Mahatma Education Society's Pillai College of Engineering (Autonomous)
ELECTRONICS AND TELECOMMUNICATION ENEGINERING

16-QAM COMMUNICATION SYSTEM SIMULATION WITH BER ANALYSIS IN MATLAB

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INTRODUCTION

•Communication signals face noise, interference, and multipath fading.

•Bit Error Rate (BER) measures system performance.

•16-QAM MATLAB simulation analyzes BER under noisy, multipath conditions.

Includes:

•Bit generation & 16-QAM modulation

•Raised cosine pulse shaping

•Multipath fading & AWGN

•Matched filtering & demodulation

•Goal: Study channel effects on data accuracy and visualize constellation & spectrum.

SYSTEM SETUP AND SIGNAL GENERATION

System Parameters

- Total bits transmitted: 20,000 bits (numBits = 20000)
- Modulation type: 16-QAM (Quadrature Amplitude Modulation)
- Each symbol represents 4 bits (since $\log_2(16) = 4$)
- Total number of symbols = numBits / 4
- A random 20,000-bit binary data stream is generated as the input signal
- Data is modulated using 16-QAM, where each symbol represents 4 bits.
- A Raised Cosine Filter is applied for pulse shaping to reduce inter-symbol interference (ISI) and limit bandwidth.

PERFORMANCE ANALYSIS

•**Bit Error Rate (BER)**: Measures the ratio of bit errors to total transmitted bits.

•**Delay Compensation**: Align transmitted and received bits to account for filter processing delay.

•**Error Counting**: Compare aligned bits to calculate number of errors (numBitErrors).

Spectrum Analysis:

- Visualize signal before and after channel using a spectrum analyzer.
- Observe signal distortion caused by noise and multipath effects.

CONCLUSION

- MATLAB successfully simulates a realistic digital communication system.

  System performance evaluated through:

  - BER Calculation
  - Constellation Plot
  - Spectrum Analysis
- The model helps understand channel effects, noise impact, and filtering importance in communication systems.

Thank you