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High Rate Direct Sequence Spread Spectrum (HR/DSSS) in Wireless Mesh Networks for High Data Rate Transmission

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ABSTRACT

Wireless Mesh Networks (WMN) is an emerging technology which provides wireless network access more efficiently for all important areas like telecom and mobile communications. The interconnection of access points (AP) using wireless links exhibits greater potential in addressing the Blast mile connectivity issue. Some of the physical layer techniques like orthogonal frequency division multiple access OFDM and UWB have been available in WMN. These are used only to improve the transmission rate and the performance of physical layer, but the physical layer is having a problem of low transmission rates.
To achieve the high date transmission in WMN we have proposed a new technique complementary code keying (CCK). The primary objective ofCCK is to provide higher data rates within the 2.4 GHZ ISM band and compatibility with modulations used by direct sequence spread spectrum of physical layer (DSSS PHY). To improve the data rate by a new spread spectrum technology we are using high data rate (HR/DSSS). By using this technique the performance of the physical layer can be improved and also supports higher data bit rate in large area networks like WMN, because the HR/DSSS having many more advantages than the OFDM and UWB.

Keywords: WMN,OFDM,DSSS,HRDSSS,CCK.

1. INTRODUCTION

Now a day the Wireless Mesh Networks (WMN) is the emerging technology for telecommunications and mobile communications in the world. Some of the important area such as Wireless Local Area Network(WLAN).WLAN contains different IEEE standard categories like IEEE 802.11a(OFDM),IEEE 802.11b(DSSS).These wireless networks provide a comparable performance for normal Ethernet .some features of WLANs are seamless connectivity, flexibility, and mobility. With WLANs, applications such as Internet access, e-mail and file sharing can be done in the home or office environments with new levels of freedom, easy and flexibility. It is noticed that there are 20 million WLAN systems installed in 2004 now it can be doubled.

IEEE introduced three important implementations for PHY (Physical) layer such as:

- Infrared (IR): IR is a modulation technique where data is sent with infrared light (wavelength 800nm-950nm) and requires line of sight. This technique is intended for indoor use.

- Frequency Hopping Spread Spectrum (FHSS): with low rates 1Mbps and 2Mbps.It supports Radio Frequency (RF).
- Direct Sequence Spread Spectrum (DSSS): with low rates 1Mbps and 2Mbps.It also supports Radio Frequency (RF).

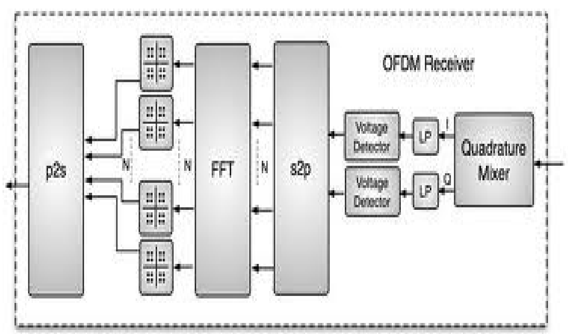
To transfer data from one system to another system with high data rates the physical layer needs new technique which is to be introduce in IEEE 802.11 with spread spectrum technology. This is known as High Rate Direct Sequence Spread Spectrum (HR DSSS) to provide higher rates of 5.5Mbps and 11Mbps.This transmission rate is higher than the Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS). HR DSSS is represented with IEEE 802.11b,which operates in the 2.4GHz in Industrial, Scientific, and Medical (ISM) band with strong growth. The wireless local area network (WLAN) is the basic technology for one of the wireless emerging technology is called as wireless mesh networks(WMN).Most of the physical layer techniques of WLAN is used in wireless mesh networks(WMN).

2. LITERATURE REVIEW

OFDM Transmission:

The OFDM based communication systems

transmit multiple data symbols simultaneously using orthogonal sub carriers. The principle behind the OFDM system is to decompose the high data stream of bandwidth W into N lower rate data streams and then to transmit them simultaneously over a large number of sub carriers. The value of N is kept sufficiently high to make the individual bandwidth (W/N) of sub carriers narrower than the coherence bandwidth (BC) of the channel. The flat fading experienced by the individual sub carriers is compensated using single tap equalizers. These sub carriers are orthogonal to each other which allows for the overlapping of the sub carriers. The orthogonality ensures the separation of sub carriers at the receiver side. As compared to FDMA systems, which do not allow spectralover lapping of carriers, OFDM systems are more spectrally efficient.OFDM transmitter and receiver systems are described in Figs. 1(a) and 1(b).At the transmitter, the signal is defined in the frequency domain. Forward Error Control/Correction (FEC) coding and interleaving block is used to obtain the robustness needed to protect against burst errors .The modulator transforms the encoded blocks of bits into a vector of complex values. Group of bits are mapped onto a modulation constellation producing a complex value and representing a modulated carrier. The amplitudes and phases of the carriers depend on the data to be transmitted. The data transitions are synchronized at the carriers, and may be processed together, symbol by



