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BER Analysis Wavelet Based OFDM in LTE Using Different Modulation Techniques

Khushbu Mehta, Aabhas Mathur, Dr. Hemant Dhabai

Research scholar M.Tech. (D.C), Arawali Institute of Technical Studies, Udaipur, Rajasthan, India

Associate Professor & Head, Arawali Institute of Technical Studies, Udaipur, Rajasthan, India

Professor, Arawali Institute of Technical Studies, Udaipur, Rajasthan, India

ABSTRACT: In this paper wavelet based OFDM at the place of Discrete Fourier Transform (DFT) based OFDM in LTE. We have compared the BER performance of wavelets and DFT based OFDM. The performance analysis of an Orthogonal Frequency Division Multiplexing (OFDM) system and the bandwidth extension achieved with carrier aggregation (CA). Data, when transmitted through any communications system, primarily faces three types of problems, errors, power management, and bandwidth. For the purpose of analyzing OFDM performance, we have taken a two-fold approach. Different types of modulation schemes such as QPSK and 16-QAM with OFDM are studied for their Bit Error Rate (BER). A noisy channel adversely affects data transmission. For this work, we study the modulation schemes with OFDM over two types of noise channels, BER rates for both these channels has been simulated in MATLAB simulation

KEYWORDS: QPSK,QAM,OFDM,BER,DFT

I. INTRODUCTION

Wireless communication, or sometimes simply wireless, is the transfer of information or power between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio waves. With radio waves distances can be short, such as a few meters for Bluetooth or as far as millions of kilometers radio communications. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Other examples of applications of radio wireless technology include GPS units, garage door openers, wireless computer mice, keyboards and headsets, headphones, radio receivers, satellite television, broadcast television and cordless telephones. Somewhat less common methods of achieving wireless communications include the use of other electromagnetic wireless technologies, such as light, magnetic, or electric fields or the use of sound. The term wireless has been used twice in communications history, with slightly different meaning. It was initially used from about 1890 for the first radio transmitting and receiving technology, as in wireless telegraphy, until the new word radio replaced it around 1920. The term was revived in the 1980s and 1990s mainly to distinguish digital devices that communicate without wires such as the examples listed in the previous paragraph, from those that require wires or cables. This became its primary usage in the 2000s, due to the advent of technologies such as LTE, LTE Advanced, Wi-Fi and Bluetooth. operations permit services, such as long-range communications, that are impossible or impractical to implement with the use of wires. The term is commonly used in the telecommunications industry to refer to telecommunications systems (e.g. radio transmitters and receivers, remote controls, etc.) [10][12][9] which use some form of energy (e.g. radio waves, acoustic energy,) to transfer information without the use of wires. Information is transferred in this manner over both short and long distances. In the existing system the discrete Fourier transform is used for the orthogonal basis function. [6][8] First the Random data is generated and then the data is encoded by the encoder and the corresponding modulation is processed. The modulated signal is applied with the inverse Fourier transform is performed. After that the cyclic prefix data is added to the modulated signal and then the signal is passed into the channel with the noise. And the aforementioned process are

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performed on the transmitter side and then the reversal operations of the aforementioned processes are performed. In the receiver side the cyclic prefix is removed from the channel output data and then the pilot synchronization is performed after that the Fourier transform is applied on the synchronized data and then the demodulation is formed. [10][5] And the demodulated data is decoded at the receiver. Finally the BER performance is estimated. Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input and Multiple Output (MIMO) are two main techniques in the Long term evolution communication process. In the OFDM system multiple carriers are used and it provides higher level of spectral efficiency as compared to Frequency Division Multiplexing (FDM). In the OFDM systems there exist some problems such as Intersymbol interference and Intercarrier Interference which due to the loss of orthogonality between the subcarriers. In order to avoid this problem cyclic prefix is added to the signal before passing into the channel. By adding that the cyclic prefix data which uses 20% of available bandwidth. So the inefficiency of the bandwidth is raised. In order to solve that Wavelet based OFDM provides good orthogonality and with its use Bit Error Rate (BER) is improved. Wavelet based system does not require cyclic prefix, so spectrum efficiency is increased [1][7][5]

