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BER Performance Analysis For MIMO-OFDM In Time-Varying Channels

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Abstract: **In orthogonal frequency division multiplexing (OFDM) systems, time varying channels leads to destroy the orthogonality among subcarriers and yielding inter carrier interference (ICI) in OFDM Systems. A time domain approach is used to reduce time variations in ICI-mitigating block. A time domain equalizer (TEQ) is often used at the receiver to mitigate the total response transmission time but the design of TEQ is a difficult task. In this paper, a linear time varying channel is considered to suppress inter carrier interference and to lower computational complexity. The receiver structure of Time domain Synchronous OFDM is able to estimate the linear time varying channels easily, so TDS-OFDM is suitable for proposed ICI mitigation algorithm. Multi input multi output OFDM system (MIMO-OFDM) needed channel estimation based on Linear Time Varying channel model. Two modulations schemes, QPSK and 16 QAM are used in proposed work to improve performance of two parameters bit error rate (BER) and minimum mean square error (MMSE). Simulation results show that the proposed work can sufficiently suppress the ICI in time varying channels by comparing linear time varying (LTV) channel and linear time invariant (LTI) channel in MIMO-OFDM.**

Keywords- **Multiple-Input Multiple-Output Orthogonal Frequency Division Multiplexing (MIMOOFDM); Inter-Carrier Interference (ICI); And Time Domain Synchronous Orthogonal Frequency Division Multiplexing (TDS-OFDM);**

I. INTRODUCTION

One of the most common models for signal prediction in large urban macro-cells is Okumura's model. This model is applicable over distances of 1-100 Km and frequency ranges of 150-1500 MHz. The Okumura model for urban areas is a radio propagation model that was built using the data collected in the city of Tokyo, Japan. The model is ideal for using in cities with many urban structures but not many tall blocking structures. The model served as a base for the Hata model. It was built into three modes (urban, suburban and rural areas), the model for urban areas was built first and used as the base for others, it is more frequently used for estimating cell radius usually 50-60% path loss is accepted for urban areas. On the other hand; it is 70-75% for rural areas as in [1]. In this phase; the analysis will be extended to the case of mobile users (Doppler shift) coexisting with randomly distributed but stationary users in co-channel cells. A specific system model will be put forward in order to evaluate system dependent parameters, e.g. Bit Error Rate (BER) - as a function of the Signal to Interference plus Noise Ratio (SINR) and the normalized Doppler shift. The model will also rely on semi-analytical techniques as well as some theoretical aspect as possible. The research methodology that characterizes this phase is the iterative convergence towards the results by extensive simulations as in [2]. Reference [3] is recommended to start firstly to this phase by a brief review and re-implementation of the results we have previously; for the average link capacity in a multi cell MIMO system covered by HAP. As the results confirms that the use of MIMO system will greatly increase the achievable rate (capacity) on Rayleigh fading channels with certain degree of correlation and shows that multi cell MIMO systems covered by HAP outperforms conventional terrestrial in terms of the per user link capacity as the performance metric of interest.

II. RELATED WORK

ICI estimation and equalization have been addressed in previous work, for example in [1–11]. In [1], the ICI for single input single output (SISO) and multiple input multiple output (MIMO) transmissions is analyzed. The authors propose to employ pilot symbols located at adjacent subcarriers in order to estimate the ICI. This approach is in contradiction to the common agreement that scattered pilot symbols are optimal [2, 3]. Nevertheless, such an approach would be suitable for ICI estimation in the case of a SISO system. In the case of a MIMO system, such a pilot symbol pattern results in a huge overhead. In [4–6] ICI estimation and mitigation assume that the channel is varying linearly in the time domain. Hijazi and Ros propose to use polynomials for channel estimation in [7]. However, their estimator works only with a limited order of the polynomials. Numerous different equalization algorithms are proposed in [8–10], in which the authors assume perfect channel knowledge for each signal sample. However, this information is not available at the receiver and algorithms proposed so far [4] cannot estimate the time-variant channel impulse response at sample level precisely enough at high Doppler spreads.

Problem Statement OFDM by itself has the advantage of turning the frequency response of a frequency selective channel into a flat nonselective fading channel. However, in fading channels with very high mobility, the time variation of the channel envelope over an MIMO-OFDM symbol period results in a loss of the sub carrier orthogonality which leads to inter-channel interference (ICI) due to power leakage among MIMO-OFDM subcarriers.

III. SYSTEM MODEL

In TDS-OFDM, some known reference symbol sequences taken as the guard interval between data to serve the purpose of both channel estimation and synchronization. MIMO TDS-OFDM uses PN sequences as the guard interval. TDS-OFDM uses pseudo noise sequences as the guard interval, which can be easily estimated. The PN sequences are given prior and posteriori to the OFDM data block which are used to estimate the channel variation model. The standard frame structure and receiver structure designed for MIMO TDS-OFDM using the proposed ICI reduction algorithm are given in proposed work in detail.

