MODULATION TECHNIQUE FOR COGNITIVE RADIO APPLICATIONS

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ABSTRACT

As the development of modern communication techniques is increasingly fast, the demand for reliable high data rate transmission had been increased significantly, which leads to much interest in modulation techniques. In this paper modulation technique is discussed for Cognitive radio networks. CR is an emerging radio approach in which transceivers are combined with sensors, intelligence, and adaptability. The idea for cognitive radio has come out of the need to utilize the radio spectrum more efficiently, and to be able to maintain the most efficient form of communication for the prevailing conditions. PSK (Phase Shift Keying) is widely used these days within a whole raft of radio communications systems. It is well suited to the growing area of data communications. PSK enables data to be carried on a radio communications signal in a more efficient manner than Frequency Shift Keying, FSK some other forms of modulation. Transferring from analogue formats to digital formats data communications is growing importance, and along with it the various forms of modulation which are used to carry data.

Keywords-**Cognitive Radio, Phase shift keying, Radio Communication, Frequency Shift Keying.**

I. INTRODUCTION

The wireless communication industry is facing new challenges due to constant evolution of new standards (2.5G, 3G, and 4G), existence of incompatible wireless network technologies in different countries inhibiting deployment of global roaming facilities and problems in rolling-out new services/features due to wide-spread presence of legacy subscriber handsets. The various advantages of 3G over 2G such as higher data rate as well as increased system capacity have been major motivations to move to 3G [1].
With the emergence of new standards and protocols has led to wireless communication development at a furious pace. High-speed wireless network of next generation are also expected to support multimedia applications. Existing technologies for voice, video, and data use different packet structures, data types, and signal processing techniques. Integrated services can be obtained with either a single device capable of delivering various services or with a radio that can communicate with devices providing complementary services. The supporting technologies and network that the radio might have to use can vary with the physical location of the user. The radio has to communicate and decode the signals of devices using different air interfaces to successfully communicate with the systems. To manage changes in network standards, protocols, services, and environments, the mobile devices require reconfigurable hardware that can support seamlessly multiple protocols, such as **IP, VoIP** and **MExE** .

Cognitive radio (CR) is one of the new long term developments taking place and radio receiver and radio communications technology. A cognitive radio may be defined as a radio that is aware of its environment, and the internal state with knowledge of the elements and any stored pre-defined objectives can make and implement decisions about its behavior. A cognitive radio is a radio which can sense its environment and has the capability to adapt some of its features, such as carrier frequency, modulation, and transmission bandwidth and transmission power allowing dynamic reuse of the available spectrum. With the rapid deployment of various wireless systems, the limited radio spectrum is becoming crowded increasingly. On the other hand, it is evident that most of the allocated spectrum experience low utilization [6].

As advancements in digital technology continue, the Communication industry continues to feel the impact of these advancements and the relationship between digital and communication technology strengths. As a result new digital technologies gain great exposure through the communication market. Phase shift keying, PSK, is widely used these days within a whole raft of radio communications systems. It is particularly well suited to the growing area of data communications. PSK, phase shift keying enables data to be carried on a radio communications signal in a more efficient manner than Frequency Shift Keying, FSK, and some other forms of modulation. With more forms of communications transferring from analogue formats to digital formats, data communications is growing in importance and along with it the various forms of modulation that can be used to carry data.

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several flavours of phase shift keying, PSK that are available for use. Each form has its own advantages and disadvantages, and a choice of the optimum format has to be made for each radio communications system that is designed. These are just some of the major forms of phase shift keying, PSK, that are widely used in radio communications applications today.

II. PHASE SHIFT KEYING

Phase Shift Keying (PSK) is a modulation technique in which the phase of the carrier wave is modified based on input signal to map data symbol to corresponding phase status. PSK is considered to be an efficient form of data modulation as it provides the lowest probability of error for a given received signal level, when it is measured over one symbol period. Satellite communication systems and Terrestrial microwave radio links and also utilize PSK as their modulation format. If the phase of the signal is changed in accordance with the digital information data, then the modulation scheme is called Phase Shift Keying [2].