II. RELATED WORK

In the existing system the discrete Fourier transform is used for the orthogonal basis function. First the Random data is generated and then the data is encoded by the encoder and the corresponding modulation is processed. The modulated signal is applied with the inverse Fourier transform is performed. After that the cyclic prefix data is added to the modulated signal and then the signal is passed into the channel with the noise. And the aforementioned process are performed on the transmitter side and then the reversal operations of the aforementioned processes are performed. In the receiver side the cyclic prefix is removed from the channel output data and then the pilot synchronization is performed after that the Fourier transform is applied on the synchronized data and then the demodulation is performed. And the demodulated data is decoded at the receiver. Finally the BER performance is estimated.

III. PROPOSED METHO

The proposed system we are using inverse discrete Fourier transform IDWT and discrete Fourier transform DWT at the place of IDFT and DFT. SUI - 2 channels is used for transmission and cyclic prefixing is not used. In the transmission side conventional encoding is performed and then interleaving is performed on the encoded data. Then the data is converted to decimal form and modulation is done. Here we are use the QPSK, QAM-16 and QAM-64 is performed. After modulation the pilot insertion and sub carrier mapping is performed on the data and then IDWT of the data, which provides the orthogonality to the subcarriers. IDWT will convert time domain signal to the frequency domain. After passing through th

channel on the signal DWT will be performed and then pilot synchronization where the inserted pilots at the transmitter are removed then the demodulation is performed. Demodulated data is converted to binary form and the de-interleaved and decoded to obtain the original data transmitted. Finally the performance of the system is evaluated by using the BER analysis.

ALGORITHM :SUI – 2 Channel Model: Imax technology is a broadband wireless data communications technology based around the IEE 802.16 standard providing high speed data over a wide area. Stanford University Interim (SUI) model is developed for IEEE 802.16 by Stanford University. It is used for frequencies above 1900MHz. IEEE 802.16. Broadband Wireless Access working group proposed the standards for the frequency band below 11 GHz containing the channel model developed by Stanford University, namely the SUI models. The SUI model describes three types of terrain; they are terrain A, terrain B and terrain C. Terrain A can be used for hilly areas with moderate or very dense vegetation. OFDM has been incorporated into WiMAX technology to enable it to provide high speed data without the selective fading and other issues of other forms of signal format

QAM MODULATION:QAM (quadrature amplitude modulation) is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth. QAM is used with pulse amplitude modulation (PAM) in digital systems, especially in wireless applications. This modulation technique is a

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combination of both Amplitude and phase modulation techniques. QAM is better than QPSK in terms of data carrying capacity. QAM takes benefit from the concept that two signal frequencies; one shifted by 90 degree with respect to the other can be transmitted on the same carrier. For QAM, each carrier is ASK/PSK modulated. Hence data symbols have different amplitudes and phases. QPSK: quadrature phase shift keying. Quadrature means the signal shifts among phase states that are separated by 90 degrees. The signal shifts in increments of 90 degrees from 45° to 135°, -45° (315°), or -135°