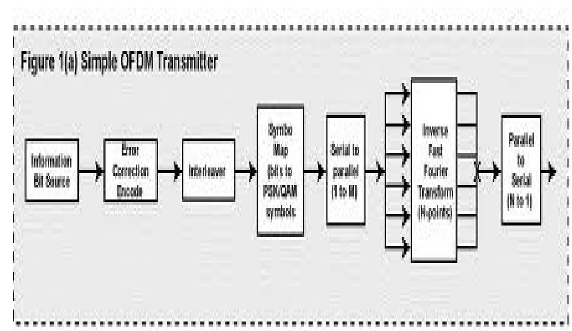


Figure 1(a) Simple OFDM Transmitter

fig1&2:OFDM Transmitter& Receiver

Applications of OFDM

OFDM has been incorporated into four basic applications:

(1) Digital Audio Broadcasting (DAB);

(2) Digital Video Broadcasting (DVB), over the

terrestrial network Digital Terrestrial Television Broadcasting (DTTB); (Wireless ATM Network Demonstrator); and

(4) IEEE 802.11a/HiperLAN2 and MMAC WLAN Standards.

DAB and DVD were the first standards to use OFDM. Next Magic WAND was introduced, which demonstrated the viability of OFDM. Lastly, and most importantly, the most recent 5 GHz applications evolved which were the first to use OFDM in packet based wireless communications. Few of the OFDM application and their details based on the type of wireless access technique are used in different areas.

Disadvantages of OFDM Systems:

1.Strict Synchronization Requirement[1]:

OFDM is highly sensitive to time and frequency synchronization errors, especially at frequency synchronization errors[1].

2.Peak-to-Average Power Ratio:

Peak to Average Power Ratio (PAPR) is proportional to the number of sub-carriers used for OFDM systems. The PAPR for an OFDM system is given by 10 log (N) where N is the number of subcarriers.

3.Co-channel Interference Mitigation in Cellular OFDM:

A conventional OFDM system exhibits performance degradation due to frequency coherence of the channel. The closer the spacing between the adjacent subcarriers or the narrower the required coherence bandwidth is.

HR/DSSSModulationtechnique:

HRDSSS uses a combination of DQPSK and complementary code keying (CCK) for modulation. In which either four or eight bits are encoded in each symbol period. Four bits are used for 5.5 Mbps communications, and eight bits are used for 11 Mbps communications.

HR/DSSS codingtechnique:

Complementary code keying (CCK) is used in HRDSSS implementation such as IEEE 802.11b and is much more complicated than the processing gain used in IEEE 802.11 systems.First, CCK uses a PN code capable of processing gain of 8 instead of 11. This 8 chip sequence results in 1.375 million codes per second instead of the 1 million codes per second in DSSS systems. Eleven million chips per second are processed by both DSSS and HR/DSSS, but **HR/DSSS uses the shorter 8 chip PN code, and this provides the higher rate of total codes per second.**With the help of a higher rate of codes per second, we reduced the amount of resilience against interference. Sowe can only maintain 11 Mbps when the two communicating devices are closer together, increasing the chipping code size increases the resilience against interference. The second difference between CCK and Barker sequencing is that CCK uses different PN codes for different bit sequences. Whereas the Barker sequence is always uses 10110111000, the CCK 8 chip sequence is calculated according to the data being encoded. The data being encoded is encoded in 8 bit chunks at 11 Mbps and 4 bit chunks at 5.5 Mbps. There is a one to one relationship (complementary) that exists between every possible 8 bits of actual data and the 8 chip sequence that is calculated to represent that data. The same is true for the 4 bit data when it is encoded. Once the data is encoded with CCK, it is modulated onto the carrier signals using DQPSK. The PLCP for the 802.11 HR/DSSS is the same as DSSS expect for the following:

•Alternate short SYNC field a shorter alternate SYNC field can be used in implementationsin order to minimize overhead and maximize throughput. The short SYNC field consists of 56 scrambled bits.

• Signal field contents the signal field value multiplied by 100Kbps indicates the data rate. The following are mandatory data rates specified by HR-DSSS:Service field values Bit 2 of the Service field indicates whether the transmitter frequencyand the symbol clocks are derived from the same oscillator.

Data rate	Signal Field Value
1Mbps	00001010
2Mbps	00010100
5.5Mbps	00110111
11Mbps	01101110.

