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HIGH PERFORMANCE VARIABLE RATE CODED OF DM SYSTEM FOR 5G NR SYSTEM

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Abstract

In recent years 5G NR (New Radio) and long-term evolution (LTE)systemic steadily emerging to meet desired data rate and QoS. The emerging applications like IoT demands data-rich services and sophisticated server related applications with reduced latency measures. In this paper introduces variable rate coded OFDM system, optimal channel estimation, multi user detection (MUD) and MIMO pre-coding to meet the 5Gsystem requirements. In this work, we also analyze both performance metrics and vulnerability of 5G NR over different channel conditions. The proposed system includes OFDM and error correction with the combined convolution codes (CE) and reed Solomon codes and improved diversity gain with parameters chosen to meet 5G NR wireless standards. The SNR requirements at the base station to achieve 95% of the maximum throughput specified for fixed reference channels are the subject of this paper's analysis and discussion of the receiver reference sensitivity requirements for 5G New Radio (NR) wireless communications systems. A wide range of different transmission bandwidths and radio interface numerologies are investigated at sub-6GHz and millimeter-wave frequency ranges, covering both AWGN and fading channel scenarios as well as various mobility conditions, based on the most recent 3GPP specifications and evaluation assumptions agreed upon for Release. The performance results utilizing the LDPC coding scheme are shown and examined, and results using LTE turbo code are also supplied for comparison. Performance results are measured in terms of relative throughput and block error rate. According to the findings, LDPC code consistently outperforms turbo code in terms of reference sensitivity and UL radio link performance in frequency-selective channels. The results further show that the purely front-loaded demodulation reference signal (DM-RS)-based system can perform better than the corresponding two DM-RS-based system even at greater velocities and high center frequencies, enabling minimal decoding latency and effective pipelined receiver processing.

Keywords - Forward error correction (FEC), MIMO, channel estimation, BER, pilot information, SNR, coded OFDM etc.

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Introduction

Next-generation wireless communication, 5G will require intelligence and flexibility across mobile networks and devices; the rollout of 5G from the cloud to the edge will transform the network to handle the data wave we expect in the coming years. Several works proved that un-coded OFDM symbols are completely not solved the BER interference problem. But as a consequence MIMO based diversity gain is introduced to overcome the limitations of error related problems that exists in CP-OFDM system.

Some investigations also include the improved diversity gain using Massive MIMO system. Existing studies also showed that any BER reduction in CP-OFDM methodologies greatly influence the system performance and the complexity overhead. In most cases advance multi user detection (MUD) technique is preferred for its improved quality metrics with finite computational complexity trade off. In order to narrow down the semantic gab between conventional CP-OFDM and coded MIMO OFDM while retaining the attainable performance metrics in terms of SNR and BER strategies. In this work, the effects of MIMO antenna gain and associated antenna dimension in coded MIMO OFDM system in QOS problem and attainable directive gain are analyzed and present optimal CSI aware antenna selection and error correction code model and signal detection at the receiver side. The system utilizes spectral properties of MIMO antenna elements to control the channel environment. And also proposed CSI enabled SNR threshold driven MIMO pre-coding and forward error correction (FEC) scheme. The term "demodulation reference signals" (DM-RSs) is generally used to describe the well-known training signals used for channel estimation (CE) to support data channel demodulation 5GNR With 5G NR, the fundamental DM-RS pattern is front-loaded to support low-latency applications with quick decoding. However, higher DM-RS densities in the time domain are typically thought to be required as user speeds increase in order to be able to respond to the quick changes in the channel. In general, the DM-RS design seeks to balance system overhead and CE performance, especially in high-speed cases with significant Doppler effects. While networks installed at FR1 are typically made up of larger cell sizes and geared to support higher user speeds, it is common to expect small-cell deployment situations in FR2 with lower user speeds. The findings in this study describe evaluations of first physical layer performance made under several deployment scenarios that included various OFDM numerologies, carrier frequencies, and speeds to evaluate the needs of the 5G base station (GNB) REFSENS. The minimal receiver signal-to-noise ratio (SNR) level at which the base station achieves at least 95% of the related maximum throughput of the analyzed MCS is generally referred to as the REFSENS measurement.

