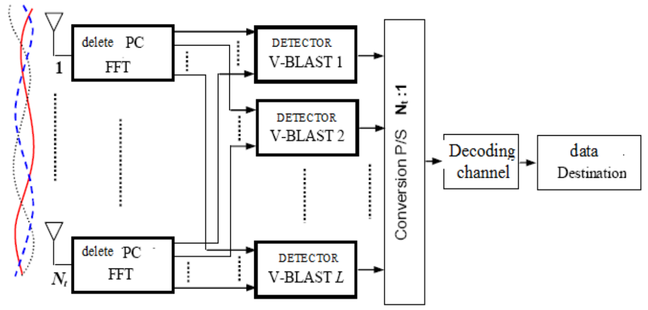

Fig.7: VBLAST-OFDM Receiver

Fig7 shows the block diagram of a receiver V-BLAST-OFDM. Each receiving antenna receives a signal for each of the L sub channels [6]. After the cyclic prefix is removed, each received signal is passed through a bloc FFT operation for demodulation.

The received signal after demodulation at the receiving antennas j for sub-channel l is given by:

$$y_{j,l} = \sum_{i=1}^{Nt} H_{j,i,l} x_{i,l} + n_{j,l}$$

(10)

where $h_{i,j,l}$ is the normal path complex gain of transmitting antenna i to receive antenna j at the frequency l, $x_{i,l}$ is the OFDM symbol transmitted from antenna i at frequency l, and the nj are independent Gaussian noise samples. The outputs of FFT blocks are passed through the L-VBLAST detectors, each with Nr inputs, and Nt outputs. The outputs of the VBLAST detectors are converted to sub-parallel streams into a single serial stream of data. Finally, the data is decoded by the channel decoder.

8. Study of Wi-Fi (802.11n):

Recent developments in telecommunications technology use multiple antennas spatial diversity. This principle already existed on the old generation wireless systems; in this case the addition of antennas to the receiver can, for example to make a selection on a criterion of antenna power to take advantage of transmission with the highest signal to noise ratio (SNR), and thus achieve the modulation with the best rate. Spatial diversity is now fully used in the modulator/ demodulator itself. Unlike the older generation WI-FI, MIMO uses multiple antennas technology to transmit different information on each antenna.
When the 802.11a and g wireless terminals used two antennas [7], the goal was to find and use the antenna that had the best power to communicate with other equipment. The access point then uses one of two antennas for communication. After various improvements had been made to the 802.11 a and g, a new generation of Wi-Fi has been designed taking into account two constraints: keep the same frequency spectrum and not to increase power. The MIMO then appeared. The latter, combined with WI-FI 802.11 a and g, gave birth to802.11n.

Unlike the previous generation terminals, the MIMO uses at least two antennas to send different information on each.

9. Performance of MIMO VBLAST-OFDM for the WI-FI:

9.1 Parameters simulation:

Our simulation is based on the following parameters:

- A band B of 2.4 GHz and 5 GHz;
- Number of subcarriers (N): 64 of which only 52 are used (the external carrier 12 are set to 0to reduce interference between adjacent channels) for the 2.4GHz band.
- Number of subcarriers (N): 128 of which only 108 are used (the external carrier 20 are set to 0 to reduce interference between adjacent channels) in the 5GHz band.
- OFDM symbol duration: 3.2 microseconds (312.5 kHz carrier).
- Modulation: QPSK.
- Cyclic prefix (averaging 800 ns max): 1/4 (Total symbol=4ms)
- Number of drivers: 4 for B=2.4GHz and 8 for B=5GHz.
- Nt and Nr are the Number of transmitting and receiving antennas.

