PowerReduction in Co-Operative Communication Using MIMO-OFDM Systems

M. Srinivas[1], P.N.Venkateswara Rao[2]
[1]PG Student, Dept of ECE, Viswanadha Institute ofTechnology And Management, Vishakhapatnam, AP, India, E-mail: srinivasm429@gmail.com.[2]Assistant Professor, Dept of ECE, Viswanadha Institute of Technology And Management, Vishakhapatnam, AP-531173, India, E-mail: pvr5hs@gmail.com.

ABSTRACT:-
In this paper, we can analyze the power reduction in co-operative communication systems using multiple relays. The power distribution among multi users in relay path has more complexity compared with direct path but in direct path getting high Power Consumption. To reduce this effect in MIMO-OFDM we are using the water filling algorithm. In this paper we look into the performance of such cooperative MIMO-OFDM systems under the multiple relay path of cooperative communication on difference modulation on 16QAM, 64QAM, 128QAM and 256QAM used to reduce the power reduction and complexity. Its performance in terms of signal to interference and noise ratio (SINR) is evaluated by relay analysis and Computer simulation results show that the proposed system can significantly improve the overall power reduction performance of the MIMO-OFDM systems with multiple relay systems.

Keywords: - Power Reduction, Co-operative Communication, Relay Path, Direct Path, MIMO-OFDM, Water Filling Algorithm, QAM, SNR.

I. INTRODUCTION

The MIMO-OFDM system is the milestone in the telecommunication field. The 3rd Generation Partnership Project (3GPP) Long Term Evolution was implementing by using MIMO-OFDM systems and next-generation wireless networks are expected to provide broadband multimedia Services such as voice, web browsing, and video conference by using MIMO-OFDM systems. MIMO uses multiple transceivers at both the transmitter and receiver to operate. Because MIMO allows more bits/sec/hertz to be transmitted in a given bandwidth, it improves spectral efficiency and allows operators to simultaneously support more users with high data-rate requirements. Increased spectral efficiency, higher data rates and the ability to increase data throughput without additional bandwidth or transmit power, makes MIMO especially attractive for use in wireless communication systems.

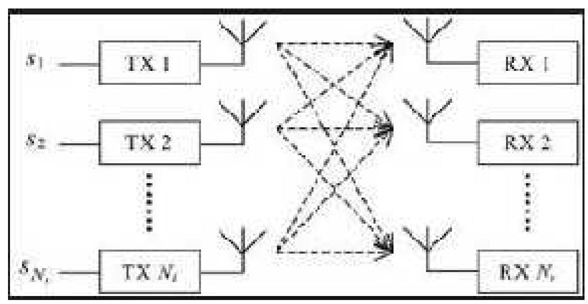


Fig.1.MIMO-OFDM System

Orthogonal Frequency Division Multiplexing (OFDM) and Orthogonal Frequency Division Multiple Access (OFDMA) are two different variants of the same broadband wireless air interface that are often mistaken for one another. OFDMA is a form of OFDM, which is the underlying technology. The interfaces of both OFDM and OFDMA work by separating a single signal into subcarriers, or, in other words, by dividing one extremely fast signal into numerous slow signals that optimize mobile access, as the subchannels can then transmit data without being subject to the same intensity of multipath distortion faced by single carrier transmission.

The difference between OFDM and OFDMA is that OFDMA has the ability to dynamically assign a subset of those subcarriers to individual users, making this the multi-user version of OFDM, using either Time Division Multiple Access (TDMA) (separate time frames) or Frequency Division Multiple Access (FDMA) (separate channels) for multiple users. OFDMA simultaneously supports multiple users by assigning them specific sub channels for intervals of time. Point-to-point systems are OFDM, and do not support OFDMA. Point-to-multipoint fixed and mobile systems use OFDMA. A small body of research has already proposed various sub-carrier based duplexing schemes. Although subcarrier based duplexing appears possible in ideal OFDM systems, the orthogonality between different subcarriers is lost in realistic communication systems due to the non-ideal characteristics of different subsystems (e.g., frequency offset of local oscillator, nonlinearity of power amplifier, etc.) and these effects need to be addressed to understand how the transmitting subcarriers will interfere with neighboring receiving subcarriers.