The major goal of the REFSENS criteria is to evaluate the authorized receiver noise figure in the base station as well as to verify the appropriate throughput performance with various allocation sizes to ensure reliable UL operation. The performance study is based on the notion of 5G NR FRCs, whose REFSENS evaluation criteria have been established.

These are significant.

I. RELATED WORKS

The invention of 5G wireless communication system requires optimal FEC coded scheme, channel estimation and improved MIMO antenna configuration etc. With the inclusion of MIMO in existing OFDM system reduce the sensitiveness of data propagation towards various interferences and vulnerable to ICI and ISI. In general coded MIMO OFDM is only desirable because it results with suppresses intrinsic interference and support all existing wireless standards developed for conventional OFDM system. Though coded OFDM system has almost the similar kind of robustness to multipath fading as like CP OFDM system still it suffers significant BER degradation due to orthogonality losses. In [9] introduced low-density parity check (LDPC) coded MIMO OFDM systems and analyzed the performance metrics and carried out design optimization for improved data rate for next generation wireless communication system. Here highly irregular LDPC codes are incorporated to optimally reduce the signal-to-noise ratios (SNRs) over high mobility channels. Moreover, number of antennas is optimally used with different antenna configurations for different modulation orders to maximize the channel capacity. At the receiver side soft maximum a posteriori (MAP) is applied to achieve 1 dB with optimal ergodic capacity. In [10] two ambiguity matrices are developed to accommodate the pilot symbols for improved frequency domain channel estimation. Here the CE is based on semi blind approach to approximate the channel state information.

The coded MIMO OFDM system proposed in [11] used continuous wideband transmission at the uplink side and MIMO based decoding at the downlink side for radar communication system. Here both code rate and pre coding matrix is optimally changed with associated FEC and MIMO system. The performance metrics are using subcarrier interleaving coded OFDM with 4×4 MIMO system and achieved 77GHz performance measures. In [12] combined MIMO and OFDM systems to maximize the spectral efficiency with improved channel capacity. To increase the QoS at the receiver improved frequency domain equalization (FDE) and improved diversity gain. To comprise the computational complexity three different equalization techniques namely iterative maximum rate combining (MRC) and equal gain combining (EGC) and an iterative block decision feedback equalizer (IB-DFE).

In [13] detailed comprehensive analyzes is carried out over Massive MIMO-OFDM system and discussed merits and limitations. The parameters of different Massive MIMO-OFDM systems are investigated for next generation 5G wireless communication system which includes PAPR reduction, MIMO pre-coding, diversity gain, most accurate channel estimation and optimal forward error-correcting codes (FEC).In [14] introduced improved multi-user detection (MUD) for MIMO-OFDM systems to optimally reduce the error rate performance by suppressing the influence of multi-access interference (MAI). Here both channel estimation and multi-user detection are combined to reduce the various interferences significantly with improved bit error rate (BER). For improved CE using k-nearest neighbor based classifier and optimal symbol detection at the receiver side.

Discrete-time algorithms proposed in [15] introduce a novel turbo coded MIMO system for both timing and frequency synchronization, and improved channel estimation process. Experimental results validate the coded turbo coded MIMO system offers BER of 10^{-5} at SNR value of 5.5dB. In [16] developed two orthogonal prototype filters for FBMC QAM system to improve the BER performance and analyzes the OOB radiation causes by filter coefficient discontinuity. Sim et al., (2016) et al proposed decision feedback equalization (DFE) and successive interference cancellation (SIC) to improve BER rate without causing OOB radiation overhead. In general both of these models for FBMC QAM incur high complexity and quality always comes with finite trade off in hardware design complexity.

