Beacon Based SDR Communication System

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Abstract— The Software defined radio (SDR) is an advanced type of radio communication that provide a more flexible design for the wireless and mobile industry. In this paper we are proposing methods which can increase the efficiency of SDR. The beacon, Multi transmitter and receiver, pipelining and parallel processing are some techniques used for enhancing the system. We are proposing a system that will improve power efficiency of SDR and will reduce delay of SDR using beacon based technique.

Key words: SDR, Radio Communication, Beacon, Transmitter, Receiver, Pipelining, Efficiency, Delay

I. INTRODUCTION

In conventional radio systems, parameters defining the modulation/demodulation methods, waveforms , signal generation and link layer protocols are based on a fixed hardware where a set of hardware elements perform signal processing functions . The SDR technology aims to overcome these limitations by offering flexible radio systems that can be upgraded efficiently by providing software control of a variety of modulation/demodulation techniques. Thus this technology offers potentially longer product life and the radio can be upgraded efficiently, where efficiency can be measured by the cost and the physical volume consumed per information bit.

II. DIGITAL COMMUNICATION SYSTEM

There are many advantages of Digital Communications. The most important among them is the fact that digital circuits are subjects to lesser distortion and interference than analogs. Since binary digital works in one of two states – ON or OFF, '1' or '0'. A disturbance must be large enough to change the circuit operating point from '1' to '0' or vice versa. Such two state operations prevent noise and other disturbances from affecting the transmission.

Due to this reason regeneration of digital information can be performed easily unlike the analog signal where the signal regeneration cannot be performed perfectly even when small amount of noise and distortion are present.

Moreover, digital circuits are more reliable and less expensive as compared to analog circuits. Also digital hardware is more flexible to implement as compared to analog circuits because digital circuits make use of digital hardware such as microprocessors, VLSI chips, digital switching, Field Programmable Gate Arrays(FPGAs), Digital Signal Processors (DSP) etc .All these hardware are extensively available at lower costs.

A basic digital communication system is shown in figure1.

On the transmitter side information source may already consists of Analog to Digital conversion. Source coding may involve one of the following: predictive coding, block coding, variable length coding, synthesis/analysis coding etc.

Data encryption involves the encryption key which is used to modify the digital word and is unique and random key. Channel encoding involves the following: linear block codes, cyclic codes, convolution codes etc. Modulation involves one of the following: Phase Shift Keying (PSK), Frequency Shift Keying (FSK), Amplitude Shift Keying (ASK), and Quadrature Amplitude Modulation (QAM) etc.

After the modulation the signal is passed onto the IF stage where there is frequency Up-Conversion. Then this signal passes through RF front-end and through the antenna is transmitted in air.

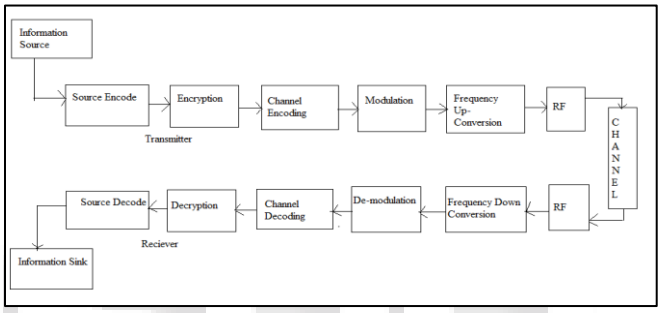

Fig. 1: Digital communication system

On the receiver, the signal is intercepted by the antenna, is passed onto the RF section which amplifies this weak signal and passes it onto the IF section for frequency down conversion. The signal is then demodulated. It is then given to the detector for detection of the bits. After detection the remaining blocks are just reverse of the corresponding blocks in the transmitter.

III. GENERAL OVERVIEW OF THE ARCHITECTURE OF SDR

SDR can be defined as a radio communication system that uses software to modulate or demodulate radio signals. Hence by changing the software, any given communication scheme can be implemented even in a run time. Therefore the systems can achieve high flexibility at a lower cost than traditional analog systems.

The implementation of software defined radio is based on two popular concepts. The first approach is to program a conventional DSP processor which is based on Harvard architecture, an extension of Von-Neumann architecture. So, by changing the program a desired modulation scheme can be established Second approach is to configure a Programmable hardware by using "Hardware Description Language (HDL)". Thus by changing the program, the hardware device can be configured to a particular modulation scheme. By taking the advantage of the programmable hardware like FPGA it is possible to overcome the limitation of the conventional DSP processors where most of the instructions are executed sequentially.

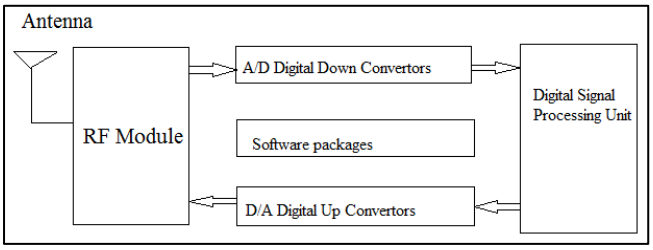

Fig.2 SDR general architecture

IV. THE MAIN FUNCTIONS OF SDR ARE DESCRIBED

A. *Smart Antenna:*

The baseband controllers control the antenna operations. At the transmitter side, the antenna makes an interface between the network (NET) layer and the MAC layer on the receiver side. The antenna can achieve the signal by space division multiplexing.

