Visible Light Communication with MAC Enhanced By OFDM

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Abstract

Visible Light spectrum enhances the wireless technology with the new concept of Visible Light Communication that paves a way for emerging wireless technology. The standard behind this is IEEE 802.15.7 which put forward the idea of optical wireless communication. Medium Access Control (MAC) protocol helps in effective transmission of data across channel. But as per the nature of transmission and applications its effectiveness may vary, so further enhance it the feature of OFDM (Orthogonal Frequency division Multiplexing) is used. OFDM provides transmission through channels with high frequency selectivity. The work introduces the OFDM with MAC enhances Optical Wireless Communication.
Keywords: *IEEE 802.15.7, MAC, OFDM, Visible Light Communication.*

1. Introduction

The short range wireless RF communication is nowadays preceeded by visible light communication. The visible light communication here uses the idea of illumination and communication. Visible Light Communication is introduced with IEEE 802.15.7 draft standard. The network of IEEE 802.15.7 consists of two nodes and they are: the co-ordinator which manages and initializes the device, another is the remote device for connecting the devices.

Here MAC protocol is being used for operation in wireless network that will enable to use the full duplex logical communication channel and, comparatively much effective compared to other protocols [1].

A sub-layer of Data Link layer is the MAC layer that includes functions and procedures for proper communication of data over the network; there are specific activities for framing, physical addressing and flow error controls. Mobility of the nodes and the unreliable time varying of the channel can be addressed with the MAC protocols.

The efficiency of the MAC protocol can be even more enhance with the idea of OFDM. OFDM (Orthogonal Frequency Division Multiplexing) is very effectively used because it uses multiple orthogonal carriers across the transmission channel for data transmission [4]. This modulation scheme is quite efficient since it has high data transmission rate through high bandwidth channel that will result in less Inter Symbol Interference.

2. Visible Light Communication

Visible Light Communication (VLC) is an emerging technology in communication that pulls out the way for free space communication. VLC utilizes the wavelength of visible light spectrum that offers a range from 380 nm to 720 nm and has many advantages than RF communication. It provides unlimited bandwidth and has unregulated spectrum for immediate utilization. Spatial confinement helps to eliminate eavesdropping and helps in spatial reuse

with substantiated increased throughput. While the case of unprotected RF links the removal of multipath fading degrades the performance of the system. But here since optical signals are used there will not be electromagnetic interference [2].
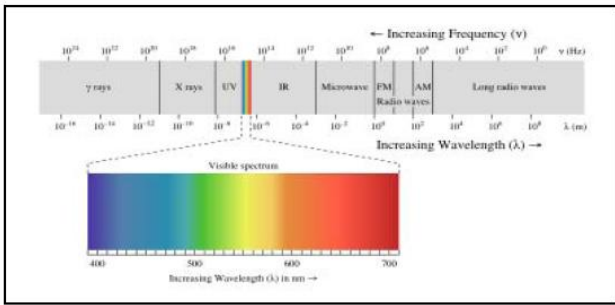

Figure 1: Visible Light Spectrum

3. Overview of IEEE 802.15.7

3.1 IEEE 802.15.7 Topologies

Visible light communication is standardized with the IEEE 802.15.7 draft standard that effectively implements the technique. It paves a way for initializing, managing and communicating in the network. Also has ISO/OSI protocol which includes PHY and MAC layer. When you submit your final version, after your paper has been accepted, prepare it in two-column format, including figures and tables. This standard defines with three topologies and they include: peer to peer, star and broadcast [1].
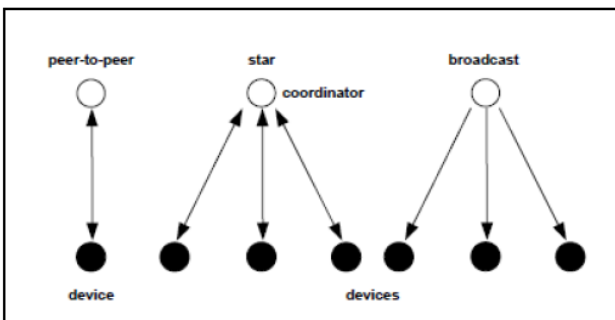