In recent years MIMO is emerging as predominant technique that allows sharing the resources (antenna, channel) among different users in order to meet increasing demands such as channel capacity and user data rates. Several objectives are needed to be optimized particularly energy-efficient and cost-effective solutions. To respond to these challenges, 5G networks are required to incorporate new emerging techniques which are been used for wide range of applications like IP TV, DVB, DAB and DTMB etc. The obtained 5G NR radio connection performance findings and the accompanying GNBR x REFSENS results are shown and discussed in this section. The agreed-upon simulation assumptions in Release 15 are used in all assessments, which are carried out using a radio link simulator that complies with 3GPP standardization. As mentioned in the preceding section, results are presented and analyzed using various OFDM numerologies, propagation channel models, coding schemes, DM-RS allocation densities, and different mobility circumstances. Tables III and IV, which illustrate the SNR requirements for the 95th percentile of the UL relative throughput performance, respectively, are collections of the acquired values for the FR1 and FR2 scenarios. Also addressed and examined for particular scenarios are radio link block error rate (BLER) and maximum throughput performance in terms of SNR.

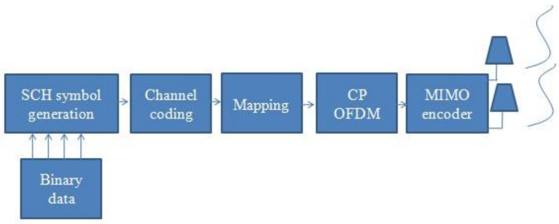

Figure 1 Proposed 5G transmitter architecture.

II. PROPOSED CODED OFDM MIMO SYSTEM

MIMO pre-coding system

In 5G NR Multiple-Input and Multiple-Output (MIMO) system has been predominantly used to improve the channel capacity and system performance of wireless communication system. Here the basic principle is to exploit multipath signals in order to improve signal quality. In general pre-coded systems are equipped with more number of antennas for signal transmission and reception to improve communication performance as shown in Figure 1. In multi-antenna wireless communications, precoding is a generalization of beamforming that supports multi-stream (or multi-layer) transmission. With typical single-stream beamforming, the transmit antennas emit the same signal with the proper weighting (phase and gain), maximizing the signal power at the receiver output. Single-stream beamforming cannot simultaneously maximize the signal level at all of the receive antennas when the receiver contains multiple antennas. Multi-stream transmission is typically necessary to maximize the throughput in systems with numerous reception antennas. Precoding is a generalization of beamforming that permits multi-stream (or multi-layer) transmission in multi-antenna wireless communications. The signal power at the receiver output is maximized with standard single-stream beamforming since the transmit antennas emit the identical signal with the correct weighting (phase and gain). Since the receiver has many antennas, single-stream beamforming cannot simultaneously maximize the signal level at every receive antenna. In systems with several reception antennas, multi-stream transmission is often required to maximize throughput. It has several advantages like increased throughput with improved spectral efficiency. In addition to these coded OFDM systems also widely used for many applications such as wireless LANs and cellular telephony etc. the multi-user MIMO system is investigated in many research works since it can provide space-division multiple access as an additional metric with improved channel capacity of conventional MIMO system. However, achieving the quality of services over MIMO channel is always problematic since MIMO system is greatly influenced by inter-cell interference over channel capacity and practical assessments related issues. In general the multipath propagation model is the important point to consider during the wireless channel modeling design process of any wireless communications system. The transmitted wave not only follows a direct line of sight during channel propagation, it undergoes multipath propagation due to many reflections and attenuated randomly in each path. And all these multipath signals are having a different phase relationships among different users. The end results at the receiver side are depends on the relative phase difference between the multipath signals. Hence in most cases the certain carrier frequency will not be the unique at any from one other. The resultant signal which is the combination of many reflected signals could cause completely constructive or destructive phenomena as shown in Figure 2.