Bit 7 is used in conjunctionwith the Length field to eliminate ambiguity when converting the number of octets to corresponding transmit time for data rates greater than 8Mbps. For example, at 11Mbps, the Length field value equals the number of octets times 8, divided by 11, and rounded up to the next integer. Bit 7 of the Service field will be 0 if the rounding takes less than 8/11 and 1 if the rounding is equal to or greater than 8/11. High Rate/Direct Sequence Spread Spectrum Physical Layer (HR/DSSS PHY) is the enhanced physical layer defined by IEEE 802.11b which supports data transfer at up to 11Mbps. Unlike the earlier versions of IEEE 802.11 which supported data rates of up to 2Mbps. OFDM doesn't provide high data transmission rates due to its limitations such as High synchronism accuracy, multipath propagation, Large peak-to-mean power ratio, more complex than single-carrier Modulation, requires a more linear power amplifier, OFDM signal has a noise, RF power amplifiers with a high peak to average power ratio,It is more sensitive to carrier frequency offset and drift, Peak to average power ratio (PAPR) is high power transmitter amplifiers need linearization, Capacity and power loss and band widthis high due to guard interval.

4. OBJECTIVE:

The main objective of this paper is to achieve high data rate transmission in physical layer by usingSpread Spectrum technology .The core principle of spread spectrum is the use of noise like carrier waves, and as the name implies, bandwidths much wider than that required for simple point to point communication at the same data rate.This Spread Spectrum technology contains many advantages than the OFDM and UWB.Some of the Spread Spectrum technologies are:

1.Direct Sequence (DS).

2.Frequency Hopping (FH).

3.Time Hopping (TH).

4. Hybrids.

The Spread Spectrum technologies are used in many application areas likecellular/PCS base station inter-connect, private networks, rail and roads transportation, utilities like electricity, oil, gas and water, banks, hospitals, universities and corporations, disaster recovery and special-event PSTN extensions, TELCO bypass, rural telephony, videoconferencing, LAN/WAN/Internet connection. In the above Spread Spectrum technologies the Hybrid Spread Spectrum technology is one of the best technique. Hybrid Spread Spectrum technology is the High Rate Direct Sequence Spread Spectrum(HR/DSSS). The major enhancement to IEEE802.11 by IEEE 802.11b is standardization of physical layer to support higher bit rate.The IEEE 802.11b PHY is one of the PHY layer extensions of IEEE 802.11 and is referred to as high rate direct sequence spread spectrum (HR/DSSS). HR/DSSS PHY provides two functions. First, the HR/DSSS extends the PSDU data rates to 5.5 M bps and 11 M bps using an enhanced modulation technique. Secondly, the HR/DSSS PHY provides a rate shift mechanism, which allows 11 M bps networks to fall back to 1 and 2 M bps and inter operate with the legacy IEEE 802.11 2.4 GHz RF PHY layers. The OSI structure and operation of the PHY's PLCP sublayer and PMD sublayer for HR/DSSS is similar to the existing IEEE 802.11 DSSS PHY. Some of the advantages of HR/DSSS are:

1.High data rate transmission.

2. Better voice quality/data integrity and less static noise.

3. Lowered susceptibility to multi path fading.

4. Inherent security.

5. Co-existence.

6.Longer operating distances.

7. Hard to detect.

8.Hard to intercept or demodulate.

9.Harder to jam than narrow bands.

10.No crosstalk interference.

11. Provides redundancy help

12. Transmits info on multiple sub carriers.

IEEE 802.11b introduced higher data transmission rates and it also uses a different spread spectrum coding to achieve higher transfer rates.This spread spectrum coding is called as Complementary Code Keying (CCK)
The higher data bit rate in HR/DSSS is done by complementary code keying(CCK).HR/DSSS uses complementary code keying(CCK). Because CCK is one of the best modulation technique used by physical layer.By using this modulation technique in HR/DSSS we can achieve the higher bit rate in physical layer.Complementary code keying (CCK) provides an increased tolerance to multipath distortion and is attractive for use in high data rate WLAN applications.

Complementary Code Keying(CCK):

CCK as the basis for the high rate physical layer extension to deliver data rates of 11Mbps. This higher rate extension was chosen because it easily provides a path for interoperability with the existing 1 and 2Mbps networks by maintaining the same bandwidth and incorporating the samepreamble and header, which already has a rate shift mechanism.IEEE 802.11 is the only one addressing high data rates for building wide networks.CCK, uses a complex set of Walsh/Hadamard functions known as Complementary Codes.

