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Performance Analysis of Low Power Superimposing OFDM System Architecture

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Abstract: Modern communication required high speed of data transmission and reception. Orthogonal Frequency Division Multiplexing (OFDM) offers high data rate for communication in wireless medium. The multi users can be transmitted using OFDM system in parallel way of transmission and reception approach. The main limitation of multiuser OFDM system is that it can able to transmit the data of unicast and multicast separately. In this paper, superimposing OFDM architecture is proposed to overcome such limitations in conventional methods. The performance of the proposed superimposing OFDM architecture is analyzed in terms of power consumption with state of arts.

Keywords: OFDM, encoder, unicast, multicast, power consumption.

I. INTRODUCTION

OFDM plays an important role in wireless communication system. In conventional OFDM systems, single user data can be communicated to distance location at a single time interval period. The OFDM system has the following properties as high diversity gain and high signal to noise ratio over different frequency selective and fast fading channels. Forward Error Correction (FEC) is integrated with OFDM system in order to reduce the error rate of the symbol data transmission and reception [8]. Space diversity is adopted in OFDM system to improve the diversity properties to reduce bit error rate. The power consumption of the conventional OFDM system [9] is high which is not suitable for advanced 4G/5G wireless communication systems. The error rate is also high due to the time varying channels. In this paper, multi user OFDM system is designed with low power encoder and adaptive modulation architectures. Abhinav Johri et al. (2017) proposed low power architecture for multi user OFDM system for improving the fitness factor. The authors used genetic algorithm for improving the fitness ratio of the proposed circuit architecture. The proposed low power architecture was applied on different hardware circuit's in order to verify the power consumption of the system. Wang et al. (2015) developed low power architecture for multi user OFDM system. The authors designed and proposed their low power architecture for visible light communication system. The proposed method was constructed using simple logic gates for obtaining high efficiency and low power consumption in multi user OFDM system environment.

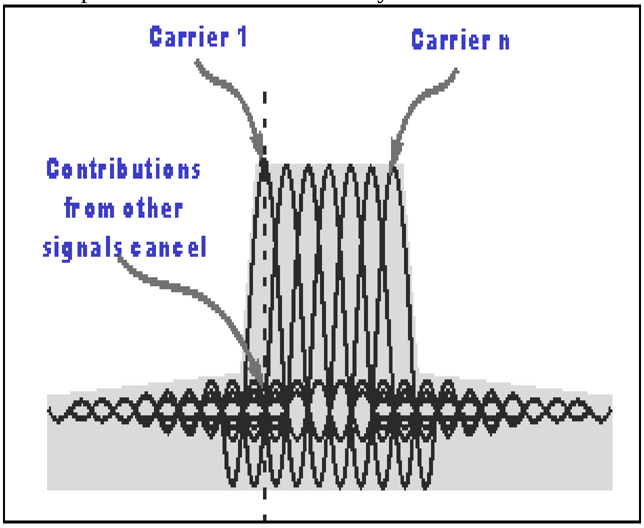

Figure 1: Spectrum of OFDM symbols

Fig.1 shows the spectrum of OFDM symbols in multi user OFDM system. Section 2 proposes an efficient low power superimposing OFDM architecture and its various modules and section 3 discusses the simulation and synthesis results of the proposed architecture design. Section 4 concludes the paper.

II. PROPOSED METHODOLOGY

In this paper, the unicast signals are superimposed with broadcast signals in order to reduce the bandwidth utilization, so that maximum number of user's data can be transmitted through the channel medium in OFDM system.

The proposed superimposing architecture (transmission section) in OFDM system is illustrated in Fig.2 (a) and its de-superimposition system (reception section) is illustrated in Fig.2 (b). In case of superimposing architecture for OFDM system, it consists of separate encoder for both unicast and broad cast signals, superimposing block which function is to perform multiplexing, serial to parallel converter which converts the serial data into parallel data, IFFT block which performs the frequency domain parallel information into time domain information, P/S converter, which converts parallel information signals into serial data.

This serial data is only able to be transmitted over the time varying channels. This transmission section also contain cyclic insertion and Digital to Analog Converter (DAC) block.