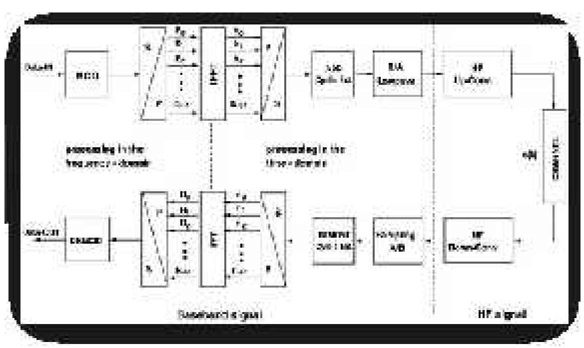


Fig.2.Block Diagram of OFDM System

To perform this we make use of a transceiver structure that utilizes baseband echo cancellation to suppress the interference between the transmitting and receiving subcarriers. The performance of this transceiver is verified by analysis and computer simulation. This scheme is then incorporated into the cooperation strategy of to investigate its performance under realistic conditions. It is revealed that although the performance of the cooperative network is degraded due to the residual interference imposed on the receiving subcarriers by the transmitting subcarriers, it still performs better compared with conventional cooperation schemes

II. COOPERATIVE COMMUNICATION

Wireless communication which is most functional in terms of mobile access is currently a highly demanded communication technology. It has gone through several developmental phases since its inception so that it can meet to the ever changing needs of its wide range of applications. The biggest challenges in the history of wireless communications which has induced considerable research for possible solutions are the multipath fading, shadowing and path loss effects of wireless channel.

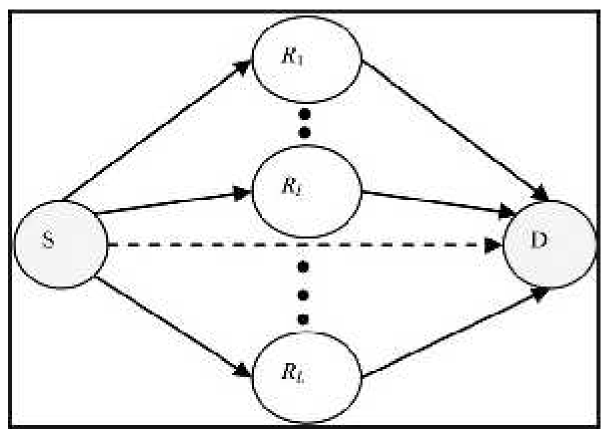


Fig.3.Multiple Relay Communication System

Random variations of channel quality in time, frequency and space are caused by these effects. The method that involves the use of a single all purpose device to deploy network services results in design complications which result in inefficient use of battery power causing short battery life. Users can ease off the load on the network and in turn increase the capacity and battery life for their devices by cooperative communications in such situations.

This technique which was based on the analysis of the capacity of a three- node network consisting of a source, a relay and a receiver has the assumption that all nodes operate in the same band. Therefore the system could be decomposed into a broadcast channel with respect to the source and a multipath access channel with respect to the destination. The relays whole and sole purpose is to help main channel, in the work on the relay channel but in cooperative communication, he total system resources are fixed, and users act both as information sources and as relays. In spite of indisputable of the historical importance of the first work on relay channel, recent work in cooperation has taken a somewhat different emphasis. To enable cooperation among users, different relaying techniques could be employed depending on the relative user location, channel conditions, and transceiver complexity. These are methods that define how data is processed at the relays before onward transmission to the destination. There are different types of cooperative communication strategies which would be outlined. These include the Amplify and Forward (AAF) and Decode and Forward

A. AMPLIFYAND FORWARD METHOD

This is a simple cooperative signaling method where each user receives a noisy version of the signal transmitted by its partner amplifies it and re-transmits to the base station. The base receives two independently faded versions of the signal and combines them in order to make better decisions on information detection.

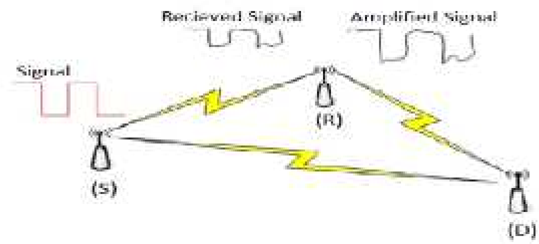


Fig.4Block diagram of AAF

B. DECODE-AND-FORWARD METHOD

This strategy follows that the relay station decodes the received signal from the source node, re-encodes it and forwards it to the destination station. It is the most often preferred method to process data in the relay since there is no amplified noise in the signal sent. Again, consider the case of a single relay. The simplest algorithm described below again divides transmissions into two blocks of equal duration, one block for the source transmission and one block for the relay transmission. For the simplest algorithm, the source transmits Xs[k] for k = 1, 2, n.

