IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834, p- ISSN: 2278-8735.
PP 79-82
www.iosrjournals.org

Comparison of BER Performance of QPSK and OFDM-QPSK Modulation

Sreelakshmi T S[1], Noble C Kurian[2]
[1]*Electronics and Communication Dept, SNGCE, India*
[2] *Electronics and Communication Dept, SNGCE, India*

Abstract: *Deep space data transmission is the most challenging mission in satellite communication. The main difficulties faced in this mission includes transmission delay, weak signal to noise ratio, disrupted communication links etc. Channel coding and efficient modulation scheme can be used efficiently to recover data at low SNR. This paper makes a comparison between QPSK modulation and OFDM-QPSK modulation in terms of bit error rate in an AWGN channel. The results showed that the bit error rate performance of OFDM-QPSK is better than that of QPSK. This paper also provides a comparison between different coding techniques used in deep space communication.*
Keywords - *AWGN ,Bit error rate,OFDM-QPSK, QPSK ,Signal to Noise Ratio*

I. INTRODUCTION

Wireless communication has attained a tremendous advancement in the last few decades. These developments led to another phase of communication called Deep Space Communication. Error control coding, modulation of data to be transmitted etc are the key technologies used to overcome the challenges in deep space communication system. In this paper we are focusing on the BER performance of deep space data transmission using different coding schemes and modulation schemes. The main concern is given to reduce the bit error rate, as the non-reliability of data received lead to wrong conclusions in scientific missions. Advancement in error control coding technique leads to the development of new channel coding schemes which can be used to reduce the bit error rate.

II. DEEP SPACE CHANNEL

Deep space is an Additive White Gaussian channel (AWGN) with constant power spectral density. This channel is free from fading, frequency selectivity, interference, non-linearity or dispersion. Considering X(t) as the input, n(t) as the white Gaussian noise Y(t) as the received signal, the deep space channel can be represented as,

$$Y(t) = X(t) + n(t) \qquad (1)$$

III. CODING TECHNIQUE

Reliability of data transmitted can be improved by use of coding techniques. Source coding and channel coding are two separate coding methods used for this purpose. Source coding is the compression of data or removal of redundancy of the data to be transmitted so that available bandwidth can be efficiently utilized and storage capacity can be increased. Channel coding enables us to retrieve the compressed data with minimum error. Various channel coding techniques are developed to improve the image reconstruction capability of the retrieved data. Joint source-channel coding was introduced to achieve a good bit error rate and image reconstruction quality.

In the early times coding techniques used in deep space communication were linear block codes.If the channel is noisy, the performance of convolutional codes out-performs that of linear block codes. More over the convolutional codes can be used for continuous data as well. Thus linear block codes are replaced by convolutional codes. The advancement in error control coding lead to the development more efficient coding techniques like concatenated convolutional codes, LDPC codes, turbo codes, concatenated turbo-ldpc code etc.

Convolutional codes can be concatenated mainly in two ways.
1. Serial Concatenated Convolutional Codes (SCCC)
2. Parallel Concatenated Convolutional Codes (PCCC or Turbo Codes)

In serial concatenated convolutional code the output of one convolutional encoder is interleaved and given as the input of next convolutional encoder. Interleaving is used to eliminate burst errors. The overall rate of the transmitted message is the product rate of inner and outer coder. In parallel concatenated code two convolutional coders are used in parallel. First encoder input is the original message and the second encoder input is an interleaved version of the original message. The overall code rate of PCCC is less than that of individual convolutional encoders. Comparing the performance of SCCC and PCCC the performance of PCCC is better than that of SCCC at low SNR and at high SNR SCCC performance is better.

In deep space communication better performance at low SNR is required so PCCC or turbo code is used for deep space image transmission. In all the above cases the modulation scheme used is BPSK.

Low Density Parity Check Code (LDPC) is a coding technique in which the generator matrix is low density (less number of ones are present in the parity matrix). In LDPC coding the codeword is generated by multiplying the message with the low density generator matrix. LDPC code in concatenation with turbo can be used for deep space image transmission. In concatenated turbo-LDPC code turbo is used as the inner code and LDPC is used as the outer code. The encoding section is designed in such a way that both the coding technique can be decoded with the same algorithm. When this method is used for deep space transmission using BPSK modulation scheme BER of 10^{-5} is attained at an SNR of nearly 0.36 dB[3].

Raptor code is a form of rateless codes. LT-codes are a new class of codes introduced by Luby for the purpose of scalable and fault-tolerant distribution of data over computer networks. Raptor code is an extension of LT-codes with linear time encoding and decoding. They exhibited a class of universal Raptor codes: for a given integer k and any real $\varepsilon>0$, Raptor codes in this class produce a potentially infinite stream of symbols such that any subset of symbols of size $k(1+\varepsilon)$ is sufficient to recover the original symbols with high probability[5]. Each output symbol is generated using $O(\log(1/\varepsilon))$ operations, and the original symbols are recovered from the collected ones with $O(k\log(1/\varepsilon))$ operations. They also introduced novel techniques for the analysis of the error probability of the decoder for finite length Raptor codes. Moreover, they implemented and analyzed systematic versions of Raptor codes.

In deep space communication channel characteristics is varying abruptly. So if a coding technique which can vary the transmission rate depending upon the channel conditions it will be an added advantage. The development of raptor codes (rateless codes) was a bench mark in deep space transmission. Raptor code is concatenated LDPC-Luby transform code. The rate flexibility is obtained by the use of luby transform. In this coding technique, the code rate of data transmission is changed considering the entropy of image to be transmitted as well as the channel conditions. If the channel is very noisy low code rate is preferred and viceversa. In [4] image was transmitted through deep space using QPSK modulation and raptor coding. Image reconstruction quality was very good even at an SNR of 1 dB.

