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Channel Estimation of FFT-OFDM and DWT-OFDM for Different Fading Channels

Snehal Rajurkar[1], Vrushali Bhosale[2], Rohit Dighe[3], S.D. Pujari[4]
[1]*Student of B.E., Department of Electronics and Telecommunication, SKNCOE, Pune, India*
[2]*Student of B.E., Department of Electronics and Telecommunication, SKNCOE, Pune, India*
[3]*Student of B.E., Department of Electronics and Telecommunication, SKNCOE, Pune*
[4]*Assistance Professor, Department of Electronics and telecommunication, SKNCOE, Pune*
[1]*sr442050@gmail.com*
[2]*bhosalevrushu100@gmail.com*
[3]*rohitdighe47@gmail.com*
[4]*pujariswapnil@hotmail.com*

Abstract

The Orthogonality frequency division multiplexing (OFDM) is a method of encoding digital data on multiple frequencies. TheOrthogonality allows high spectral efficiency and almost the whole available frequency to be utilized. By comparing the performance of FFT-OFDM and DWT-OFDM for channel noise and fading environment. Channel noise is additive white noise (AWGN) that affects the transmitted signal when passes through the channel. Fading environment is Rayleigh fading and Rician fading. To characterize the performance of FFT and DWT, bit error ratio (BER) is used as a parameter. This technique is more complicated than earlier forms of signals format, it provide some distinct advantages in terms of data transmission, especially where high data rates are needed along with relatively wide bandwidth.

Keywords*—Orthogonality frequency division multiplexing (OFDM), FFT (fast fourier transform), DWT (discrete wavelet transform), Rayleigh, Rician, Additive white noise (AWGN), Bit error ratio (BER)****.***

I. INTRODUCTION

As we know there are many data transmission technique for internet purpose and they are having minimum speed and they also have intersymbol interference in data transmission process. As the world is moving towards digital word with the higher data rate and speed, Greygory Rayleigh was the first to use the MIMO in OFDM combination. Rayleigh published research on additional MIMO OFDM under the time varying conditions, channel estimation, synchronization techniques and the performance analysis with three leading techniques i.e quadrature amplitude modulation (QAM), direct sequence spread spectrum (DSSS), discrete multi-tone (DMT). [1]

II. EARLIER WORK

This is the scenario for which many projects have been tried and developed. Although not same but many related work have been done by many researchers. Some of papers have been referred and explored here. A detailed analysis of the existing systems is done. This study helped in identifying the benefits and also the drawbacks of existing systems.