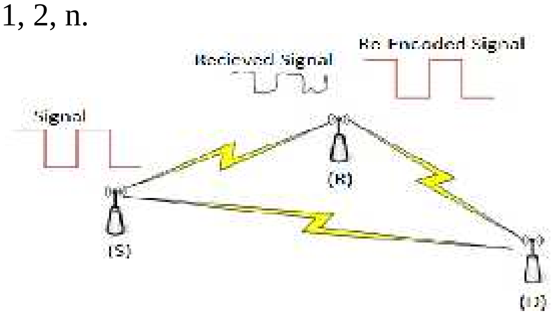


Fig.5.Block diagram of DFF

C. WATER FILLING ALGORITHM

The process of water filling is similar to pouring the water in the vessel. The unshaped portion of the graph represents the inverse of the power gain of a specific channel. The portion representing the shadow represents the power allocated or the water. μ shows the maximum water level. The total amount on water filled (power allocated) is proportional to the Signal to noise ratio of the channel.

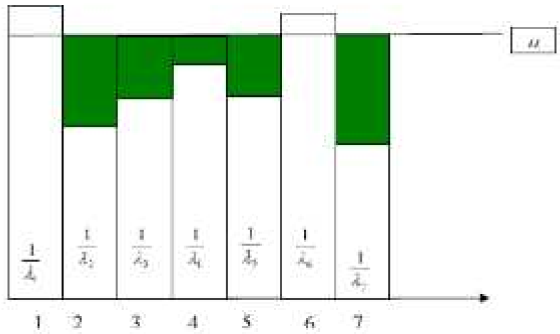


Fig.6.Water filling algorithm

Steps to implementation of WFA:-

1. We do not need to reorder the MIMO-OFDM sub channel gain realization in a descending order.
2. Take the inverse of the channel gains.

$$P_t + \sum_{i=1}^{n} \frac{1}{H_i}$$

3. Water filling has non uniform step structure due to the inverse of the channel gain.
4. Initially take the sum of the Total Power Pt and the Inverse of the channel gain .It gives the complete area in the water filling and inverse power gain.

$$\frac{P_t + \sum_{i=1}^{n} \frac{1}{H_i}}{\sum channels}$$

5. Decide the initial water level by the formula given below by taking the average power allocated (average water Level).
6. The power values of each sub channel are calculated by subtracting the inverse channel gain of each channel.
7. In case the Power allocated value becomes negative stop the iteration process.

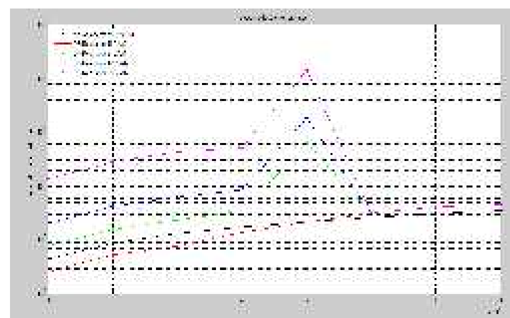
$$\frac{P_t + \sum_{i=1}^{n} \frac{1}{H_i}}{\sum channels} - \frac{1}{H_i}$$

8.Finally, we can calculate the all signals Capacity by using below formule.

$$\text{Capacity of MIMO system } \sum_{i=1}^{n} \log_2(1 + PowerAllocated * H)$$

III. PROPOSED METHODOLOGY

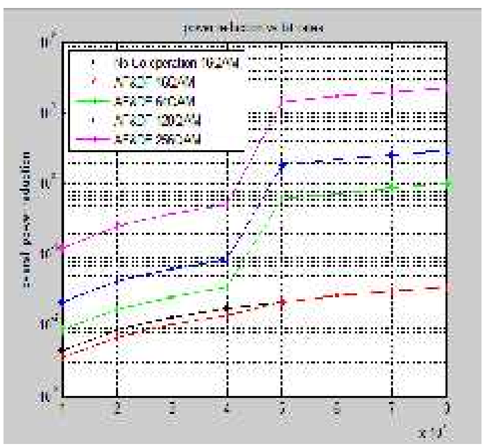
In principle, the input waveform can be perfectly regenerated at the receiver since the transmit data is known inside the device. Thus, again in principle, signal can be perfectly cancelled in the receiver path.