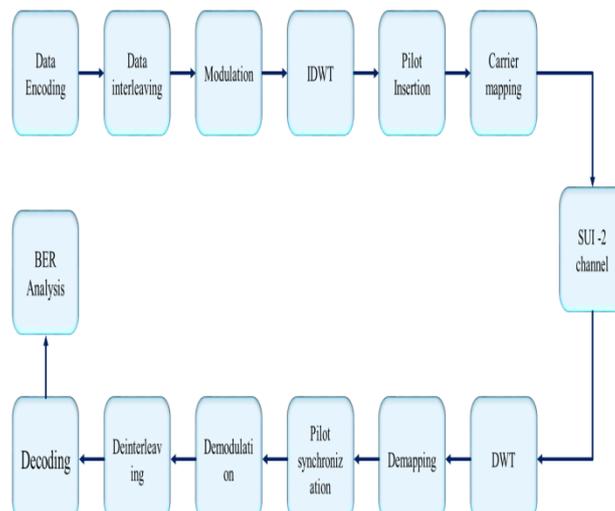


Fig 1 Proposed Diagrams

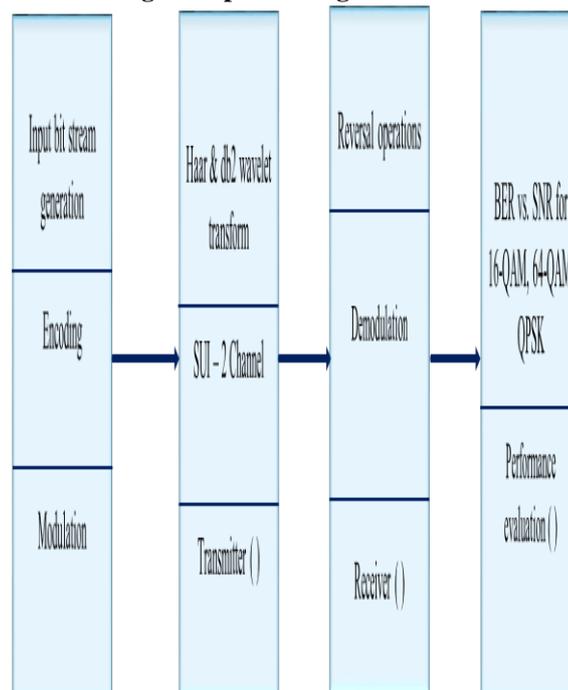


Fig.2 class Diagram of OFDM

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(225°). Data into the modulator is separated into two channels called I and Q. Two bits are transmitted simultaneously, one per channel. Each channel modulates a carrier. The two carrier frequencies are the same, but their phase is offset by 90 degrees (that is, they are “in quadrature”). The two carriers are combined and transmitted • Four states because $2^2 = 4$. Theoretical bandwidth efficiency is two bits/second/H.

USECASE DIAGRAM

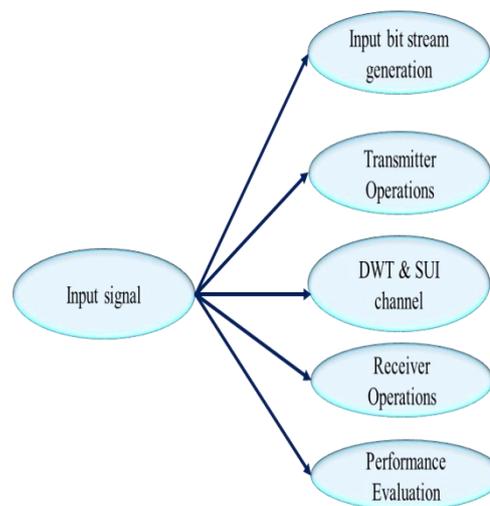


Fig.3 use case Diagram

Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input and Multiple Output (MIMO) are two main techniques employed in 4th Generation Long Term Evolution (LTE). In OFDM multiple carriers are used and it provides higher level of spectral efficiency as compared to Frequency Division Multiplexing (FDM). In OFDM because of loss of orthogonality between the subcarriers there is inter carrier interference (ICI) and intersymbol interference (ISI) and to overcome this problem use of cyclic prefixing (CP) is required, which uses 20% of available bandwidth. Wavelet based OFDM provides good orthogonality and with its use Bit Error Rate(BER) is improved. Wavelet based system does not require cyclic prefix, so spectrum efficiency is increased. It is proposed to use wavelet based OFDM at the place of Discrete Fourier Transform (DFT) based OFDM in LTE. We have compared the BER performance of wavelets and DFT based OFDM