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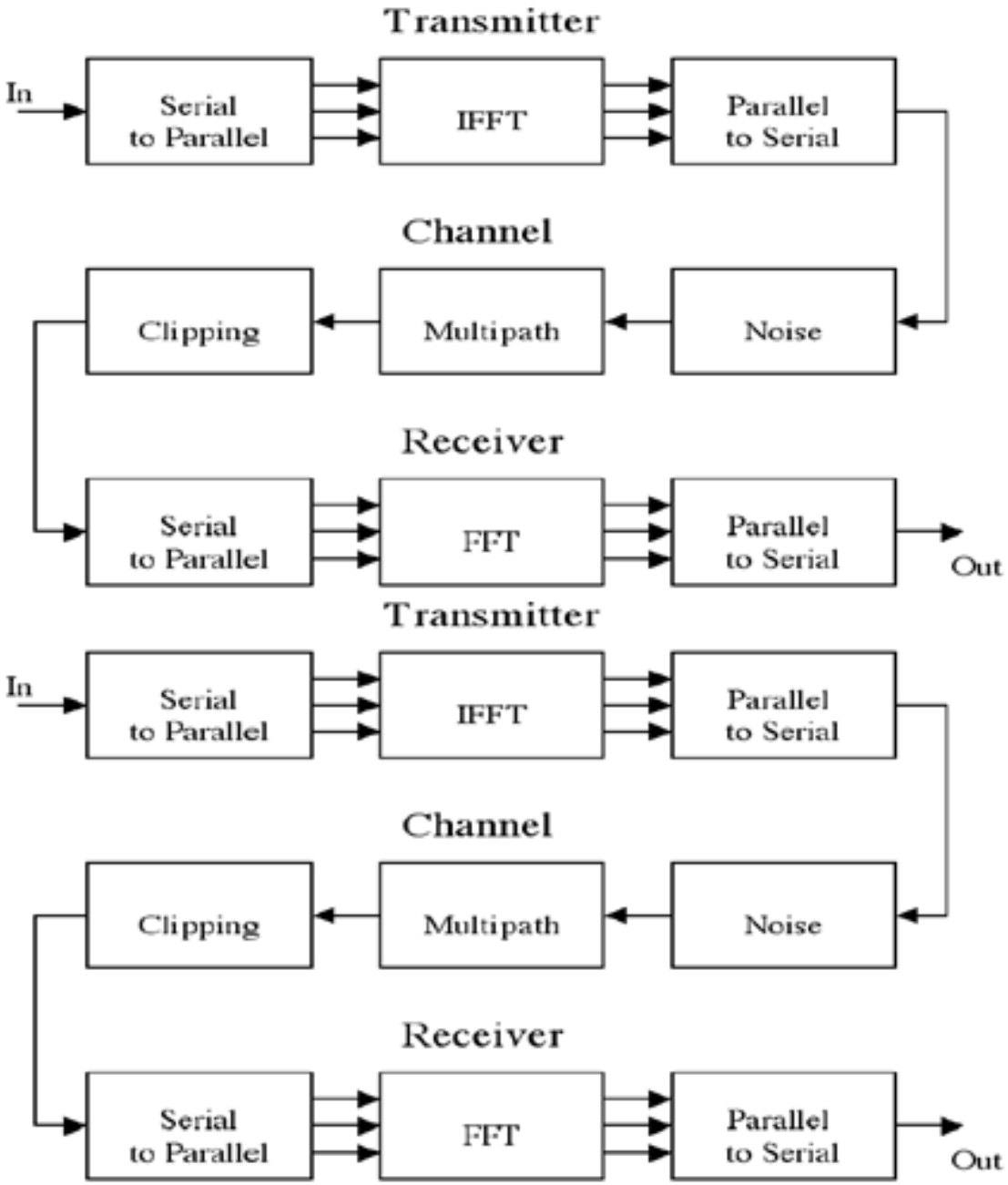
[1] Robert w.chang, et al, "Introduced an orthogonal frequency technique to simultaneously transmit large number of data messages with maximum data rate through transmission medium which is band limited but without ISI and ICI. Adaptive correlation is used for data processing as the orthogonality is sustained among the received signal without any effect of phase distortions. This proposed system provides strong protection against channel noises as well as intersymbol interference. [2] L.J Climini, "Analyzed a modulation technique which combats the effects of co-channel interference and multipath propogation in digital mobile channel. DFT is used to multiplex signal frequency orthogonally and Rayleigh fading effect is significally reduced when used with pilot based correction with an improvement in 6dB. [3] S.B weinstein, "Proposed a data communication system using DFT and IDFT for modulation and demodulation process. The system requires bank of subcarrier oscillator and coherent demodulators. The effect of linear channel distortions are studied and differential phase modulation is used. [4] R. kumar et al, "Compared the performance of time domain equalization with frequency equalization technique by using the window function in time domain equalization. It is shown that the window technique suppress ICE better than correlative coding. [6] Hyunsoocheon (2002), "Effect of channel estimation error in OFDM based WLAN published in IEEE COMMUNICATION.

III. PROPOSED METHODOLOGY



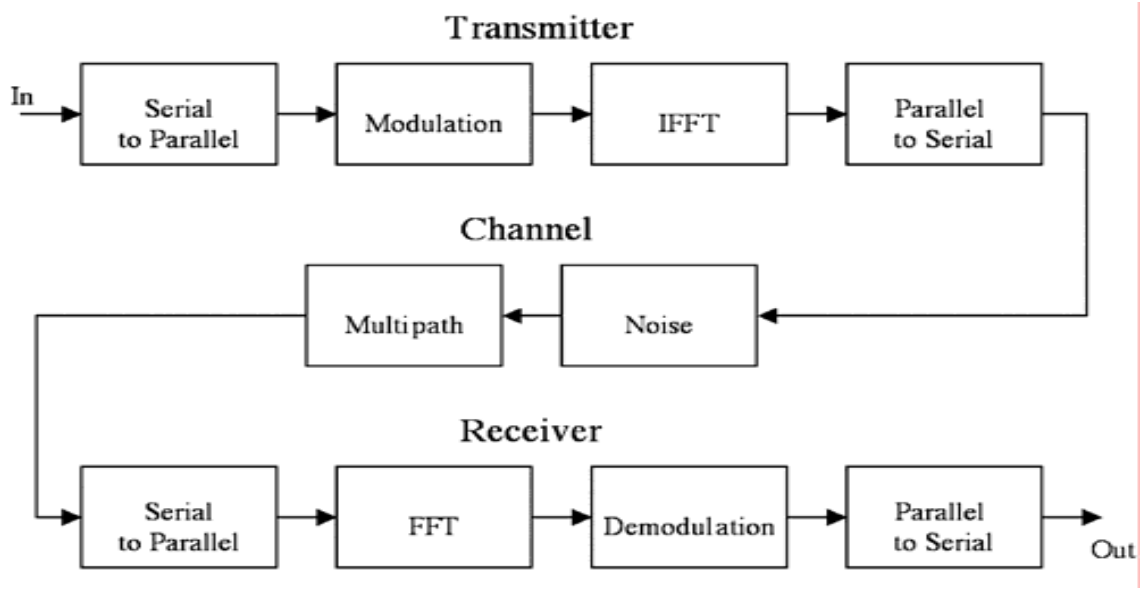


Fig1.Block Diagram of System

1. OFDM Transmitter

The OFDM transmitter consists of the Random Data Generator which generates the random bit sequence as an input signal. Consider that we want to send the following data bits using OFDM : D = {d0,d1,d2,…). The first thing that should be considered in designing the OFDM transmitter is the number of subcarriers required to send the given data. As a generic case, lets assume that we have N subcarriers. Each subcarriers are centered at frequencies that are orthogonal to each other (usually multiples of frequencies). Since we assumed that there are N subcarriers allowed for the OFDM transmission, we name the subcarriers from 0 to N-1. Now, the Serial to Parallel converter takes the serial stream of input bits and outputs N parallel streams (indexed from 0 to N-1). These parallel streams are individually converted into the required digital modulation format (BPSK, QPSK, QAM etc..,). Let's call this output $S_0,S_1,..S_N$. The conversion of parallel data (D) into the digitally modulated data (S) is usually achieved by a constellation mapper, which is essentially a look up table (LUT). Once the data bits are converted to required modulation format, they need to be superimposed on the required orthogonal subcarriers for transmission. This is achieved by a series of N parallel sinusoidal oscillators tuned to N orthogonal frequencies ($f_0,f_1,…f_{N-1}$). Finally, the resultant output from the N parallel arms are summed up together to produce the OFDM signal

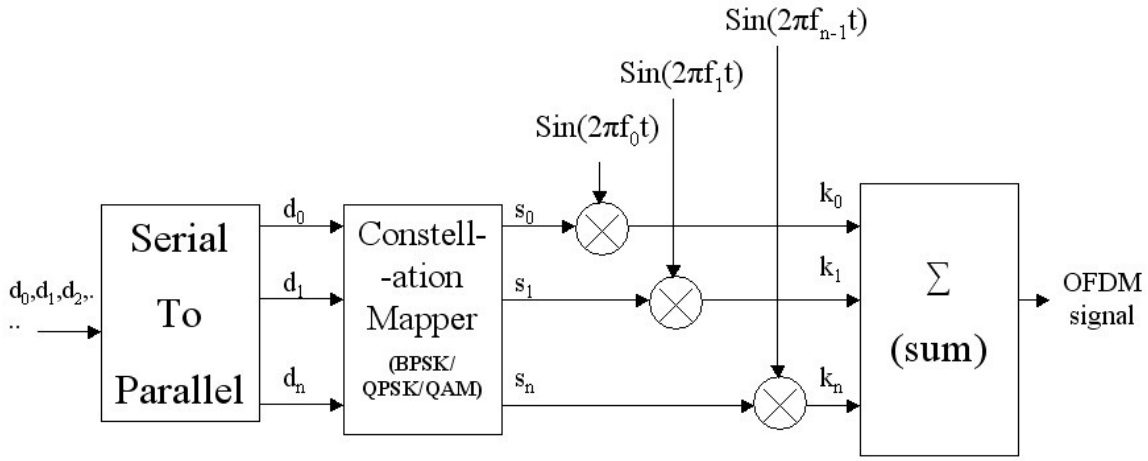


Fig 2. OFDM Transmitter

Now, the important concept in OFDM is guard band. The guard band is used to achieve high level of multipath robustness because time for multipath signals from the previous signal die away before the information from the current signal is gathered this eliminates Inter symbol interference (ISI) also using

cyclic prefix as guard interval helps cyclic prefix keeps the transmitted signal periodic and this techniques helps to avoid Inter carrier interference (ICI

2. OFDM Receiver

The OFDM signal at transmitter consists of some Gaussian noise. The data received at the receiver and the guard interval is removed from the OFDM signal. Then the data is converted from serial stream to parallel stream. The parallel data is transformed by the Fast Fourier Transform block and the time domain signal gets converted into frequency domain signal. The signal is further demodulated and decoded. Thus the received signal is equalized and detected to retrieve the originally transmitted symbol.
The use of Fast Fourier Transform avoids the complexity in the circuit. It reduces the number of modulators and filters to be used at the transmitter as well as complementary filters and demodulators at the receiver. This greatly simplifies the design of both transmitter and receiver; unlike conventional FDM, a separate filter for each sub-channel is not required.

3. BER Calculation

A common problem found in high-speed communication is inter-symbol interference (ISI). ISI occurs when a transmission interferes with itself and the receiver cannot decode the transmission correctly. Because the signal reflects from large objects such as mountains or buildings, the receiver sees more than one copy of the signal. In communication terminology, this is called multipath. Since the indirect paths take more time to travel to the receiver, the delayed copies of the signal interfere with the direct signal, causing ISI. This project will focus on Orthogonal Frequency Division Multiplexing (OFDM) research and simulation. In an OFDM scheme a large number of sub- channels or sub-carriers are used to transmit digital data. Each sub-channel is orthogonal to each other. They are closely spaced and narrow band.
As communication systems increase their information transfer speed, the time for each transmission necessarily becomes shorter. Since the delay time caused by multipath remains constant, ISI becomes a limitation in high-data-rate communication. OFDM avoids this problem by sending many low speed transmissions simultaneously on different carriers as shown in following fig,

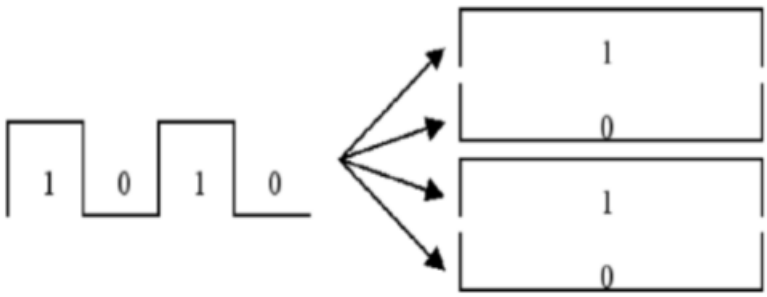


Fig. 3 signal transmitted to the transmitter.

IV. PROPOSED DESIGN

This paper discusses the design and implementation of an OFDM modem used in wireless communication. This technique has high transmission rates over wire line and wireless channels with protection from multipath fading which can turn out to be a predicted technique in fourth Generation (4G) mobile phones. The advantages of this modulation are the reason for its increasing usage. OFDM can be implemented easily, it is Spectrally efficient and can provide high data rates with sufficient robustness to channel imperfections. These system will reduce BIT ERROR RATE ALSO increase data rate.

