ANALYSIS OF 16QAM MODULATION WITH INTER-LEAVER AND CHANNEL CODING

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Abstract: In this paper 16QAM Communication system performance is observed with AWGN channel, Doppler spreading effect, and then we introduced the concept of interleaver in order to raise the performance of overall system. In this project, hamming code (15,11) is used to improve the system performance. In next part of the project we take mobile movement of receiver into consideration and applied the concept of Doppler Spreading to Uncoded 16QAM and observed its effect on system performance. Then Hamming code is applied to Doppler spreaded 16QAM and system is simulated to observe coding effects on system performance. Then we introduced interleaver concept and system is simulated to observe the progress in system performance.

Key Words: *Coded Interleaver, BER, Performance of system, 16QAM, AWGN Coded system.*

Introduction:

1. 16-QAM Modulation

Quadrature amplitude modulation (QAM) is a modulation scheme which conveys data by changing (modulating) the amplitude and phase of the carrier. If rectangular pulse shapes are assumed, then the signal can be expanded into two basis functions that are orthogonal to each other, usually they are out of phase with each other by 90° and are thus called quadrature carriers. The amplitudes of these two waves are changed in response to the information.In a 16-QAM modulator input data is divided into 4 bit groups and each of the group is mapped to any of the 16 constellation points Each constellation points are divided into two components (I and Q) and these values are used to modulate two orthogonal carriers. The modulated orthogonal carriers are combined together and transmitted in the channel.

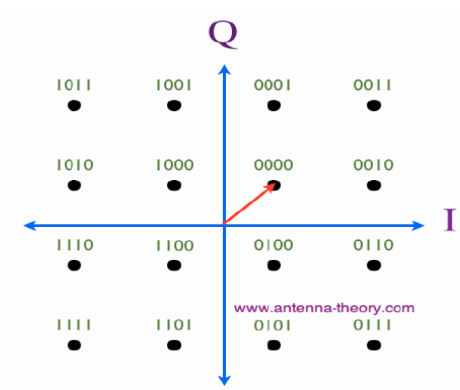


Fig.1 Constellation diagram of 16-QAM

2. Hamming Code

When this Data is propagating through channel where noise gets added to the original data, and

ISSN 2229-5518

signal undergoes degradation. So in order to minimize the effect of noise in channel, Coding technique is used. There are various coding techniques available, although Hamming code is one of them. Hamming code is a linear error correcting code. It can detect up to two bits error or corrects one bit errors without detection of uncorrected errors. Hamming codes are called as perfect codes, it means they achieve highest possible rate for codes with their block length and minimum distance is 3 bits. Hamming code is implemented using following formulaes.

Generator matrix (G) = [P:IK]

Code word(CW) = M* G Parity check Matrix(H) = [In-k: PT] Syndrom Table (ST) = e* HT

Syndrom (S)= R* HT

Following block diagram describes the sequence through which simulation has been carried for Coded 16-QAM communication system

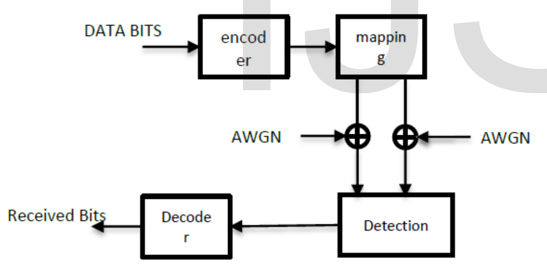


Fig.2 Block diagram of 16-QAM Encoder

3. Doppler Spreading effect and Rayleigh fading

When a mobile user is not stationary, the transmitted signal changes and

undergoes Doppler spread. Doppler Spread is measure of the spectral broadening caused by the time rate of change of the mobile radio channel. If the signal bandwidth is much greater than the Doppler spread, the effects are negligible at the receiver, and this is called slow fading. An interleaver is used to combat fading.

Rayleigh fading is caused by multipath reception. Due to Rayleigh fading, receiver antenna receives large number of reflected and scattered waves. Because of wave cancellation effect, Instantaneous received power seen by moving antenna becomes random variable, and thus depends on the location of the antenna of receiver. In this project movement of mobile receiver is considered as 42.3KM/Hr and imposed on uncoded 16 QAM, in order to observe worst effect of fading on uncoded 16 QAM. Following block diagram brief out the procedure by which Coding is applied to faded channel 16-QAM Communication system.