A carrier signal may be represented as follows:-

$$s(t) = A\cos\left(2\pi f_c t + \theta(t)\right) \qquad (1)$$

Where, A = Amplitude, *fc* = Center frequency and $\theta(t)$ = Time-variant phase of the carrier wave signal.

Figure 3.1 shows a schematic block diagram of a Radio receiver illustration how the recognition section is integrated into the radio.

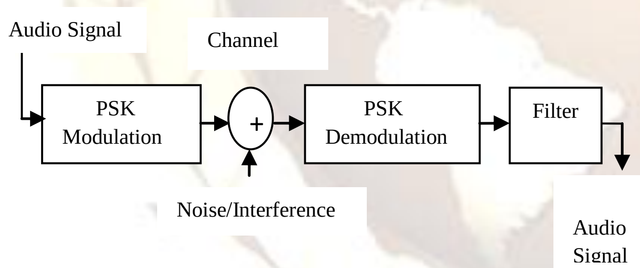

Figure 3.1: Schematic Block Diagram of Radio System

III. ARCHITECTURE OF COGNITIVE RADIO

The Digital Radio system mainly consists of three functional blocks [7]: RF section, IF section and Baseband section.

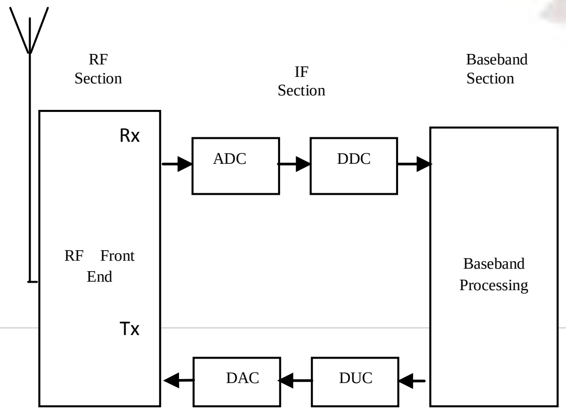

Figure 1: Block Diagram of a generic Digital Transceiver

The architecture of Cognitive radio is more or less related to SDR. The RF section consists of essentially analog hardware modules while IF and baseband section consists of digital hardware modules. The RF section is responsible for transmitting/receiving the radio frequency signal from the antenna and converting the RF signal to an intermediate frequency (IF) signal. On the transmit path, it performs analog up conversion and RF power amplification. The ADC/DAC blocks perform Analog to Digital conversion on the receive path and Digital to Analog conversion on the transmit path, respectively. DUC/DDC blocks perform Digital Down Conversion (receive path) and Digital Up Conversion (transmit path) respectively. To achieve the performance required for a cognitive radio, not only must the DACs and ADCs have an enormous dynamic range, and be able to operate over a very wide range, extending up to many GHz, but in the case of the transmitter they must be able to handle significant levels of power.

IV. CONVOLUTION CODING

Convolution FEC codes were discovered by Elias in 1955, whereas Wozencraft and Reiffen as well as Fano and Massey also proposed various algorithms for their decoding. A major milestone in the history of convolution error correcting coding was the invention of maximum likelihood sequence estimation algorithm by Viterbi in 1967 [3]. One of the first practical applications of convolution codes was proposed by Heller and Jacobs during 1970's. Viterbi Algorithm did not resulted in minimum Bit Error rate; instead it finds the most likely sequence of transmitted bits. Convolution codes work on bit or symbol streams of arbitrary length Convolutional codes are frequently used to correct errors in noisy channels. They have rather good correcting capability and perform well even on very bad channels (with error probabilities of about 10^{-3}) [4].These codes are extensively used in satellite communications.