V. BIT ERROR RATE

In digital transmission, the number of bit errors is the number of received bits of the data stream over a communication channel that has been altered due to noise interference distortions or bit synchronization errors.

The bit error rate (BER) is the number of bit errors per unit time. The bit error ratio is the number of bit errors divided by the total number of transferred bits during a time interval. Bit error ratio is a unit less performance measure, often expressed as a percentage.

The bit error probability is the expectation value of the bit error ratio (BER). The bit error ratio can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors.

VI. RESULTS

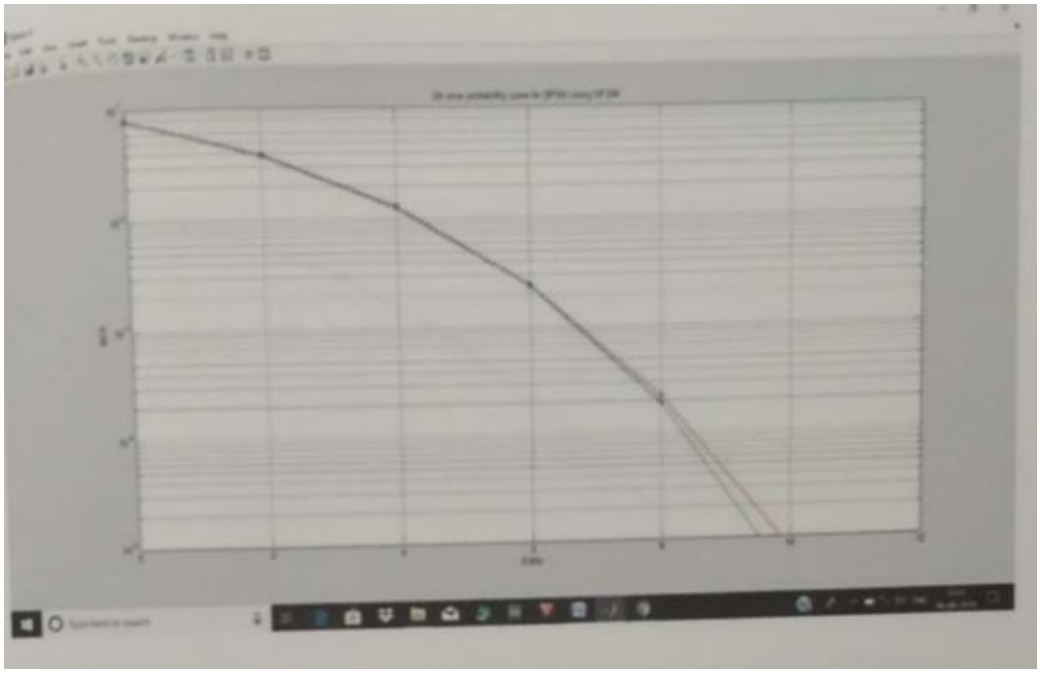


Fig. 4 BER graph using BPSK for AWGN channel.