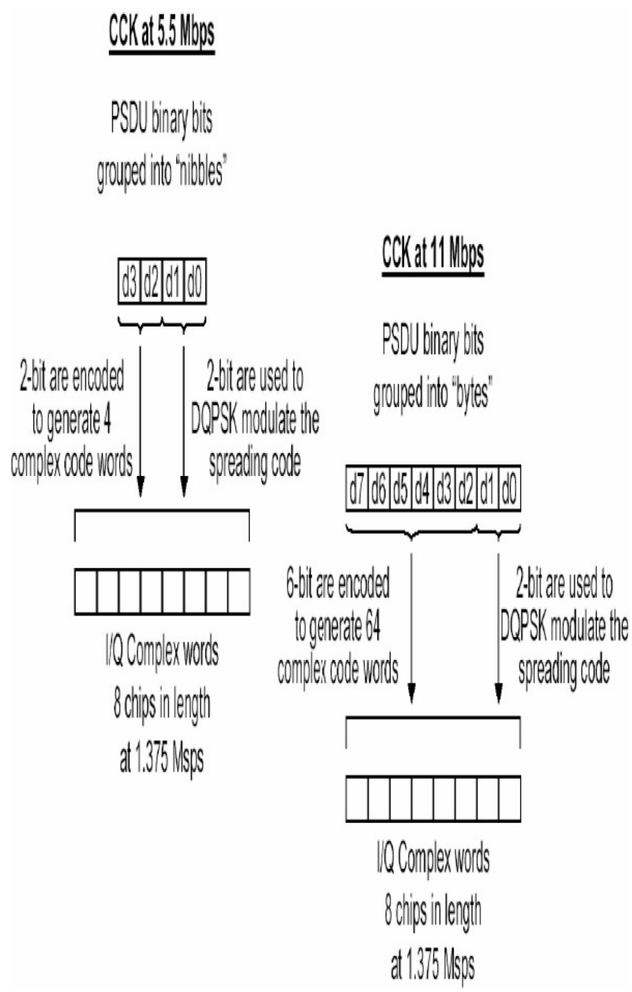


Fig 3: Our proposed technique

CCK can be described as a variation of many Orthogonal Keying (MOK) using codes with complex symbol structures. CCK allows for multi channel operation in the 2.4GHz ISM band byvirtue of using the existing 802.11 1 and 2Mbps direct sequence spread spectrum (DSSS) channelization scheme. The spreading employs the same chipping rate and spectrum shape as the802.11 Barker code spread functions allowing for three non-interfering channels in the 2.4 to 2.483 GHz ISM band. The scheme is also interoperable by virtue of using the same pre-amble and header for all transmission rates.The basic operation of Complementary Code Keying. CCK is a form of Mary code word modulation where one of set of M unique signal code words is chosen for transmission.The spread function for CCK is chosen from a set of M nearly orthogonal vectors by the data word. CCK uses one vector from a set of 64 complex (QPSK) vectors for the symbol and thereby modulates 6-bits (one-of-64) on each 8 chip spreading code symbol. Two additional bits are sent by QPSK modulating the whole code symbol and this thus modulates 8-bitsonto each symbol.The formula that defines the CCK codewords is shown in Fig 6. In it, there are 4 phase terms which are.The IEEE 802.11 complementary spreading codes have a code length 8 and a chipping rate of 11 Mchip/s. The 8 complex chips comprise a single symbol.By making the symbol rate 1.375 MS/s the 11Mbps waveform ends up occupying the same approximate bandwidth as that for the 2Mbps 802.11 QPSK waveform thereby allowing for 3 non-overlapping channels in the ISM band. This is important for maximizing aggregate system throughput in a wireless LAN network and was one reason for choosing CCK as the modulation technique.

Advantages of CCK:

Complementary Code Keying(CCK) havingmany more advantages like high data bit rate transmission in physical layer, modulation technique provides accuracy in the transmitted data, Provides timeliness for transmission of data.

5.CONCLUSION

The demand for high data rate in wireless mesh networks has been increasing drastically over the lastdecade. One way is to transmit this high data rate information is to employ wellknown conventionalsingle carrier systems.Since the transmission bandwidth is much larger than the coherence bandwidth of the channel; highly complex equalizers are needed at the receiver foraccurately recovering the transmitted information.Sub carrier techniques can solve this problem significantly. We have implemented the basic technique behind the HR/DSSS,This paper has explored the role of HR/DSSS in the WMN and its advantages over single and multi carrier transmission.

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10.”SPREAD-SPECTRUM TECHNOLOGY AND ITS APPLICATIONS” In the future, hardly anyone will escape being involved, in some or the other way, with spread-spectrum the art of secure digital communications.