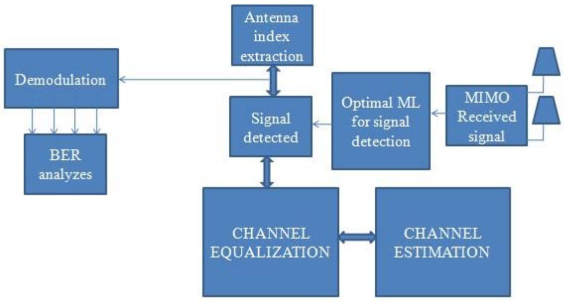

Figure 2 Proposed 5G receiver architecture

Coded OFDM system

Several factors are considered for selecting the optimal technique which optimally reduces the BER effectively over un-coded MIMO OFDM system as shown in Figure 3 while simultaneously regularizing the BER performance. The proposed system includes factors are as follows

1. MIMO antenna gain: Number of antenna used at uplink and downlink side are major factor to decide the BER measures in 5G NR. Here optimal diversity gain is introduced using space time block code (STBC)to increase the diversity gain while reducing the destructive effects of un-coded OFDM system.

2. Optimal ML detector: To suppress the interference by deriving weights for each symbols from the minimum mean square error (MMSE) criterion which retain at low complexity irrespective of user rate. In general linear MMSE MUD cannot perform well over multi user environment which is highly sensitive to co-channel interferences.

3. BER performance tradeoff with coded OFDM: Here optimal number of error correction codes is used for each users and appropriate decoding method is accomplished at the receiver side for multiuser detection which minimize light to moderate interferences among users. Coded OFDM technique is applied at the receiver side to completely reduce the impact of inter user interference which results with considerable signal-to-noise ratio (SNR) as shown in Figure 4 and Figure 5.

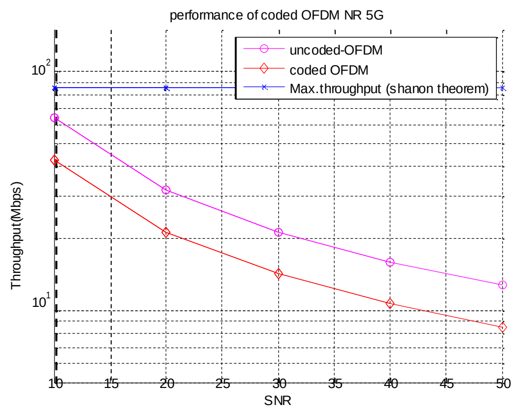

Figure 3 Performance comparison between coded vs un-coded OFDM system in 5G

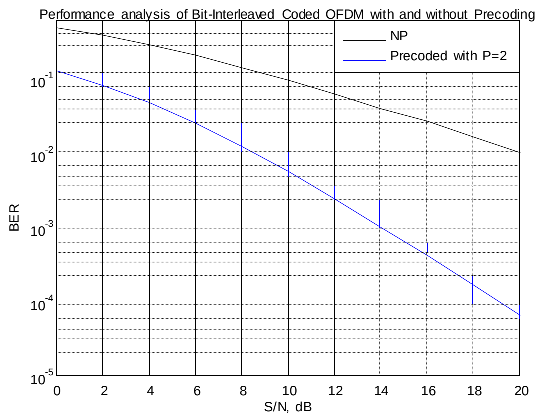

Figure 4 BER performance comparison of proposed precoded vs. conventional OFDM system