SEQUENCE DIAGRAM

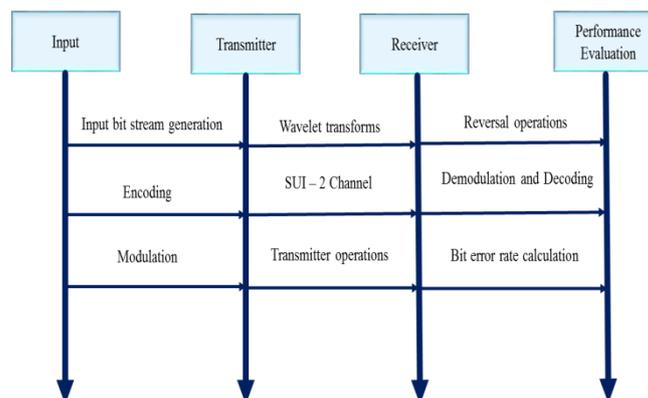


Fig 4 sequence Flow Diagram

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ER DIAGRAM

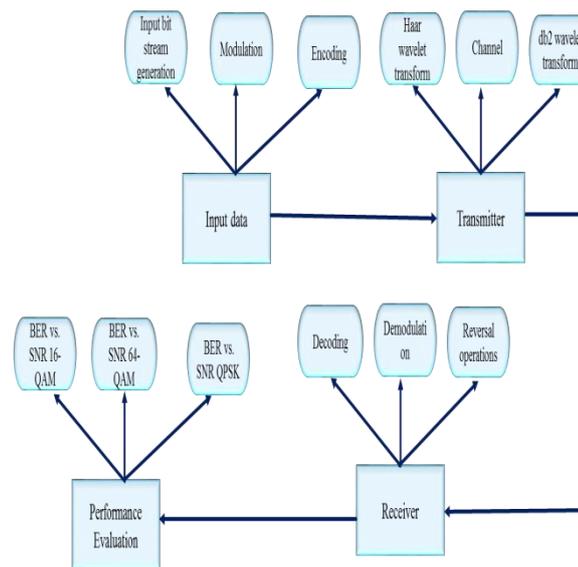


Fig.5 ER Diagram

IV. MODULES

- OFDM Symbol Generation Model
- Modulation Model
- SUI – 2 Channel Model
- Performance Analysis Model

OFDM SYMBOL GENERATION MODEL: Using a large number of parallel narrow-band subcarriers instead of a single wide-band carrier to transport information. OFDM is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method and is essentially identical to coded OFDM (COFDM) and discrete multi-tone modulation (DMT). It is used in such diverse applications as digital television and audio broadcasting, wireless networking and broadband internet access. OFDM has also been adopted in some military communication systems. OFDM scheme, a large number of orthogonal, overlapping, narrow band sub-channels or subcarriers, transmitted in parallel, divide the available transmission bandwidth. The separation of the subcarriers is theoretically minimal such that there is a very compact spectral utilization. The attraction of OFDM is mainly due to how the system handles the multipath interference at the receiver. Multipath generates two effects: frequency selective fading and intersymbol interference (ISI). The "flatness" perceived by a narrow-band channel overcomes the former, and modulating at a very low symbol rate, which makes the symbols much longer than the channel impulse response, diminishes the latter. Using powerful error correcting codes together with time and frequency interleaving yields even more robustness against frequency selective fading, and the insertion of an extra guard interval between consecutive OFDM symbols can reduce the effects of ISI even more. Thus, an equalizer in the receiver is not necessary.

MODULATION MODEL:QAM (quadrature amplitude modulation) is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth. QAM is used with pulse amplitude modulation (PAM) in digital systems, especially in wireless applications. This modulation technique is a combination of both Amplitude and phase modulation techniques. QAM is better than QPSK in terms of data carrying