The Orthogonality between subcarriers is partially lost in OFDM systems due to the non-ideal characteristics of different subsystems (e.g., nonlinearity of power amplifier, frequency offset of local oscillator etc.), resulting in signal leakage between subcarriers or inter-carrier interference (ICI). When a user is operating in subcarrier-based duplexing mode, due to the enormous difference in the power of the transmitting signal and desired signal, the effect of ICI on the receiving Sub-carriers could be significant. The subsystem imperfections that are important to consider include carrier frequency offset (CFO), time synchronization, quantization error of Analog/Digital Converter (ADC), nonlinearity of Power Amplifier (PA), I/Q imbalance and Phase Noise of Local Oscillator (LO).

D. AF AND DF RELAY PATH ON COOPERATIVE COMMUNICATION

AF and DF aforementioned are often called fixed cooperation modes because the relay node always participates in cooperative communication no matter what the channel transmission characteristics are. As a matter of fact, cooperation does not always bring benefits. For example, in a half duplex mode, the data transmission rate and the utilization of the degrees of freedom will decrease. This indicates when to cooperate is a critical issue.



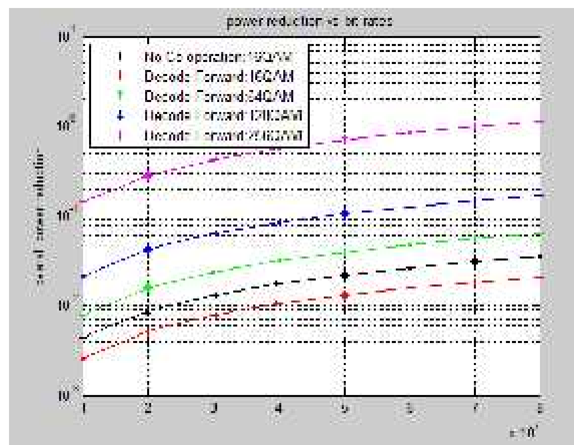
Only when the characteristic value is greater than the threshold, cooperative communication is implemented; otherwise, the source node direct transmission again. Hence, the key in selection modes is the conditions of source-relay channel. In incremental modes, the feedback of the destination node is used to determine whether the direct transmission is successful. If the data are correctly detected, source node will send new data; otherwise, the relay node will participate in the cooperative communication process. This process is equivalent to adding redundancy mechanism or automatic detection and retransmission mechanism in the relay transmission.

$$\mathrm{SNR}_{1,\mathrm{MRC}} = \frac{\left(|\mathbf{h}_{11}^H \mathbf{w}_1| + |\mathbf{h}_{12}^H \mathbf{w}_3|\right)^2 \cdot \mathrm{E}(s_1 s_1^*)}{\sigma_{\mathrm{MS}}^2},$$

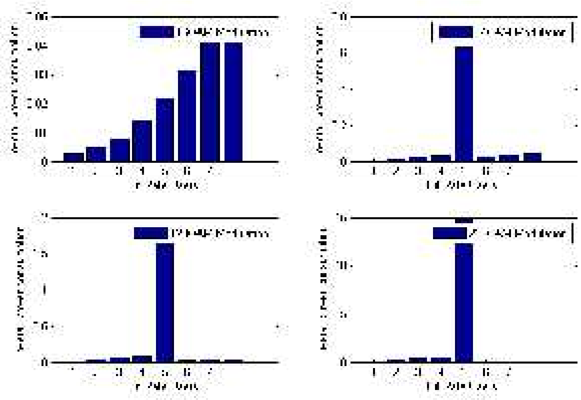
$$\mathrm{SNR}_{2,\mathrm{MRC}} = \frac{\left(|\mathbf{h}_{21}^H \mathbf{w}_2| + |\mathbf{h}_{22}^H \mathbf{w}_4|\right)^2 \cdot \mathrm{E}(s_2 s_2^*)}{\sigma_{\mathrm{MS}}^2}.$$

IV. RESULT ANALYSIS

In order to align the phases of the received signals, we need phase synchronization between the relays. This is achieved without using additional resources or exchanging channel knowledge and data between different relays.