Figure 2: IEEE 802.15.7 Topologies with IEEE 802.15.7 Draft Standard

3.2 Mechanism of MAC in IEEE 802.15.7

The standard defines about the two mechanisms which are contention based channel access and contention free channel access. Contention based access uses back off algorithm for accessing the channel in contention access period (CAP) among the devices for communication. Whereas Contention free access manages the co-ordinator in contention free period (CFP) through the use of guaranteed time slot (GTS) [1].
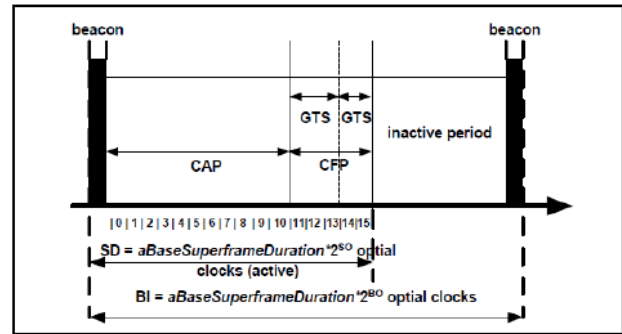

Figure 3: IEEE 802.15.7 MAC in IEEE 802.15.7 Draft Standard

3.3 MAC in VLC

Frame synchronization with TDMA uses the visible light for broadcasting with MAC protocol. MAC frame can be used for multichannel since it consists of various slots. Slot may be defined as the minimum time required to communicate the smallest data [3]. The synchronization is based on frames.

4. Research Work

4.1 OFDM

OFDM is gaining wide popularity in transmission since it effectively transmits along channel with high frequency selectivity. This modulation technique effectively transmits high data rate over high bandwidth transmission channels,   and is strongly resistive to Inter Symbol Interference since it uses the technique of adaptive equalization. This method effectively eliminates the method of complex equalization. Since the transmission of data is done among large number of closely spaced sub carriers, it provides with high bandwidth. This increases the chance of individual sub carriers of the spectrum to overlap. Hence the carriers are chosen as orthogonal. In general, the baseband modulated input signal is used in this digital modulation scheme. And then they are transmitted as N different substreams, where the signals are parallelized before transmission. The substream will modulate separate carriers when passed through IFFT modulation block and thereafter cyclic prefix is introduced. This is done so as to eliminate ISI. Now the copies of the

sampled signals and circular extension of IFFT modulated signal is obtained. The data is serially converted back so as to form the OFDM signal and it is used to modulate the high frequency of carrier signal through the channel. With appropriate demodulation scheme the data are down converted and cyclic prefix is removed at the receiver side.
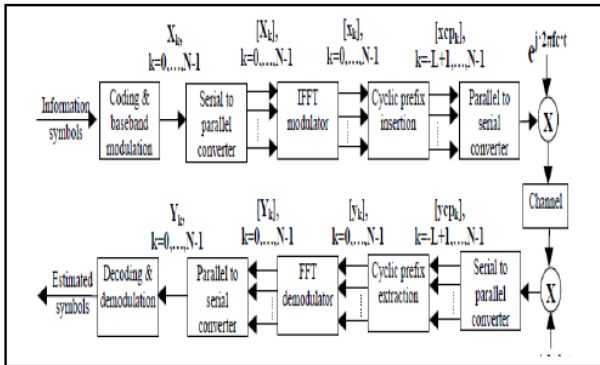

Figure 4: Block Diagram of OFDM System

4.2 Enhancing MAC with OFDM

The work deals with the introduction of OFDM system that there by enhances the MAC layer by properly rearranging and rescheduling the transmission layers. MAC protocol is very effective in short range wireless optical communication. This modulation scheme increases the data rate transmission by utilizing high bandwidth.
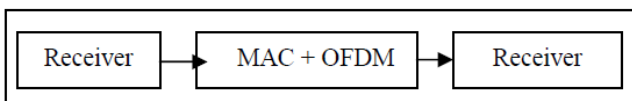

Figure 5: Block Diagram of Proposed System

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