Project: Modulation and Channel Coding

1 Introduction

Quadrature phase-shift keying is a modulation scheme where the output of two quadrature bpsk modulators - modulated individualy - are summed together. This results in a constellation diagram consisting of four points which are equispaced around a circle. A QPSK symbol conveys two bits of information.

Concatenated coding schemes are widely used in communications systems. We will demonstrate the forward error correction (FEC) performance of concatenated Reed-Solomon and Convolutional Coding with Interleaving (IEEE 802.16 WiMAX).

2 Problem Statement

In this project you must implement and evaluate a concatenated coding system with QPSK modulation and demodulation. The simulation must be implemented in Java, C++ or Matlab. Note that if Matlab is used, the Simulink toolbox may not be used. Proper commenting of the code is important, as well as applying good software engineering practices.

For your simulations you can assume an AWGN channel (choose 10 points with signal to noise power ratio per bit E_b/N_0 from 1 dB to 3 dB). The demodulator must be non-coherent, i.e., no synchronization is provided between the local oscillators of the transmitter and the receiver. However, synchronization need not be implemented in your simulation.

We choose the (255, 239) Reed-Solomon code, which is capable of correcting up to 8 symbols per codeword. This Reed-Solomon code use $GF(2^8)$ and the generator matrix ($\alpha = 02H$) is

$$g(x) = (x+1)(x+\alpha)(x+\alpha^2)\dots(x+\alpha^{15}) \tag{1}$$

with field generator

$$h(x) = 1 + x^2 + x^3 + x^4 + x^8. \tag{2}$$

Soft-decision Viterbi algorithm is chosen to decode a 1/2-rate convolutional code with generator polynomial $g^{(1)}(D) = 1 + D + D^3 + D^4 + D^6$ and $g^{(2)}(D) = 1 + D^3 + D^4 + D^5 + D^6$.

We will implement a simplified concatenated scheme as shown in Fig 1.

3 Deliverables

The project must be carried out in groups of 3 students (maximum). Each group must hand in an individual report. The technical report style must be used, conforming to the school standard (Blue Book). You will be assessed on the following deliverables:

1. A complete technical report that contains the following:
   - A detailed description of your implementation (diagrams, descriptions, equations, pseudocode, etc.) and why a particular approach was taken, as well as its limitations.

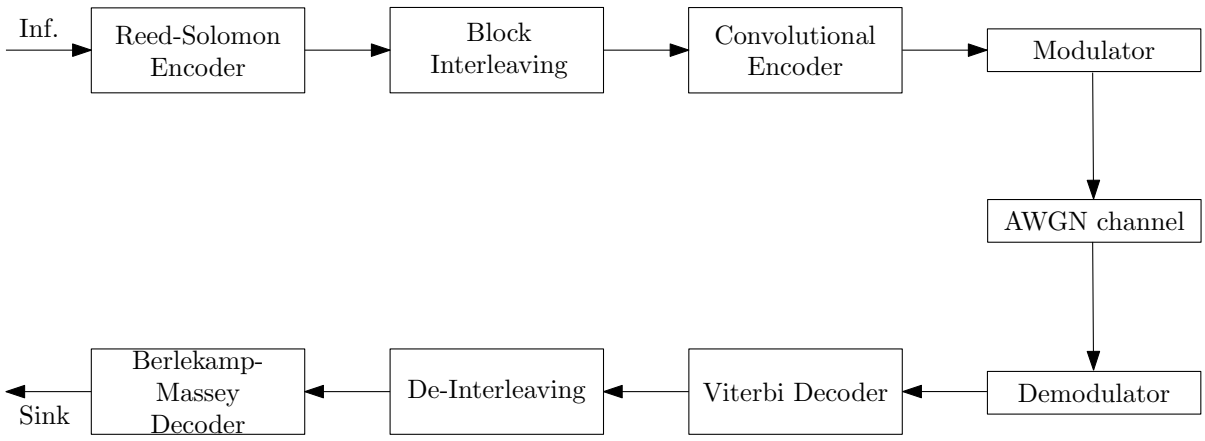

Figure 1: System diagram of concatenated scheme

- Discussion on how your code was tested, with fully documented test results.
- Problems in the design and implementation.
- Sample test data.
- An appendix detailing the division of work between team members, the milestones used to manage the project and a signed-off section, by both team members, of the work division.

Your code must be submitted on a disk (preferably optical) and be attached securely to your report.

4 Hand in details

The deadline for the report is 13:00 Monday 1 Nov. 2010. Late submissions will be subject to school policy.

5 Assessment

The following sections must be included in your report:

- Modulator implementation
- Demodulator implementation
- A plot of the actual signal waveform generated by the modulator
- An eye diagram
- Bit error rate of the demodulator
- Reed-Solomon encoding and decoding implementation
- Convolutional encoding and decoding implementation
- Interleaving implementation
- Bit error rate performance of the concatenated coding scheme

6 Plagiarism

The report is an individual effort, equivalent to an exam, so if there is the slightest indication of copied or plagiarised work all parties, i.e., the offender and supplier of information, will be given zero and reported to the University Disciplinary Committee.