B. *RF Modules:*

The RF module is used to assist the smart antenna. The RF module is having the following functions, Digital frequency synthesizer, pre-amplifier, power output, RF conversion.

C. *Digital up/down Converters:*

A/D is used to convert the digital signal into an analog signal. The signal from the antenna is in the RF range. Then the RF signal is converted into IF signal. The high speed converters are designed according to the sampling theorem. The up converters do the reverse operation of this.

D. *Digital Signal Processing:*

The digital signal processing (DSP) functions can be implemented on an FPGA. All the physical layer functions like modulation/demodulation, encoding/decoding, and multiplexing/demultiplexing will be performing in this block.

V. PROPOSED PLAN OF WORK

The proposed work can be divided into the following modules:

1) Design of SDR transmitter
2) Design of SDR receiver
3) Design of SDR communication system
4) Integration of beacon based system
5) Result evaluation and comparison

VI. PROPOSED SYSTEM

Software Defined Radio (SDR) is an opening architecture based on the modern communication theory and digital signal processing, which consist of antenna, RF front end, Processor.

In SDR it is very difficult to create a Radio Frequency (RF) front end that is applicable to variety of signals with different parameters such as Bandwidth, and center frequency. A receiver consists of an Antenna, Filter, and ADC. The main purpose of the receiver is to isolate the desired signal from interference and noise for demodulation and further processing. It catches signal from an antenna filter it to remove an undesired signal and then convert the signal to the center frequency with amplitude compatible with the analog to digital conversion process.

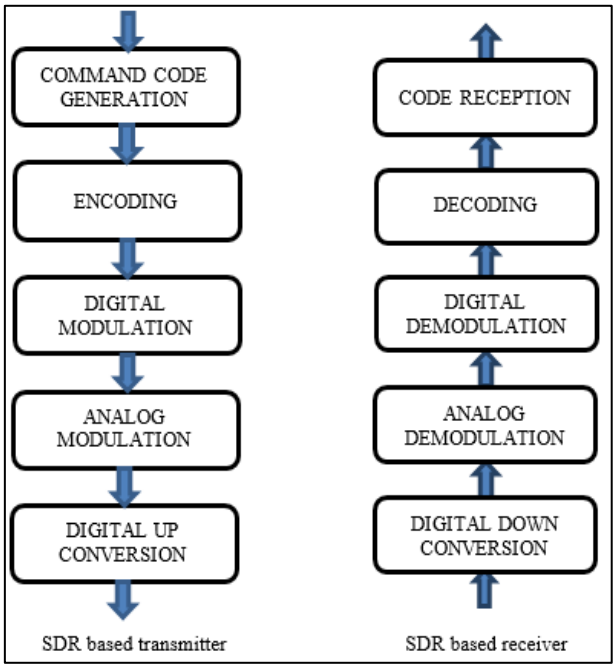

Fig. 3: SDR based transmitter and receiver

Transmitter Section consists of an Antenna, amplifier and DAC. The purpose of the transmitter RF section is to convert the digital representation of the analog signal into radiated analog signal .This process at the transmitter end is nearly reverse t that of receiver. The DAC is used to convert digital to analog signal. The converted analog signal is up- converted to the desired RF center frequency. The signal is further amplified to the appropriate power level, and limiting the signal's bandwidth before it is radiated. In practice, multiple stages of conversion and amplification may occur before the signal is radiated.

In the proposed system, we will design the normal SDR transmitter and receiver using continuous transmissions.

This will be improved using beacon based transmitter and receiver and the system's delay and power will be compared for efficiency

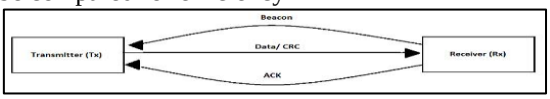

Fig. 4: Beacon Based SDR

As shown in Fig 4, Beacon based SDR uses the request and acknowledgment policy to transfer data. As observed from the figure there are two nodes namely the transmitter and the receiver. The transmitter is having the data which is required by the receiver. When the receiver is free to accept the data, the receiver will send a Beacon Packet to the transmitter. The Beacon Packet contains the request from the receiver.

When the request reaches the Transmitter, it checks the request of the receiver and the Data required. If all the constraints match then the data is sent. The data is attached with CRC, that is error detection and removal is applied so that at the receivers end if the data received is faulty, it can be reconstructed by the CRC. The Data and CRC are received at the receivers end and from the newly received data again CRC is calculated and is XOR with the received CRC and the error bits can be found using this. The error bits are then XOR with the received data and finally the original data is

reconstructed. Once the original data is retrieved the receiver sends an Acknowledgment to the transmitter. The acknowledgment contains that the receiver has received the desired data and the transmitter can now stop sending the data and can wait until the next Beacon request.

VII. SYSTEM MODEL OF BEACON BASED SDR

The main processing steps in the Beacon based SDR are described below

1) Check if the transmitter is free if yes initialize Beacon packet send the packet to transmitter,
2) Calculate the CRC, for the data.
3) Send the Data with CRC to the receiver.
4) At the receivers end calculate the CRC of the received data.
5) XOR with the CRC received and CRC calculated.
6) XOR Error with the data to get the Original Data.
7) Sent Acknowledgment to the transmitter.

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