Convolutional codes are commonly specified by three parameters; (*n, k, m*) where n = number of output bits; *k* = number of input bits; *m* = number of memory registers. The quantity *k/n* called the code rate is a measure of the efficiency of the code. A simple Convolutional encoder is shown in Figure 4 [5].

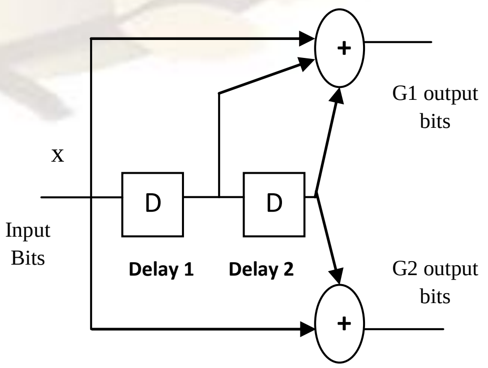

Figure 4: Convolution Encoder

Viterbi Decoding is an optimal (in a maximum-likelihood sense) algorithm for decoding of a convolutional code. Its main drawback is that the decoding complexity grows exponentially with the code length. So, it can be utilized only for relatively short codes.

V. SIMULATION RESULTS

In this section the simulation is done to test the performance of the wireless system for noisy channel. Convolution coding is performed to recover the data with very less probability of error at the receiver, From the simulation results it can be seen that wireless system designed using PSK technique which has the major advantage in terms of Bit Error Rate. The higher data rates require a better signal to noise ratio before the error rates start to rise and this counteracts any improvements in data rate performance. The graph is shown for BER vs SNR in figure 6.which shows that SNR is improved as BER decreases using the coding technique.

VI. CONCLUSION

Over a past couple of decades many Mobile communication standards have evolved and even today researches are going to develop new standards. The move to digital modulation provides more information capacity, compatibility with digital data services, higher data security, better quality communications, and quicker system availability. As for much higher order of modulation distance between adjacent points in the I-Q plane decreases so PSK had been chosen as modulation scheme, hence the constellation points will be more distinct and data errors can be reduced in wireless systems. The simulation results are shown in the form of BER and SNR using Phase Shift Keying Modulation technique which concludes that data errors can be minimized using coding techniques, hence improving Signal to noise ratio. Hence, the signal can be recovered with very less probability of error at the destination.

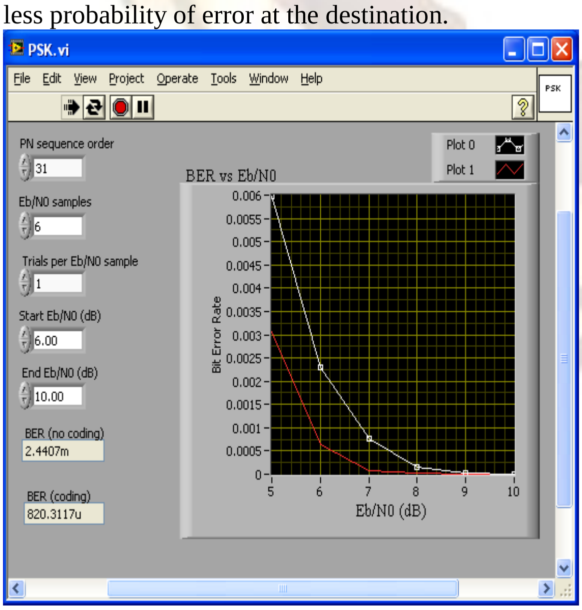

Figure 5: Received Signal Graph

Applications of Cognitive Radio (CR) allow user terminals to sense whether a portion of the spectrum is being used or not, in order to share the spectrum among neighbor users. It determines the occupancy of the available spectrum, and then decides the best power level, mode of transmission and other necessary characteristics. Thus, Cognitive radio will be an enabling technology in future generations of LTE.

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