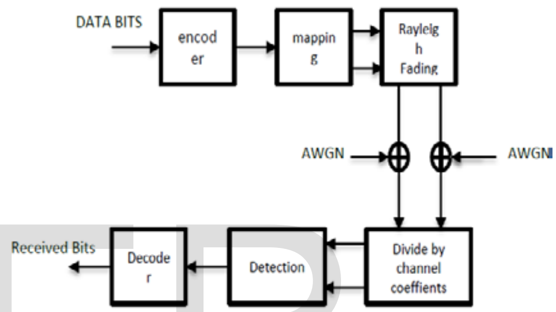


Fig3. Block diagram of Coded 16QAM AWGN

4. Interleaver

In fading channels, if there is a deep fade a large number of errors occur in sequence and are described as 'bursty' in nature. The probability of error at a certain location or time depends on whether or not its adjacent bits are received correctly. Interleaving aims to change the location of the bits such that it looks like the location of the errors is random and that it is distributed over several code words. Through this, the number of errors per block decreases and can be corrected using error-correcting code. An interleaver takes in m code words of length n and arranges each of them such that the final result is a block with m rows and n columns. This block is then read by column and is sent out. The column length m is known as interleaver depth and it's value is chosen larger than the coherence time of the channel. At

ISSN 2229-5518

the other end, the receiver also generates the same m ×n matrix however; now, the bits are by row instead as shown in figure below.

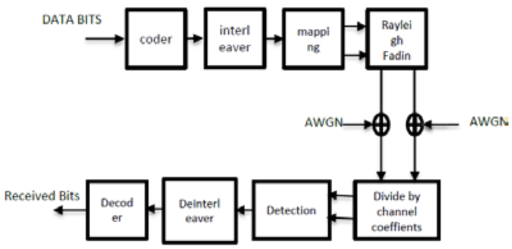


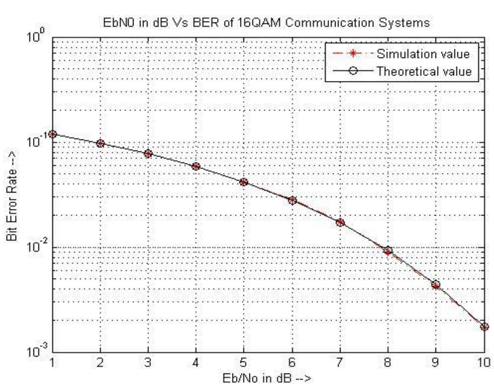
Fig.4 Block Dia of Interleaver coded !6QAM

Above block diagram indicates the procedure by which simulation moves in order to implement interleaver with coding on AWGN 16-QAM. Interleaver is placed before mapper whereas de interleaver is before the decoder, which is helping us to understand the role of coded interleaver in raising system performance. Bits of same code word face independent fading. If their separation time is greater than coherence time of channel. So depth of interleaver is given by- Tc/ Tb-coded.

Simulation, Results and observation

A. 16-QAM Modulation-

16-QAM Modulation scheme is simulated and it has been observed that theoretical and practical values coincide with each other. BER for 16 QAM varies between 10-3 to 10-1 for different values of Eb/No



B. Coded 16-QAM (15-11 Hamming Code)-

(15, 11) Hamming code is simulated and applied to Part-A to detect and correct the noise in simulated signal, which in turn will help to improve system performance and overall BER of Simulated system.

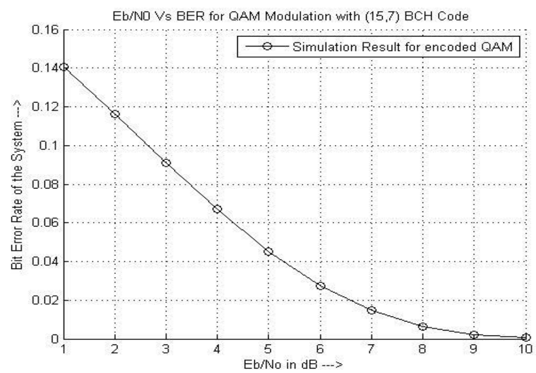


Fig6. Plot of 16 QAM coded AWGN

C. Doppler spreading in 16-QAM

16-QAM un-coded system is used to simulate and observe the Doppler spreading effect considering that mobile speed 42.3Km/hr. From the graph its observed that receiver mobility affects the communication system performance, theoretical and practical values are far apart from each other. BER is almost constant for different values of EB/NO.