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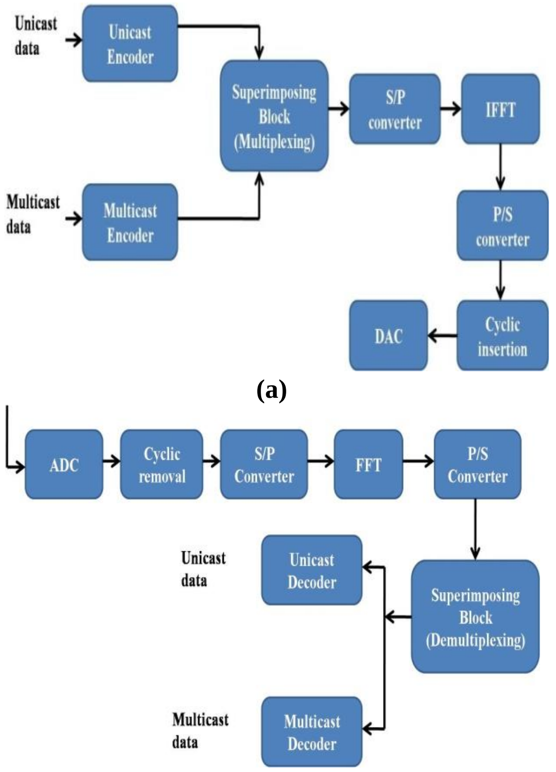

Figure 2: (a) Superimposing transmission (b) Superimposing reception

Fig.2 (b) shows the superimposing reception in OFDM system which contains ADC, cyclic removal, S/P converter, FFT, P/S converter, superimposing demultiplexing block and separate decoders for both unicast and broadcast signals.

Unicast Encoder

The unicast encoder is used to encode the unicast signals. Fig. 3 shows the architecture of unicast encoder. The unicast signal contains 9 bits of data and 9 bits of address. The data and address are separetely encoded. In 9 bits address of unicast signal, first bit represents the sign bit of the unicast data.

This bit is extracted from the 9 bit address and it is given to AND gate. The same sign bit is also extracted from the 9 bit data which is also given to AND gate. The data and address are given to compare and select unit which compares these information and select one based on the following criteria. The output of compare and select unit is concatenated with AND gate output which produces the encoded data of the unicast signal.

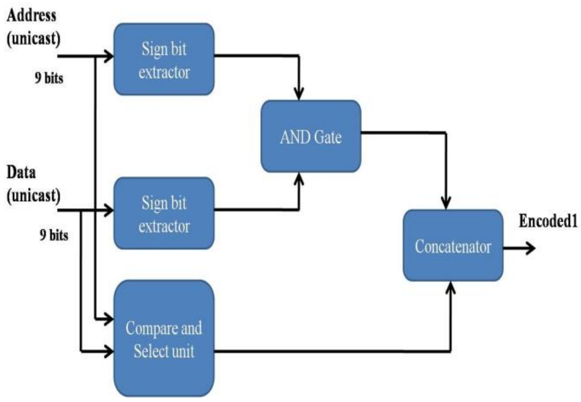

Figure 3: Architecture of unicast encoder

Multicast Encoder

Multicast encoder is used to encode the multicast signals. Fig. 4 shows the architecture of multicast encoder. The multicast signal contains 9 bits of data and 9 bits of address.

The 9 bit data and address are inverted as serial bit format and then it is added and subtracted in swapped manner. The outputs from adder and subtractor units are inverted in serial format. Both these outputs are multiplexed in order to produce the encoded information of the multicast signals.