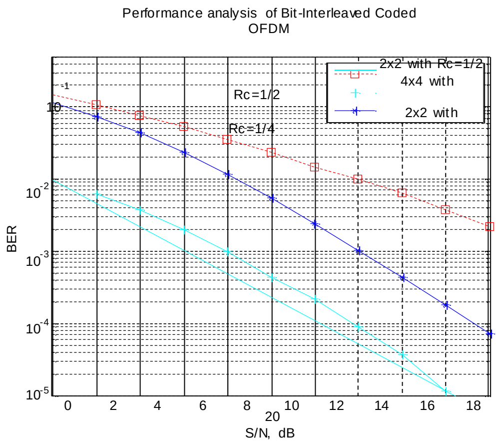

Figure 5 BER error rate analyzes of proposed system over variable puncture rate

III. EXPERIMENTAL RESULTS

As shown in Figure 5 the BER rate not showed any significant changes even when the number of parity bits are changes but increased steeply after some certain SNR bound and can reach maximum over feasible channel condition. But by keeping number of bits unchanged and change the data rate offers improved BER due to improved control over channel and associated error correction capabilities. The quantity of bit errors per unit of time is known as the bit error rate (BER). The bit error ratio (also known as BER) is calculated by dividing the total number of bits transferred during the course of the study period by the number of bit errors. Bit error ratio is a performance metric that has no units and is frequently stated as a percentage. The quantity of bit errors per unit of time is known as the bit error rate (BER). The bit error ratio (also known as BER) is calculated by dividing the total number of bits transferred during the course of the study period by the number of bit errors. Bit error ratio is a performance metric that has no units and is frequently stated as a percentage. The bit error rate will be very low, possibly negligible, and will have no discernible impact on the entire system if the medium between the transmitter and receiver is good and the signal-to-noise ratio is high. Nonetheless, there is a probability that the bit error rate will need to be taken into account if noise can be detected. Noise and changes to the propagation path are the primary causes of a data channel's deterioration and the accompanying bit error rate, or BER (where radio signal paths are used). Given that the noise follows a Gaussian probability function and the transmission model is a Rayleigh model, both effects have a random component to them. This indicates that statistical analysis is typically used to analyze the channel characteristics. If the medium between the transmitter and receiver is good and the signal to noise ratio is strong, the bit error rate will be very low, possibly negligible, and it won't have any noticeable effects on the entire system. Nonetheless, there is a chance that the bit error rate will have to be considered if noise can be identified. The main factors contributing to a data channel degrading and the associated bit error rate, or BER, are noise and changes in the propagation path (where radio signal paths are used). Both effects have a random component since the transmission model is a Rayleigh model and the noise has a Gaussian posterior distribution. This shows that the path is often studied using statistical analysis. It was also demonstrated that, despite the fact that the reference sensitivity evaluations are specified at the 95th percentile of the relative throughput, they do not always correlate to the highest possible throughput. The results show that the front- loaded, single DM-RS design, for a variety of channel circumstances and user velocities, has the best real throughput performance. This shows that the 5G NR front-loaded DM- RS design is capable of operating effectively in a variety of scenarios for sub-6 GHz and millimeter-wave carrier frequencies while enabling low-latency communications and highly efficient pipelined receiver processing.

Performance analyzes

Multi-input multi-output (MIMO) is a technique used by mobile wireless communications systems to enhance performance and attain maximum capacity. In wireless communications known as MIMO (multiple input, multiple output), several antennas are utilized at both the source (transmitter) and the destination (receiver). By letting data travel through several signal pathways simultaneously, the antennas at either end of the communications circuit are merged to reduce mistakes, improve data speed, and increase the capacity of radio transmission.

The data has a greater chance of reaching the receiving antenna unaffected by fading when numerous versions of the same signal are created, which improves the signal-to-noise ratio and error rate. MIMO improves radio frequency (RF) system and less congestion. The adaptive encoding packet approach, on the other hand, is a tool for improving the efficiency of wireless communication systems. This tool depends on using various error control strategies to encrypt sent packets with varying code rates in accordance with the channel circumstances. The adaptive packet technique can optimize capacity while minimizing power consumption and achieving good error performance. The adaptive packet approach, which offers a variable code rate but is more sophisticated than fountain codes, thus represents the concept of fountain codes. On the other hand, rate-less code error control systems are accomplished through the adaptive code rate notion. A scheme for error control is the rate-less fountain code. In this section, MATLAB simulations are carried out with proposed coded OFDM system with optimal preceded MIMO transmission to validate the BER reduction and associated error performance. Here optimal ML detector is used at the receiver side with optimal MRC combining technique. Here the number of antenna elements used in presider matrix is optimally configured based on channel condition which is estimation using pilot assisted channel estimation where CSI is always known at the transmitter side with MIMO precoding as shown in Figure 6.