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PERFORMANCE ANALYSIS: The bit error rate (BER) is the number of bit errors divided by the total number of transmitted bits over a channel. BER although unit-less also expressed in terms of percentage. The bit error rate (BER) is the number of bit errors per unit time. The bit error ratio (also BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bit error ratio is a unit less performance measure, often expressed as a percentage. The BER may be improved by choosing a strong signal strength, by choosing a slow and robust modulation scheme or line coding scheme, and by applying channel coding schemes such as redundant forward error correction codes. The BER may be evaluated using stochastic (Monte Carlo) computer simulations. If a simple transmission channel model and data source model is assumed, the BER may also be calculated analytically. By using MATLAB performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for different modulations that are used for the LTE, as shown in figures 3-5. Modulations that could be used for LTE are QPSK, 16 QAM and 64 QAM (Uplink and downlink). QPSK does not carry data at very high speed. When signal to noise ratio is of good quality then only higher modulation techniques can be used. Lower forms of modulation (QPSK) does not require high signal to noise ratio. For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through AWGN channel. Data of 9600 bits is sent in the form of 100 symbols, so one symbol is of 96 bits. Averaging for a particular value of SNR for all the symbols is done and BER is obtained and same process is repeated for all the values of SNR and final BERs are obtained. Firstly the performance of DFT based OFDM and wavelet based OFDM are obtained for different modulation

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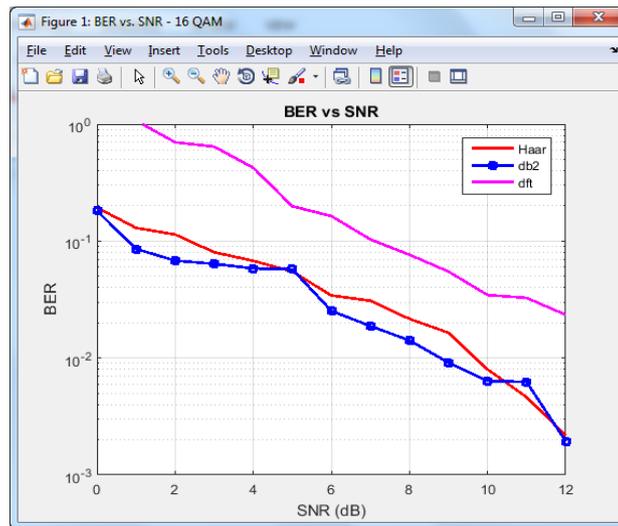


Fig.6 . BER performance of wavelets and DFT based OFDM system using QPSK modulation.

For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through AWGN channel. Data of 9600 bits is sent in the form of 100 symbols, so one symbol is of 96 bits. Averaging for a particular value of SNR for all the symbols is done and BER is obtained and same process is repeated for all the values of SNR and final BERs are obtained. Firstly the performance of DFT based OFDM and wavelet based OFDM are obtained for different modulation

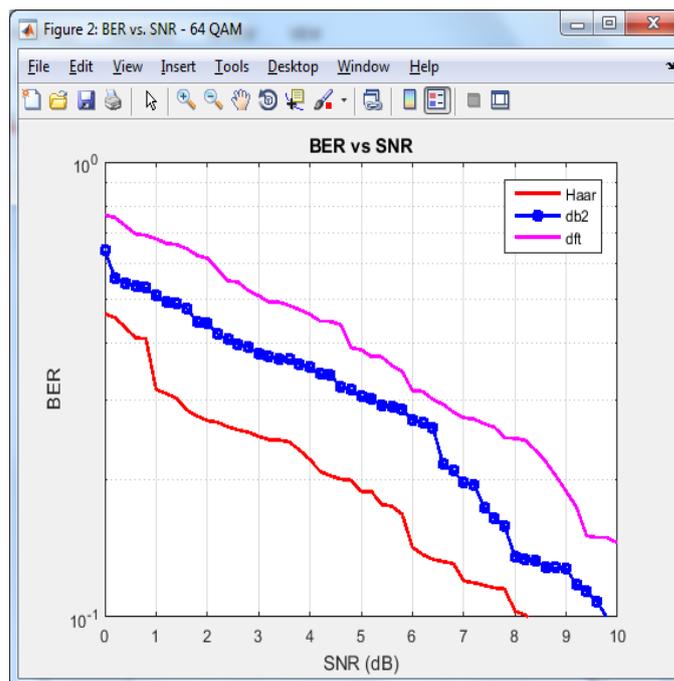


Fig.7 BER performance of wavelets and DFT based OFDM system using 64-QAM modulation.