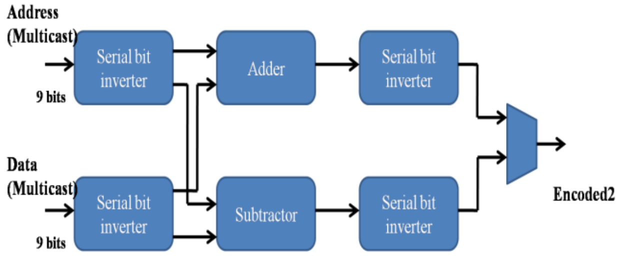

Figure 4: Architecture of multicast encoder

Superimposing Block

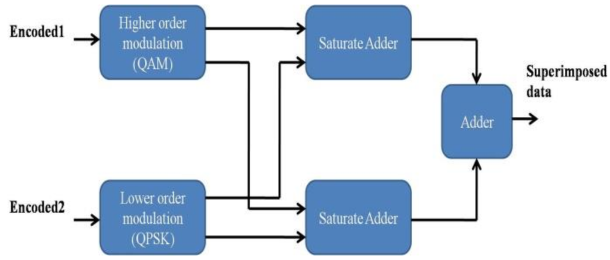

Figure 4: Architecture of superimposing block

The encoded sequence from unicast information is applied to higher order modulation as Quadrature Amplitude Modulation (QAM) and the encoded sequence from multicast information is applied to lower order modulation as Quadrature Phase Shift Keying (QPSK). The outputs from lower and higher order modulations are applied to saturate adder and saturate subtractor, respectively. Finaly, the outputs from saturate adder and subtractor are added in order to obtain the superimposed signal. The proposed superimposing architecture is illustrated in Fig.5 and the saturate adder used in this paper is depicted in Fig.6.

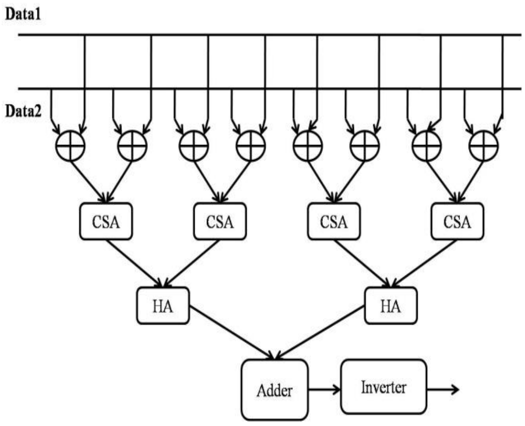

Figure 5: Saturate adder

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III. ESULTS AND DISCUSSION

The proposed superimposing architecture of OFDM system is designed using Verilog HDL language and it is synthesized using Xilinx Project Navigator software. Table 1 shows the hardware utilization of the superimposing OFDM architecture in Xilinx synthesis software.

Table 1: Hardware consumption of the proposed architecture

Performance parameters	Proposed Architecture
Slices	86
LUTs	178
Gate Counts	1029
IOBs	37

Table 1 shows the hardware consumption of the proposed architecture in terms if slices, LUTs, gate counts and IOBs. The proposed system architecture consumed 86 numbers of slices, 178 numbers of LUTs, 1029 number of gates and 37 numbers of IOBs.

Table 2: Comparisons of superimposing OFDM system with conventional methods

Methodology	Power Consumption (mW)
Proposed	17
Ismail et al. (2013)	65
Zhang et al. (2017)	46

Table 2 illustrates the comparisons of superimposing OFDM system with conventional methods. The proposed superimposing OFDM system architecture is implemented in Xilinx software for synthesis and achieved 17 mW of power consumption, while the conventional system Ismail et al. (2013) achieved 65 mW of power consumption and Zhang et al. (2017) consumed 46 mW of power consumption.

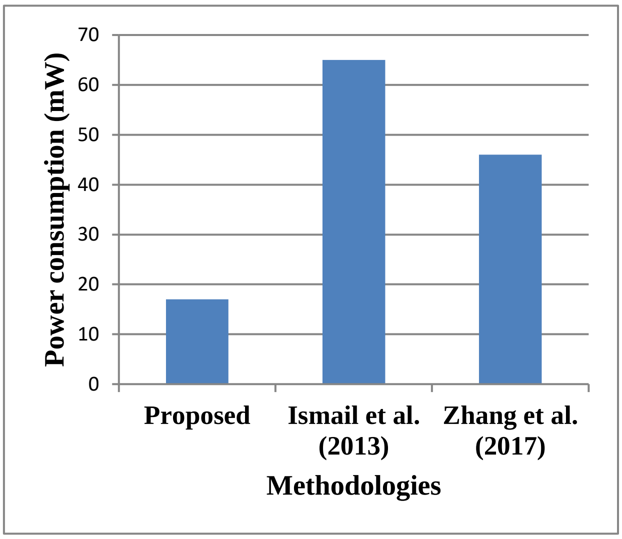

Figure 6: Graphical comparisons of proposed architecture with conventional systems in terms of power consumption

IV. CONCLUSIONS

In this paper, the unicast and multicast signals are superimposed in OFDM system for reducing the bandwidth utilizations. The proposed system has separate encoder architecture which encodes the data and address separately. These encoded data and address of both unicast and multicast signals are superimposed with each other using lower and higher order modulations. The proposed superimposing OFDM system is implemented in Virtex architecture and its power consumption is analyzed.

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