Research Article

Designing and implementation of secured OFDM Communication on a Multi-Core Software-Defined Radio Platform

Authors:
1 B. Y.S.V.S.G.Anasuya, 2M. Chaitanya Kiran.

Address for Correspondence:
1M.Tech II Year, ASR Institute of Technology
2Assistant Professor, ASR Institute of Technology.

ABSTRACT:
In this project OFDMA scheme is proposed for multi-user wireless communications with specific application in all domains. A reduced complexity software implementation of the technique is proposed and discussed in this project. Both the interoperability and adaptability among modulation operational modes of the OFDM systems is supported. Here, straight-line method is studied and implemented in method employing radix-2 decimation-in-time fast Fourier transform (FFT) algorithms.

INTRODUCTION:
Two major problems associated with data communications over terrestrial wireless channels are inter symbol interference and fading caused by multipath propagation. In multi user applications such as personal mobile communications, other-user interference could also limit the system performance and capacity. In this paper, an interference tolerant wideband multiple access scheme is discussed based on the orthogonal frequency division multiplexing (OFDM). The scheme is designed as such, the amount of other-user interference and inter symbol interference are reduced. This is achieved using both a cyclic prefix and a cyclic suffix in the transmit data frames and noting that the Fourier code words used in OFDM have a zero cross correlation on all cyclic shifts.
PRESENT METHODOLOGY:

1. Software Defined Radio Platform

Software Defined Radio (SDR) platform solves incompatible wireless network issues by implementing radio functionalities as software modules running on generic hardware platforms. The radio functionalities include the modulation format and coding techniques. These radio functionalities can be changed without changing the hardware.

1.1 Benefits of SDR platform

- SDR is a reusable platform as all the features are implemented in software.
- The implementation of additional features on SDR platform is cheaper. The crossover of SDR is also lower.
- The architecture is highly flexible.
- Flexibility is the key feature of the SDR implementation.
- SDR being a reconfigurable architecture has low power consumption.
- Lead time of SDR is also short. Lead time is the time taken between the initial stage of the system and appearance of results.

The signal transmitted from the transmitter section of SDR is in the form of digital pulses. In high frequency transmission, as the time period of the signal varies inversely with the frequency, the width of the pulse is chosen to be small. ISI is the common problem in high speed communication. ISI occurs at the receiver.

*Baseband OFDM Transmitter*
The OFDM transmitter can be implemented by using a regular IFFT, but without dividing the outputs by \( N \) as follows:

\[
x_k = \sum_{n=0}^{N-1} d_n \cdot e^{j\frac{2\pi nk}{N}} \quad k = 0, 1, ..., N-1
\]

Where \( d_n \) is the predefined data symbol from bit stream \( b_n \) and \( e^{j\frac{2\pi nk}{N}}, n=0, 1, ..., N-1 \), represents the corresponding orthogonal frequencies of the \( N \) sub-carriers. Fig. 4 shows a simplified OFDM transmitter block diagram. Note that the S/P is the serial-to-parallel converter and P/S is the parallel-to-serial converter. All baseband operations inside the dashed box are software-based processing modules on the given hardware platform as depicted in Fig. 4. After P/S, the digital signal stream is then passed through the digital-to-analog (D/A) converter, frequency up converted with a carrier, and transmitted wirelessly.

![Figure 1 Block diagram of simplified OFDM transmitter](image)

**QPSK Modulated Signal**

QPSK waveform is another form of angle-modulation where four output phases are possible for a single carrier frequency. With the four different output phase possibilities, there must also be four corresponding input conditions (00, 01, 11, 10), which enjoy for the Gray code QPSK system to transmit twice as many data bits as the BPSK system with the same transmission bandwidth. Two
serial bits b0b1 form a QPSK symbol. The b0 bit is used to encode the in-phase axis “I” and b1 bit is used to encode the quadrature axis “Q”. QPSK signal constellation with Gray coding is illustrated in Fig. 6.

![Figure 2 QPSK Signal Constellations with gray Coding](image)

**Quadrature Amplitude Modulation**

Ability of equipment to distinguish small differences in phase limits the potential bit rate. This can be improved by combining ASK and PSK. This combined modulation technique is known Quadrature Amplitude Modulation (QAM). It is possible to obtain higher data rate using QAM. The constellation diagram of a QAM signal with two amplitude levels and four phases is shown in Fig. 7. It may be noted that M-array QAM does not have constant energy per symbol, nor does it have constant distance between possible symbol values.

![Figure 3 Constellation diagram for a QAM signal](image)

**Serial-Parallel Converter**

The bits from the convolution coder is accepted serially by the serial to parallel converter and converted into parallel bits. Four bit control code is used. According to control code, each bit is assigned serially to temp data. All the bits in the temp data are grouped together to parallel data.
Parallel–Serial Converter

The parallel bits from IFFT can be converted into serial bits by using the parallel to serial converter. The input bits are stored in the shift registers. Each bit in the shift register is shifted right. The bits that are shifted right are stored in register.

Baseband OFDM Receiver

The simplified receiver architecture is depicted in Fig. 8. At the receiver, the received signal is down converted and digitized via the analog-to-digital (A/D) converter. Assuming that the synchronization process has performed, the digital sampled signal \( r_k \) is passed through S/P, FFT processing, P/S, and demodulation operation. The final detected signal \( \hat{d}_m \) of the \( m \)th OFDM symbol in additive white Gaussian noise (AWGN) channel is represented as follows.

\[
\hat{d}_m = -\sum_{k=0}^{N-1} r_k e^{-j 2\pi nk/N}, \quad n = 0, 1, ..., N-1
\]

Where

\[
r_k = r_{k,m} = x_k + w_k
\]

Note that \( w_k \) is the AWGN and the OFDM symbol period is \( T \) where \( T = NT_s \). The detected bit \( \hat{b}_m \) is obtained after the demodulation. Again all baseband operations inside the dashed box are software-based processing modules as depicted in Fig. 5.
As shown in Figs 1 and 4, the IFFT and FFT are the most time consuming part of the base-band OFDM processing for transmitter and receiver, respectively. Note that the IFFT operation can be performed using the FFT operation. By swapping the real and imaginary parts of the input sequence and swapping the real and imaginary parts of the output sequence, the FFT function is employed for the IFFT computation. Hence, if the OFDM transceiver is operated in time division multiplexing (TDM) mode, there is no additional hardware or software required for using the OFDM transmitter and receiver separately. In other words, one DSP should be able to handle both IFFT and FFT operations if its throughput is fast enough. Due to the simplicity, the radix-2, decimation-in-time FFT algorithm is chosen, implemented, and used for both IFFT and FFT operation at the transmitter and receiver, respectively. The “butterfly” is the smallest computational unit and implemented by assembly code.

RESULTS:
### Conclusion:

Thus the basic concepts of SDR architecture and OFDM have been studied and the various sections that are needed to reduce ISI are analyzed. The OFDM system is carried out in digital domain and can be easily implemented in SDR. It is demonstrated by a software reconfigurable OFDM system using a programmable fixed-point DSP. Both the interoperability and adaptability among BPSK and QPSK operational modes of the OFDM systems is discussed. Similarly, software defined antennas can also be implemented by using this approach. Adaptive modulation can be applied to this system which minimizes the antenna sizes, while still being able to provide high data rate. The software modulation and demodulation modules of a DSP-based architecture can be updated or reconfigured to meet these design requirements as discussed in this paper & also presented a partial pipelined/cached-FFT processor for the OFDMA system.

### REFERENCES:


