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# Evaluation Of MIMO-OFDM In Channel Diversity On Ship Below Deck Using QAM

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*Abstract:* **Wireless communication is very challenging on ship below deck, because of multiple reflections between compartments. In the early performed methods the improvement was made in signal strength, channel capacity and transmission of bits till 4 bps, by using BPSK modulation in MIMO-OFDM concept. In the proposing project the effective utilization of channel capacity and increase in transmission of bits can be obtained by using Quadrature Amplitude Modulation along with MIMO-SLM, OFDM and using Independent Identity Distribution method. By using these methods reflections can be avoided and more bits can be transmitted within limited channel capacity .Thereby these methods will lead to successful communication below decks.**

*Keywords:* **Multiple input multiple output (MIMO), Orthogonal frequency division multiplexing(OFDM), spatial diversity, Channel diversity, Propagations in shipboard, Quadrature Amplitude Modulation(QAM).**

## I. INTRODUCTION

Wireless system designers are faced numerous challenges to fulfill the demand of the wireless communication for higher data rates, better quality service, fewer dropped calls , higher network capacity including limited availability of radio frequency spectrum and transmission problems caused by various factors like fading and multipath distortion. These needs require new techniques that improve spectral efficiency and operational reliability. Multi-Input-Multi-Output (MIMO) technology promises a cost effective way to provide these capabilities. MIMO uses multiple antennas at both the transmitter and receiver to improve the communication performance. It is one of the several forms of smart antenna technology. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without additional bandwidth or transmit power. It achieves this by higher spectral efficiency (more bits per second per hertz of bandwidth) and link reliability or diversity (reduced fading). Because of these properties, MIMO is a current theme of international wireless research. The increasing demand for capacity in wireless systems has motivated considerable research aimed at achieving higher throughput on a given bandwidth.

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MIMO achieves this goal by spreading the same total transmit power over the antennas to achieve an array gain that improves the spectral efficiency more bits per second per hertz of bandwidth and to achieve a diversity gain that improves the link reliability reduced fadingbecause of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n,4G, 3GPP, Long Term Evolution. Orthogonal Frequency Division Multiplex or OFDM is a modulation format that is finding increasing levels of use in today's radio communications scene. OFDM has been adopted in the Wi-Fi arena where the 802.11a standard uses it to provide data rates up to 54 Mbps in the 5 GHz ISM
in all useful bands. In addition to this the recently ratified 802.11g standard has it in the 2.4 GHz ISM band. In addition to this, it is being used for WiMAX and is also the format of choice for the next generation cellular radio communications systems including 3G LTE and UMB.

If this was not enough it is also being used for digital terrestrial television transmissions as well as DAB digital radio. A new form of broadcasting called Digital Radio Mondiale for the long medium and short wave bands is being launched and this has also adopted COFDM[1]. Then for the future it is being proposed as the modulation technique for fourth generation cell phone systems that are in their early stages of development and OFDM is also being used for many of the proposed mobile phone video systems. OFDM, orthogonal frequency division multiplex is a rather different format for modulation to that used for more traditional forms of transmission. It utilizes many carriers together to provide many advantages over simpler modulation formats.

## II. SYSTEM MODEL

The system it is focused on capacity and effective utilization of bandwidth and path loss should be minimized, as well as the effects of opening/closing doors. The measurements were used to estimate coherence bandwidth and delay spread, which can be used to calculate the maximum rate at which narrow band communication techniques can transmit data without experiencing inter-symbol interference (ISI)[2]. Received power estimates were also used to evaluate the impact of deploying a wireless relay in a lift shaft aboard the ship.At each measurement location, the designated transmitter broadcast 2400 packets at a center frequency of 2.484 GHz using each physical layer. Individual packets consisted of a preamble for correlation-based packet detection, four training symbols for channel estimation, and a payload of 10 OFDM symbols. For MIMO physical layers, the total transmit power was divided evenly.

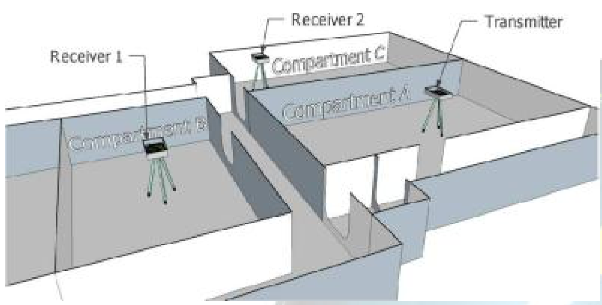


Fig 1:Design of the deck on ship

A cluster of spaces in an interior deck of the ship was used to analyze the coupling between adjacent and near-adjacent compartments. A key objective was to determine the effect of closing watertight doors on signal integrity. Fig. 2 shows the layout of these coupled compartments as well as the locations of the nodes used in the experiment. The transmitter node was located in compartment A, and the two receiver nodes were located in compartments B and C. Compartment A includes an emergency escape scuttle into compartment C (this scuttle was closed for the duration of the testing), and an exhaust duct with vents connects compartments A and B. While the doors and hatches are watertight, there exist ventilation ducts, piping, and other protrusions that create an effective aperture for electromagnetic signals to propagate between the compartments.

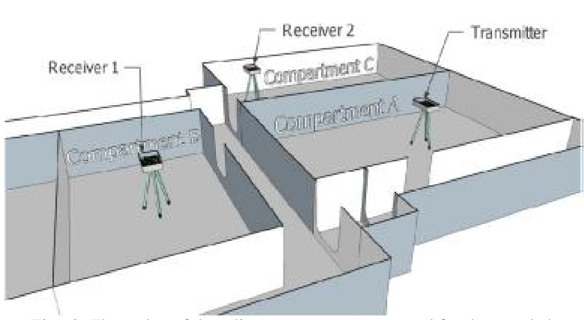


Fig 2: Floor plan of the adjacent compartments used for the coupled compartment measurements.

The system model is given in block diagram as,

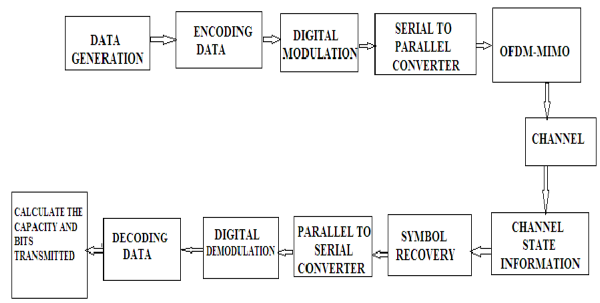


Fig 3: Block Diagram Of The System

## III. CAPACITY MEASUREMENT AND RESULTS

The measurements in the coupled compartments show two distinct behaviors emerging from differences in physical layout. As shown in Fig. 2, the Transmitter is separated from Receiver 1 by two bulkheads and a hallway. The primary pathway for the signal is through this hallway when the doors are open, but it must propagate through apertures in the bulkheads (such as the ventilation ducts) when they are closed. Christo Ananth et al. [4] discussed about Improved Particle Swarm Optimization. The fuzzy filter based on particle swarm optimization is used to remove the high density image impulse noise, which occur during the transmission, data acquisition and processing. The proposed system has a fuzzy filter which has the parallel fuzzy inference mechanism, fuzzy mean process, and a fuzzy composition process. In particular, by using no-reference Q metric, the particle swarm optimization learning is sufficient to optimize the parameter necessitated by the particle swarm optimization based fuzzy filter, therefore the proposed fuzzy filter can cope with particle situation where the assumption of existence of "ground-truth" reference does not hold. The merging of the particle swarm optimization with the fuzzy filter helps to build an auto tuning mechanism for the fuzzy filter without any prior knowledge regarding the noise and the true image. Thus the reference measures are not need for removing the noise and in restoring the image. The final output image (Restored image) confirm that the fuzzy filter based on particle swarm optimization attain the excellent quality of restored images in term of peak signal-to-noise ratio, mean absolute error and mean square error even when the noise rate is above 0.5 and without having any reference measures.The signal integrity decreases for Receiver 1when the doors are closed. Despite the crease in frequency selectivity, the attenuation of the signal when the doors are closed still results in an overall decrease in integrity. PP-SNR increases for Receiver 2 when the doors are closed consistent with the dominant signal component coming through apertures in the bulkhead and the multipath signal from the hallway deconstructive interfering when the doors are open.