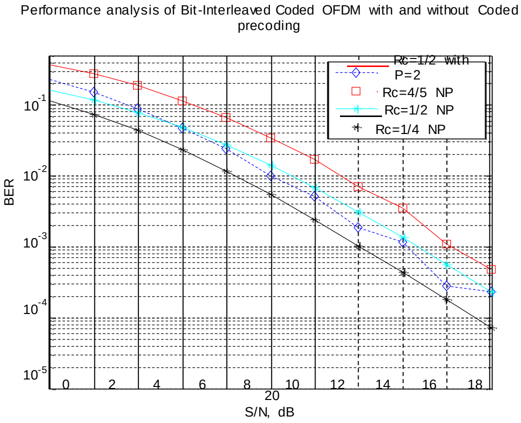

FIGURE 6 BER ERROR RATE ANALYZES OF PROPOSED CODED OFDM WITH PRE-CODER

CONCLUSION

Here In this paper, coded OFDM scheme and pre-coding MIMO is combined for the next generation wireless communication system. Here pilot assisted optimal channel estimation is used to formulate the channel state information to optimally select the code rate and diversity gain. The proposed system also includes optimal ML based signal detection to reduce the BER rate for given SNR bound values. Here both the significance of diversity gain and error correction codes is included for improved error rate system performance. The performance penalty gap that exists in existing un-coded OFDM is significantly reduced using optimal number of antenna MIMO and FEC parity codec configurations. Then performance of the proposed coded MIMO OFDM is analyzed with different channel condition and associated signal fading. The development of orthogonal frequency division multiplexing (OFDM) research is shown in this overview. The several advantages of enhancing robust multicarrier OFDM arrangements with multiple-input, multiple-output (MIMO) systems are described in this dissertation. We then go on to discuss the drawbacks of traditional detection and channel estimation methods created for multiuser MIMO OFDM systems in so-called rank-deficient circumstances, which occur when more transmit antennas are used or more users are supported than there are receiver antennas. Unless we restrict the number of people allowed access in the base station's or radio port's coverage region, we frequently run into this in practice. After providing a historical overview of the related design issues and the most recent solution. This article's second half describes a variety of traditional multiuser detectors (MUDs) made for MIMO-OFDM systems and assesses the performance they may achieve. The identification of unique, cutting-edge genetic algorithm (GA)-aided detector solutions, which have recently found several uses in wireless communications, is the focus of another section. We will examine the generally applicable principles of various GA-assisted optimization techniques that have recently been proposed also for employment in multiuser MIMO OFDM in an effort to encourage the exchange of ideas between the machine learning, optimization, signal processing, and wireless communications research communities. We show that the family of GA-aided MUDs is capable of reaching a near-optimal performance at the cost of a greatly reduced computing complexity in order to encourage new research. For 3GPP 5G NR Version 15, a thorough examination of radio link performance and uplink transmitter reference sensitivity was done. Several sub NR Version 15, a thorough examination of radio link performance and uplink transmitter reference sensitivity was done. Several sub-carrier displacements and allocation data rates, various DM-RS patterns, and user mobility's covering both sub-6 GHz and millimeter-wave frequency ranges were all taken into consideration when evaluating the performance of the UL radio connection. The performance investigation centered on the 5G NR LDPC coding method; however, LTE turbo-coded results were also shown for comparison.

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