IV. MODULATION SCHEME

Communication links for deep-space missions have traditionally been severely power limited and essentially unaffected by bandwidth limitations. This situation is rapidly changing with the advent of new technology developments such as very large antenna arrays on the ground, inflatable antennas on the spacecraft etc. Future missions adopting the technologies just mentioned will be forced to use bandwidth-efficient modulations even at Ka-band due to much higher data rates and many simultaneous users. Bandwidth-efficient modulations may be used to reduce the possibility of future congestion in the deep-space frequency bands due to a growing demand for higher data rates and to an increasing number of simultaneous missions.

Modulation scheme used in early stage was BPSK modulation. To improve the performance of deep space system then comes the use of more efficient modulation scheme QPSK. Surveys showed that the performance of QPSK modulated system is better than that of BPSK scheme.

TABLE I. BER COMPARISON

Coding Scheme	**BER**	**Rate**	**Modulation**	**SNR**
Concatenated Turbo-LDPC	10^{-5}	Turbo-1/4 LDPC- 5/6	QPSK	.36 dB
	10^{-5}	Turbo-1/3 LDPC- 3/4	QPSK	.45 dB
	10^{-5}	Turbo-1/3 LDPC- 5/6	QPSK	.60 dB

Turbo	10^{-5}	¼	BPSK	.7 dB
Convolution	10^{-5}	½	BPSK	2.7 dB
SCCC	.013	¾	BPSK	3 dB
No coding	10^{-5}	-	BPSK	9.6 dB

Orthogonal frequency division multiplexing has emerged as the most efficient modulation scheme.It divide the total data to be transmitted to different segments. Then each segment is modulated to orthogonal carriers. As the carriers used are orthogonal to each other inter symbol interference can be reduced and thus bit error rate performance can be improved. OFDM combines modulation and multiplexing techniques.

Presently modulation scheme used in deep sapce communication is QPSK.In our work we compared the ber performance of OFDM-QPSK and QPSK.

V. Simulation And Results

In our work bit error rate comparison of QPSK and OFDM-QPSK is done in an AWGN environment. The simulation is set up for OFDM system with simulation parameters

- Cyclic prefix length = 12
- Block size = 52
- FFT size = 98
- Channel = White Gaussian noise Channel
- No of OFDM Blocks = 32768
- Modulation = QPSK

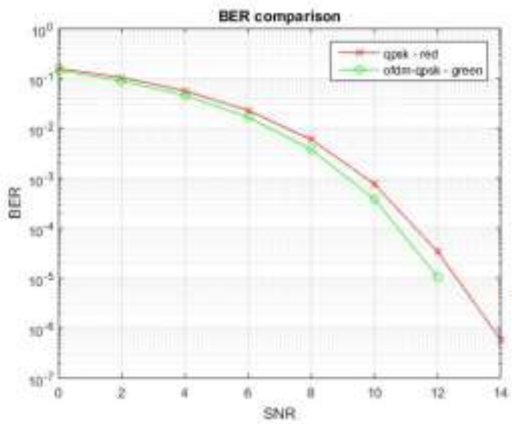

Figure 1 : OFDM-QPSK and QPSK BER Comparison

The above result shows that the performance of OFDM-QPSK is better than that of QPSK. If OFDM-QPSK is uesd instead of QPSK , then nearly 1 dB gain can be obtained at a bit error rate of 10^{-5} .

VI. Conclusion

In our work a comparison between bit error rates of QPSK and OFDM-QPSK was done. The results showed that OFDM-QPSK shows better performance as compared to QPSK. So we can conclude that use of OFDM-QPSK is good if main constraint in transmission is reduction of bit error rate.

References

[1] Deepak Mishra, T.V.S Ram , K S Dasgupta and S.Jit , 'Concatenated Convolutional Codes for Deep Space Mission', International Journal of Information and Communication Technology Research, Volume 2 No. 6, June 2012

[2] Muhammad Sher, 'Error-Control Coding in satellite communication',Pakistan Journal of Applied Sciences 2(1) : 10-16,2002.

[3] Carlo Condo, 'Concatenated Turbo/LDPC Codes for Deep Space Communications: Performance and Implementation' , SPACOMM 2013: The Fifth International Conference on Advances in Satellite and Space Communications.

[4] O. Y. Bursalioglu, , G. Caire, , and D. Divsalar, 'Joint Source-Channel Coding for Deep-Space Image Transmission using Rateless Codes',IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 61, NO. 8, AUGUST 2013.

[5] Amin Shokrollahi, 'Raptor Codes', IEEE TRANSACTIONS ON INFORMATION THEORY, VOL. 52, NO. 6, JUNE 2006.

[6] ManojBarnela ,"Digital Modulation Schemes Employed in Wireless Communication: A Literature review", International Journal of Wired and Wireless Communications Vol.2, Issue 2, April, 2014

[7] Vineet Sharma , AnurajShrivastav , Anjana Jain and AlokPanday, "BERperformance of OFDM-BPSK,-QPSK,- QAM over AWGN channel using forward Error correcting code" , International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 3, May- Jun 2012,pp.1619-1624

[8] D. S. Taubman and M. W. Marcellin, 'JPEG2000: Image Compression Fundamentals, Standards, and Practices', Kluwer Academics, 2002.

[9] Sreelakshmi. T. S, Asst. Prof . Noble C Kurian , "*A Comparative Study of BER Performance in Deep Space Communication Based on Coding Techniques*" International Journal Innovative Research in Computer and Communication Engineering (IJIRCCE), Vol. 3, Issue 8, August 2015