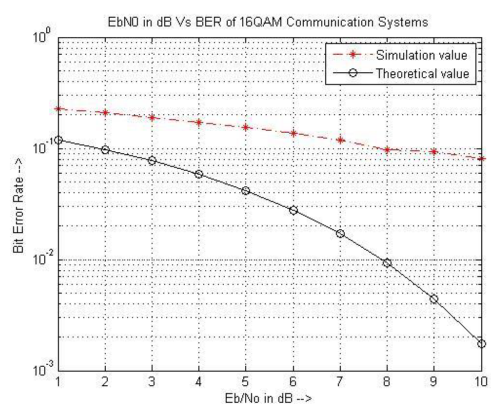


Fig7. Plot of Doppler spreaded 16QAM Uncode

D. Doppler spreading in Coded 16-QAM :

The effect of Doppler spreading effect on Coded 16-QAM to improve system performance is by coding. So Hamming Code (15-11) is imposed on 16-QAM to improve its performance which is affected due to mobility of receivers. But from the graph it has been clearly indicated that Coding is making system performance even worst than before. Because there are more than one error is one word, but hamming codes are generally usefull for correction of one bit only. So in particular situations received words which are in error can be considered as code-words by the decoder. Therefore noise retains in decoded signal, ultimately results in poor system performance. Because of which followed graph came out, in which BER of overall system is seems to be constant even after considerable rise in EB/NO.

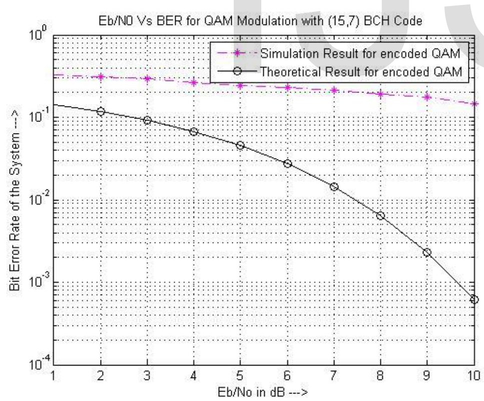


Fig8. Plot of Doppler spreaded coded 16QAM character

E. Interleaver on coded 16QAM

Interleaver in conjunction with hamming code(15,11) is used to minimize the effect of burst errors which can be concluded from the graph shown below. From simulation and graph it is very clear that there is no significant change in graph characteristics, or system performance, but it has improved performance in comparison with the graph in Part-C and Pard-D. Theoretical and practical values are still far from each other. But BER is improving as Eb/No is increasing.

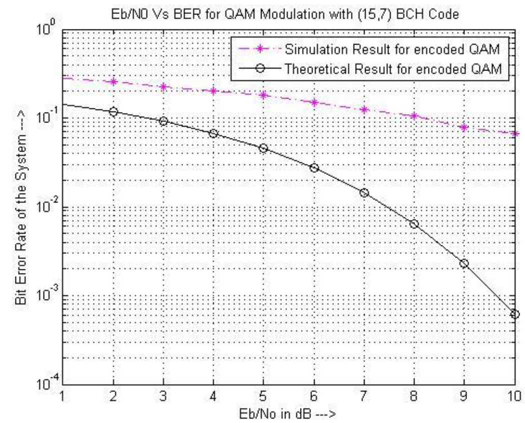


Fig.9Plot of 16QAM Interleaver Coded Doppler spreaded fading.

Conclusions and Discussion:

1. 16-QAM AWGN Communication system is simulated and theoretical and practical values are matching with each other but BER needs to be improved. To improve BER Simulation of hamming code (15,11) with 16 QAM AWGN is carried out and purpose is served.

2. Then we observed that, mobile receiver's movement badly affect the un-coded 16 QAM communication system. So in order to reduce the effect of fading , hamming code (15,11) is implemented, but still we failed to improve system performance.

3. Therefore we simulated the Interleaver coded 16QAM AWGN communication system. But from the graph it is very clear that system performance has been improved to a small extend. Still practically BER is not having significant change with increased EB/NO.

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