For a flat fading channel, the capacity is defined as

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where $P_{Tx}$ is transmit power, $|h|$ is the complex channel gain, and $N_0$ is the noise power in the channel. For an OFDM link with K subcarriers, there are K narrowband flat fading channels. The channel capacity becomes the summation of the capacities of each subcarrier[1].

$$C = \sum_{K=1}^{K} \log_2 \left(1 + \frac{P_{Tx}|h|^2}{N_0}\right)$$

This expression can be further expanded for MIMO as

$$C = \sum_{K=1}^{K} \log_2 \left[ \det \left( I_{m\times n} + \frac{P_{Tx,k}}{mN_{0,k}} H_k H_k^{+} \right) \right]$$

Where $H_k$ is an $m \times n$ channel matrix with m transmit antennas and n receive antennas. The entries $h_{i,j}$ represent the complex channel gain from Tx antenna to Rx antenna . To compare Shannon capacity fairly from experiments using separate physical layers, the channel gains are normalized such that $\|H\|_{Frobenius} = mn$ . PP-SNR has also been used as a metric to characterize channel quality .We define PP-SNR as the ratio of signal power to signal error, namely PP-SNR = E$\left[ \|x\|^2 / \left\|\hat{x} - x\right\|^2 \right]$ ,. PP-SNR is similar to SNR, but sources of error affecting PP-SNR include nonlinear distortion in the radio transceiver, error in channel estimation, and noise enhancement from equalization. As a result, PP-SNR is a more hardware-specific description of SNR. Given a PP-SNR, the symbol error rate (SER) can be estimated statistically from the receiver operating characteristic (ROC) curve of the hard decision bit decoder. Conversely, for a given SER constraint, the maximum modulation order can be calculated to estimate achievable throughput.

*Engine Room:*

Average capacities for the various physical layers used in the engine room are shown as a function of average SNR in Fig. The capacity is averaged over all receivers for each type of physical layer tested. The water-filling solution represents the upper bound of capacity for the link while independent, 67identically distributed (i.i.d.) channels represent the highest theoretical gain achievable in any MIMO link of equal channel norm. Since the channels are normalized with respect to gain per receiver, the effect of spatial correlation is isolated in the MIMO channel on Shannon capacity as shown .As demonstrated in Fig, and Table, the channel is spatially decorrelated enough to support the use of MIMO techniques to improve performance over SISO techniques. The capacity is approximately doubled by using MIMO-SM over SISO. PP-SNR for each physical layer and receiver location is shown in Table, being the shortest link and nearest to line-of-sight, has the highest PP-SNR. In most scenarios, the PP-SNR is highest for Alamouti coding. This result is expected due to added diversity gain from space-time coding, with comparable performance from MRC, another diversity scheme. While MIMO-SM has the lowest PP-SNR, it is transmitting at twice the data rate of other schemes.

*Coupled Compartments:*

The measurements in the coupled compartments show two distinct behaviors emerging from differences in physical layout. As shown, the Transmitter is separated from Receiver 1 by two bulkheads and a hallway. The primary pathway for the signal is through this hallway when the doors are open, but it must propagate through apertures in the bulkheads (such as the ventilation ducts) when they are closed. However, the Transmitter is separated from Receiver 2 by a single bulkhead. When the doors are open, there is a single long pathway for the signal to propagate to the receiver via the hallway. The capacity for the channel between the Transmitter and Receiver 1improves for SISO when the doors are closed. Since the path loss from the channel is normalized, this improvement indicates the channel has a flatter response (less frequency selectivity).