From this graph we have observed that the transmission bit rate is increased and power reduction increased by increasing the levels of QAM modulation techniques as 64-QAM, 128-QAM and 256- QAM modulations. In each level of QAM modulation we have achieved the decrement in power reduction for the DF cooperation under realistic conditions compared with the non cooperative condition. By using above comparison we investigated the water filling algorithm based duplexing in terms of different QAM modulation techniques performance of cooperative communication OFDMA systems with BER can play an important role to increase the power reduction ratio in relay systems.



V. CONCLUSION

Cooperative communication in OFDMA systems has been shown to significantly improve wireless system performance. In this project, particular water filling algorithm approach investigated to reduce the power reduction. To perform the investigation we proposed a relay structure so that the system tradeoffs and limitations of this approach could be understood. The performance of the relay was evaluated by both analysis and computer simulation and it was shown that the non-ideal characteristics of subsystems will limit the achievable SINR. From this observation, we obtained a good improvement in reduction of power consumption particularly in relay network. To achieve this, we use different levels of QAM modulations (16- QAM, 64-QAM, 128-QAM and 256). By using these levels of QAM, we improved the data rates and decrease the bit error rates. Finally, we compared all these results by computer simulations.

REFERENCES:-

[1] G. Kramer, M. Gastpar, and P. Gupta, "Cooperative strategies and capacity theorems for relay networks," IEEE Trans. Inf. Theory, vol. 51, no. 9, pp. 3037–3063, Sep. 2005.

[2]C. Y. Chiu, C. H. Cheng, R. D. Murch, and C. R. Rowell, "Reduction of mutual coupling between closely-packed antenna elements," IEEETrans. Antennas Propag., vol. 55, no. 6, pp. 1732–1738, Jun. 2007.

[3] A. Guerin, G. Faucon, and R. Le Bouquin-Jeannes, "Nonlinear acoustic echo cancellation based on Volterra filters," IEEE Speech Audio Process., vol. 11, no. 6, pp. 672–683, Nov. 2003.

[4] A. Wiewiorka and P. N. Noss, "Digital on-channel repeater for DAB," BBC R&D White Paper WHP120, BBC, Sep. 2005.

[5] L. Ding, Z. Ma, D. Morgan, M. Zierdt, and J. Pastalan, "A leastsquares/ Newton method for digital predistortion of wideband signals," IEEE Trans. Commun., vol. 54, no. 5, pp. 833–840, May 2006.

[6] S. H. Li and R. D. Murch, "Full-duplex wireless communication using transmitter output based echo cancellation," in Proc. 2011 IEEE GlobalCommun. Conf., pp. 1–5.

[7] L. Musavian and S. Aissa, "Capacity and power allocation for spectrum- sharing communications in fading channels," IEEE Trans. WirelessCommun., vol. 8, no. 1, pp. 148–156, Jan. 2009.

[8] A. Ghasemi and E. S. Sousa, "Fundamental limits of spectrum sharing in fading environments," IEEE Trans. Wireless Commun., vol. 6, no. 2, pp. 649–658, Feb. 2007.

[9] J. Jang and K. B. Lee, "Transmit power adaptation for multiuser OFDM systems," IEEE Journal on Selected Areas in Communications, vol. 21, no. 2, pp. 171–178, 2003.

[10] T. Weiss, J. Hillenbrand, A. Kroch, and F. K. Sondra, "Mutual interference in OFDM-based spectrum pooling systems," Proceedingsof the IEEE Vehicular Technology Conference (VTC '04), vol. 59, no. 4, pp. 1873–1877, 2004.

[11] Z. Hub, G. Zhu, Y. Xia, and G. Liu, "Multiuser subcarrier and bit allocation for MIMO-OFDM systems with perfect and

partial channel information," in Proceedings of the IEEE WirelessCommunications and Networking Conference, vol. 2, pp. 1188– 1193, March 2004.

[12] A. Goldsmith. Wireless Communications. Cambridge University Press, 2005.

[13] A. Czylwik. Adaptive ofdm for wideband radio channels. IEEE Globecom'96, London, UK, November 1996.

[14] T. Cover and J. Thomas. Elements of information theory. 1991.