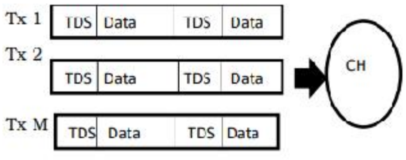

Fig.1.MIMO TDS –OFDM frame structure- CH: Time Varying channel -Tx: Transmitter

As the inversion of a large matrix is given in (24), the calculation of matrix E is determined only by M, N and K, for its irrelevant to channel realization. Therefore E is a given matrix which is calculated above and act like a predesigned linear filter the complexity is limited to filter itself.

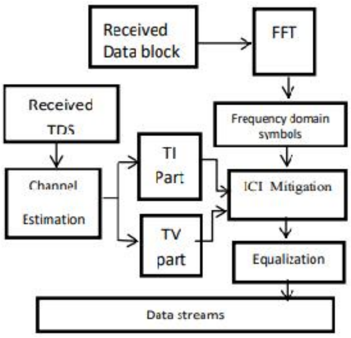

Fig.2.Receiver section of MIMO TDS-OFDM with ICI Mitigation

1) Linear Case: If we use polynomials as the basis spanning the channel space and set the variable Norder = 1, we assume that the channel is varying linearly in time. Higher order channel variations are not taken into account. The same assumption has been made in [4–6]. It was shown, that such an assumption is valid at low Doppler spreads.

2) Discrete prolate spheroidal (DPS) sequences: In [12] a low-dimensional subspace spanned by discrete prolate spheroidal sequences is used for time-variant channel estimation. The subspace is designed according to the maximum velocity vmax of the user. It is shown in [12] that the channel estimation bias obtained with the Slepian basis expansion is more than a magnitude smaller compared to the Fourier basis expansion (i.e. a truncated discrete Fourier transform) [20] or a polynomial. The concept introduced in [12], can be directly extended to the ICI estimation. The polynomials in (12) are replaced by DPS sequences. This approach allows estimating the ICI more accurately as we will show by numeric simulations in Section V.

3) Orthogonalized sequences: The authors of [7] limit the polynomial order to four due to the ill-conditioned matrix in (13). With increasing number of basic functions Norder, the condition number of the matrix MHM in (13) is also increasing. Therefore, the result of the inversion is not reliable. The maximum modeling order Norder depends on the choice of the basis vectors m. The main requirement on the basis vectors is the orthogonality between their sampled version. Orthogonal sampled sequences that span the same space as the sequences m0, m1,m2, · · · , mNorder have therefore to be found. During the search for the new orthogonal sequences it has to be considered that we have to be able to construct corresponding sequences t, t2, · · · , tNorder at the sample level. In order to solve the given problem with defined requirements, one can apply the Gram Schmidt orthonormalization algorithm [21] on the vectors m0, m1, m2, · · · , mNorder . During the orthogonalization process, also the vectors t0, t1, · · · , tNorder have to be transformed in the same manner.

IV. SIMULATION RESULTS

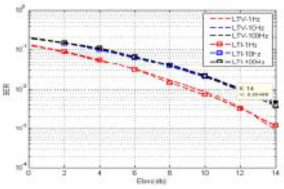

Fig 3.BER performance with QPSK when N=4

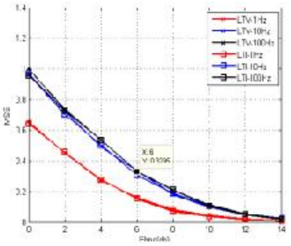

Fig.4. MMSE performance with QPSK when N=4

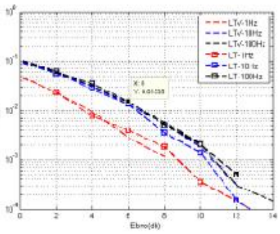

Fig.5. BER performance with QPSK when N=8

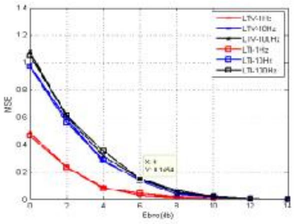

Fig.6. MMSE performance with QPSK when N=8

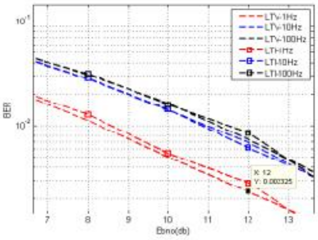

Fig .7.BER performance with 16QAM when N=4

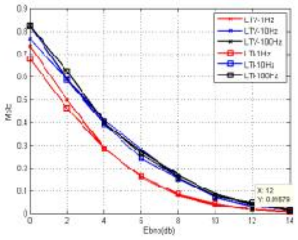

Fig.8.MMSE performance with 16QAM when N=4

V. CONCLUSION

In this paper, mitigation of inter carrier interference with low computational complexity on time varying channels is proposed. A novel technique is implemented which will overcome the drawbacks of existing systems and gives up to 2 dB SNR when the relative Doppler factor is 0.1 and maintains low complexity. Simulation results shown that BER and MMSE have a better performance on comparing LTV over LTI channel providing accuracy and reliability when compared to existing time varying channel. Finally SUI channel model applied to existing LTI and LTV equalizer for better performance. Future work is related on such equalization with iterative interference cancellation as well as the turbo equalization with soft information estimation. Also there are different channel models are recently under development which allows estimating the performance of BER and MMSE again for the outperforming results of execution for the proposed work on LTV channel in MIMO OFDM.

VI. REFERENCES

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