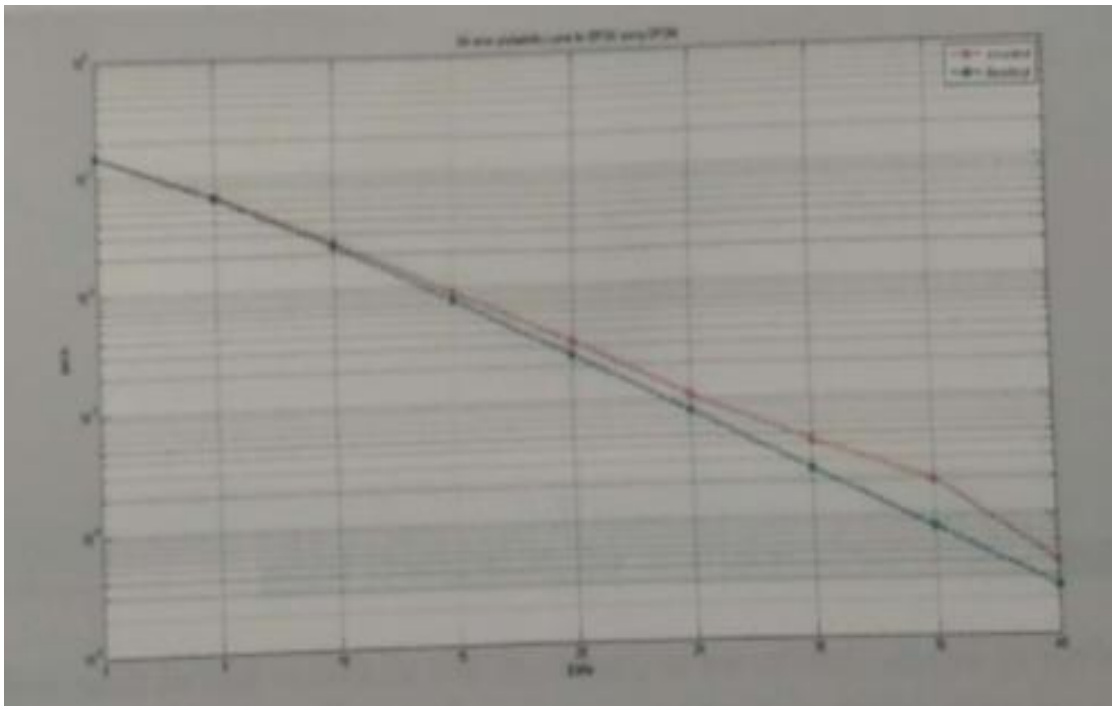


Fig.5 BER vs SNR graph for Rayleigh.

Fig. 6 BER vs SNR graph for Rician.

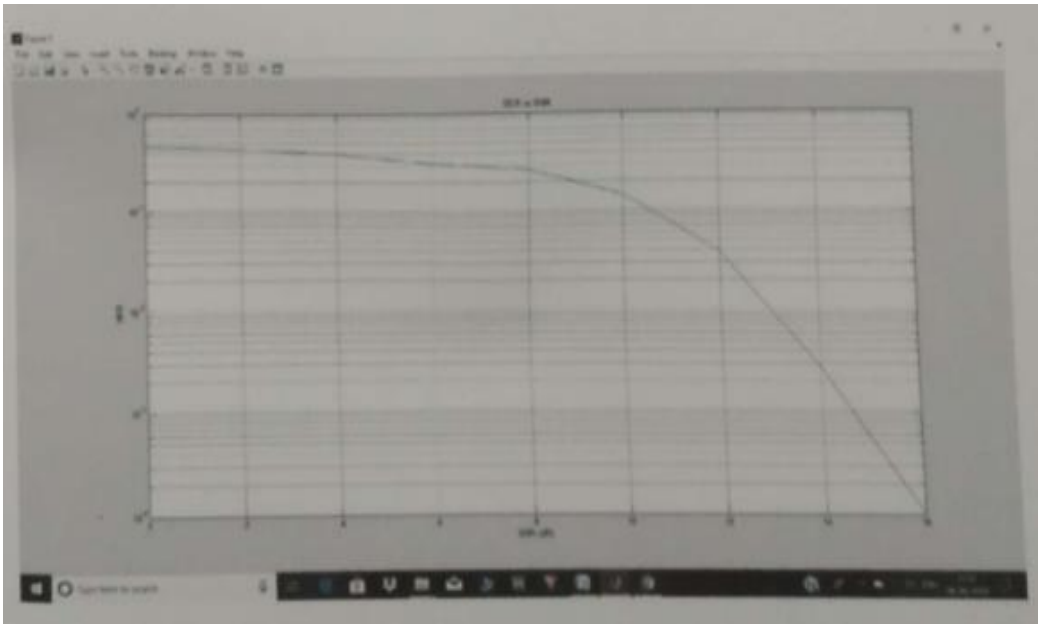


Fig. 7 BER vs SNR graph for AWGN channel

VII. CONCLUSION

BER performance for various digital modulation schemes were analyzed for AWGN, Rayleigh, Rician fading channels. Selection of modulation schemes depends on performance characteristics. Choice comes

with a trade off in hardware and performance. BPSK and QPSK gives better performance when compared to other modulation channel.

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