1. *Results of simulation:*

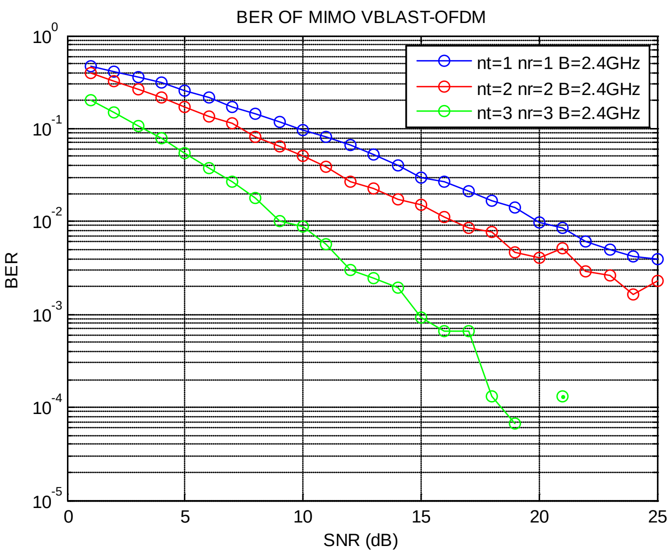

Fig.8: BER of MIMO VBLAST-OFDM for WI-FI (802.11n)
With B=2.4 GHz, N (number of subcarrier OFDM) =52

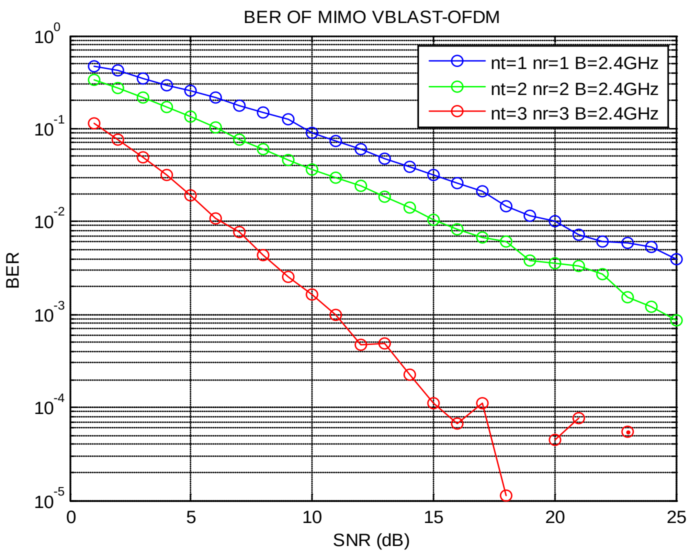

Fig.9: BER of MIMO VBLAST-OFDM for WI-FI (802.11n)
With B=5 GHz, N (number of subcarrier OFDM) =108

We note well the improvement of signal quality in terms of BER by increasing the number of transmitting and receiving antennas, which shows the usefulness of VBLAST MIMO-OFDM for wireless transmissions.

10. Conclusion

In this paper, we propose the MIMO-VBLAST-OFDM for Wi-Fi (802.11n). MIMO is a technique using multiple antennas to maximize throughput within the premises. Until recently, such environments pose serious problems for wireless networks. Waves transmitting the data tend to bounce off metal structures inside the furniture or wall and shot, to interfere with each other, resulting in performance degradation interfere with each other, resulting in performance degradation and a reduction in the scope. Other sources of interference such as cordless phones, microwave ovens, walkie-talkies and other nearby wireless networks also pose problems the standard Wi-Fi faces. It results in a reduction of the scope, or even intermittent loss of connections.

We used the encoding technique VBLAST OFDM to improve performance used the encoding technique VBLAST OFDM to improve performance and ensure the quality of the received signal.

The results of our simulations show the importance of the technology associated with the MIMO VBLAST-OFDM for wireless Wi-Fi (802.11n). The MIMO system show us a glimpse of what we can expect the Wi-Fi in the near future. With sustained higher flow, better coverage and greater resistance to interference, 802.11n will perhaps finally realize the dream of many users: namely, build a real home network entertainment, wireless.

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