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Techniques. Different wavelet types daubechies2 and haar is used in wavelet based OFDM for QPSK, 16-QAM, 64-QAM. It is clear from the fig. 3, fig. 4 and fig. 5 that the BE performance of wavelet based OFDM is better than the DFT based OFDM. Fig. 3 indicates that db2 performs better when QPSK is used. Fig. 4 shows that when 16-QAM is used db2 and haar have similar performance but far better than DFT. Fig. 5, where 64-QAM is used haar and db2 performs better than DFT. To measure the boundary SNR regions for adaptive modulation, the OFDM system has been implemented with different fixed modulation schemes such as BPSK, QPSK, 16 QAM and 64 QAM, which is shown in Figure 3.2. Figure 3.2 shows the comparison of SNR vs BER for different modulation techniques. It shows that the BER rate mainly depends on the constellation size M. BPSK provides good BER performance, but its spectral efficiency is only 1bps/Hz, which is very low compared to other modulation schemes

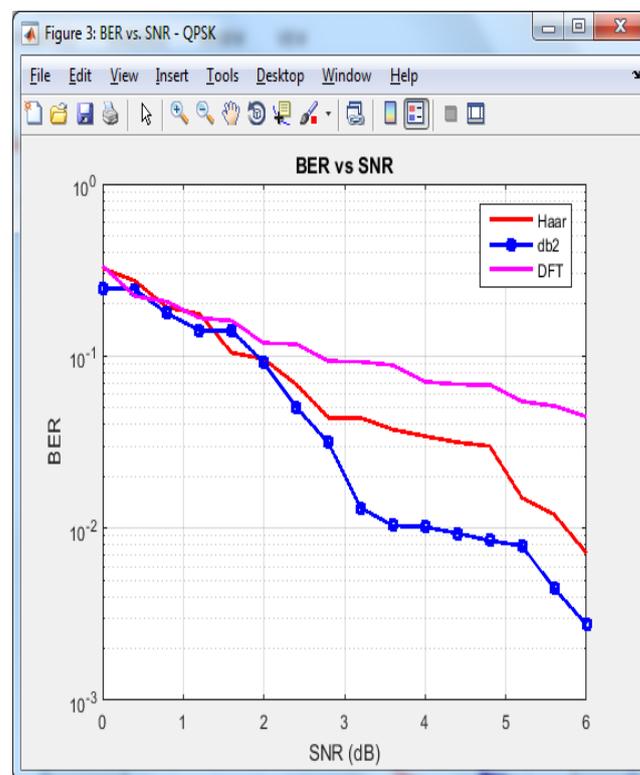


Fig. 8 BER performance of wavelets and DFT based OFDM system using 16- QAM modulation.

At the same time 64QAM will able to provide better spectral efficiency that is 6bps/Hz, but it fails to maintain good BER performance and thus low QoS. These modulation techniques are fixed modulation techniques. It provides fixed data rate irrespective of channel conditions. To maximize the spectral efficiency with achieving target BER, adaptive modulation technique is used in practice.

V. CONCLUSION

Thus in this proposed system, we analyzed the performance of the system based on the wavelet based OFDM system and the proposed system is compared with the performance of DFT based OFDM system. The performance of the proposed system which shows that the proposed system which gives better results than the DFT based OFDM system. In that proposed system we use the 16-QAM, 64-QAM and QPSK modulation technique, which are used in LTE. In wavelet based OFDM different types of filters can be used with the help of different wavelets available. The Haar based wavelet and db2 wavelet system are used for the estimation. Finally the BER vs. SNR graphs are simulated to

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show the performance of the system. results will show that performance is improved by using lower order modulation formats e.g. Binary Phase Shift Keying (BPSK) and Quadrature Amplitude Modulation (4-QAM), compared to the higher modulation schemes e.g. 64-QAM; as they offer lower data rates but are more robust in the presence of noise. The performance study of OFDM scheme is also examined with and without presence of noise and application of FEC.

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