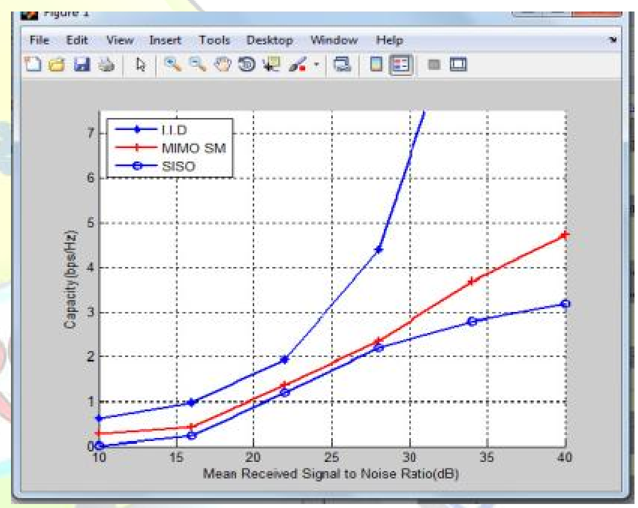


Fig 4:capacity is measured by graphing the available bandwidth with number of bits transmitted with mean received signal to noise ratio

Compared with existing techniques the capacity is effectively utilized and there is consistent with a decrease in multipath signals arriving at Receiver 1 [3]and an increase in the dominance of the signals arriving via ductwork connecting the two spaces. Since MIMO techniques mitigate frequency selectivity through antenna diversity, the negligible change in the capacity of these schemes would indicate that the channel correlation (a major factor in capacity) does not change in a significant way when the doors are opened or closed. The capacity for the channel between the Transmitter and Receiver 2 improves for both SISO and MIMO schemes when the doors are closed. The improvement for SISO indicates that frequency selectivity decreases, similar to the effect seen at Receiver 1. The improvement for MIMO indicates that the channel correlation also decreases, in contrast to the effect seen at

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Receiver 1. The PP-SNR of both receivers is shown in Table II for open and closed doors. The signal integrity decreases for Receiver 1 when the doors are closed. Despite the decrease in frequency selectivity, the attenuation of the signal when the doors are closed still results in an overall decrease in integrity. PP-SNR increases for Receiver 2 when the doors are closed, consistent with the dominant signal component coming through apertures in the bulkhead and the multipath signal from the hallway deconstructive interfering when the doors are open.

The result is when the deck door is opened/closed to find the signal strength and there should be more strength in signal so that when door is closed it should travel to destination without any loss in number of bits and it is achieved by using this techniques so the final result will be increased in bps and it ranges around 6 bps.

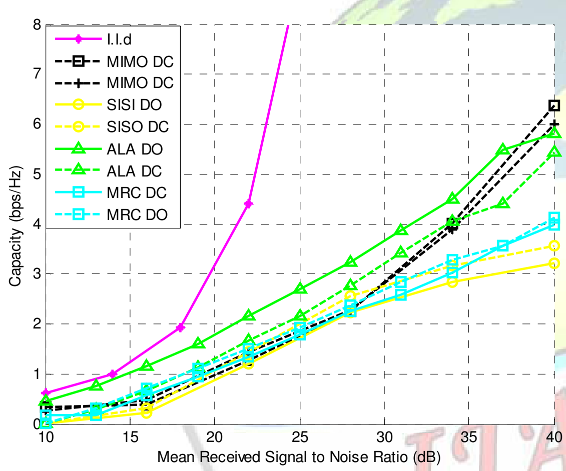


Fig 5: capacity utilized compared with mean SNR when doors are opened and closed

## IV CONCLUSION

MIMO technologies offer improved capacity and less variation in system performance despite changing environmental factors. The SNR values presented show the improvement in reliability that can be provided by space-time coding. Estimation of channel capacity demonstrates that multipath scattering can be exploited by spatial multiplexing to improve performance and increase throughput. The channel capacity was utilized more effectively and communication is made possible in decks with improved bits in transmission. And number of bits transmitted also increased with SNR upto 6bps.

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