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Influence of low power consumption on IEEE 802.15.4 in wireless networks performance

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ABSTRACT

IEEE 802.15.4 standard defines both media access control (MAC) and physical (PHY) layer protocols for low power consumption, low peak data rate, and low cost applications. Nowadays the most important feature of IEEE 802.15.4 is maximizing battery life. This paper is focusing how to achieve low average power consumption through assuming that the amount of data transmitted is short and that it is transmitted infrequently so as to keep a low duty cycle. The outcomes demonstrate that the phase shift estimation of Offset quadrature phase-shift keying (OQPSK) modulation has no impact on bit error rate (BER) if it is identical in the transmitter as same as in the receiver.

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1. INTRODUCTION

IEEE 802.15.4 standard and it is the new technology that has been developed for low power consumption, low cost and low data rate wireless network. The reasons for using IEEE 802.15.4 technology are reliability, self-healing it is secure and can be used globally [1-2]. In the recent years, a new wireless network technology STD. The IEEE 802.15.4 [3-5], which is a standard built on the top of IEEE STD. It contain a suite of technologies that provide reliability, high security and can be used globally, also it is used to enable scalable that can manage various data traffic patterns. The experiments show the effects on bit error rate (BER) of the modulation process [6]. In addition, a comparison of BER values in terms of Tx and Rx parameters is done [7-8]. The organization of the research paper is as follows. Section two introduces the IEEE 802.15.4 channel structure. While, IEEE 802.15.4 transceiver system and configuration are illustrated in Section three. Then, simulation results and analysis study are described in Section four. Finally, Section five gives the conclusions of research paper.

2. RELATED WORKS

In fact, IEEE 802.15.4 system involves the physical and medium access control layers. They are used in order to support straightforward devices with minimum power work in POS (Personal Operating Space) of 10 meters as mentioned in [9]. On the other hand, in 802.15.4 standard all the wireless connections are working in three frequency bands as shown in the following Figure 1. These bands allow free ISM (industrial scientific medical) with 250 kbps peak data rates in band 2.4 GHz, 40 kbps in band 915 MHz and finally 20 kbps in band 868 MHz. The allocated channels in 802.15.4 are aggregated 27 channels. These channels are incorporating as the following: 16 channels through the band of 2.4 GHz, 10 channels through the band of 915 MHz and the last channel in used in band 868 MHz. All the more explicitly, IEEE 802.15.4 includes layers top of this to include more system and application knowledge. IEEE 802.15.4 [10-11] is the reason for some other industrial wireless protocols also so understanding it can be extremely valuable to a security consultant [12]. The standard IEEE 802.15.4 is custom fitted to the requirements of sensor systems as shown in Figure 2. Therefore it permits more prominent extents at lower data rates and low power consumption [14].

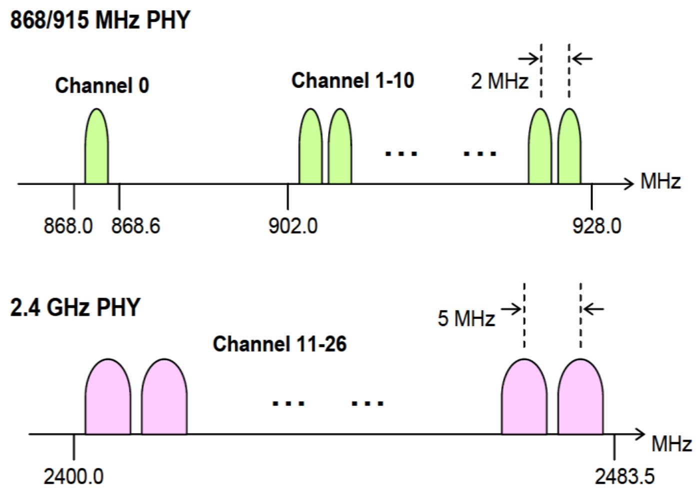

Figure 1. The structure of IEEE 802.15.4 channel [13]

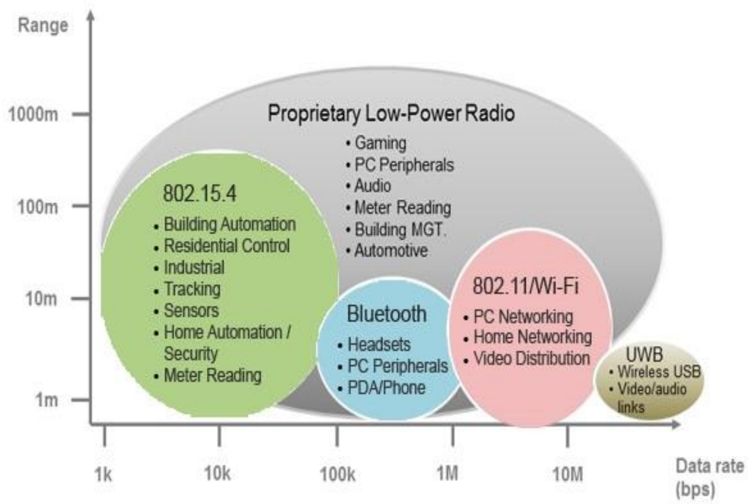

Figure 2. IEEE 802.15.4 and other relatedtechnologies

An IEEE 802.15.4 system enables a lot of devices to communicate wirelessly by means of one of a few potential topologies [15]. Packets of information can be sent between nodes and might be directed by intermediary devices to more distant nodes that would some way or another be out of range. Every device has both a MAC address and an IEEE 802.15.4 system address [16-17] and the system in general has its own personal area networks identifier shared by all devices. Packets can be ensured by encryption but for this to work all nodes will require a key.

3. IEEE 802.15.4 SYSTEM

Addition of both in phase and quadrature signals after modulation, creates the required transmitter output. The required output signal is created by utilizing sum block in commonly used blocks. There will be no phase advances in the output, which is an advantageous property. This section of research paper, describes the implementation of IEEE 802.15.4 transmitter system. The design of IEEE 802.15.4 transmitter utilizing offset quadrature phase-shift keying (OQPSK) [18-19] modulation with half sine pulse shaping is appeared in the Figure 3.

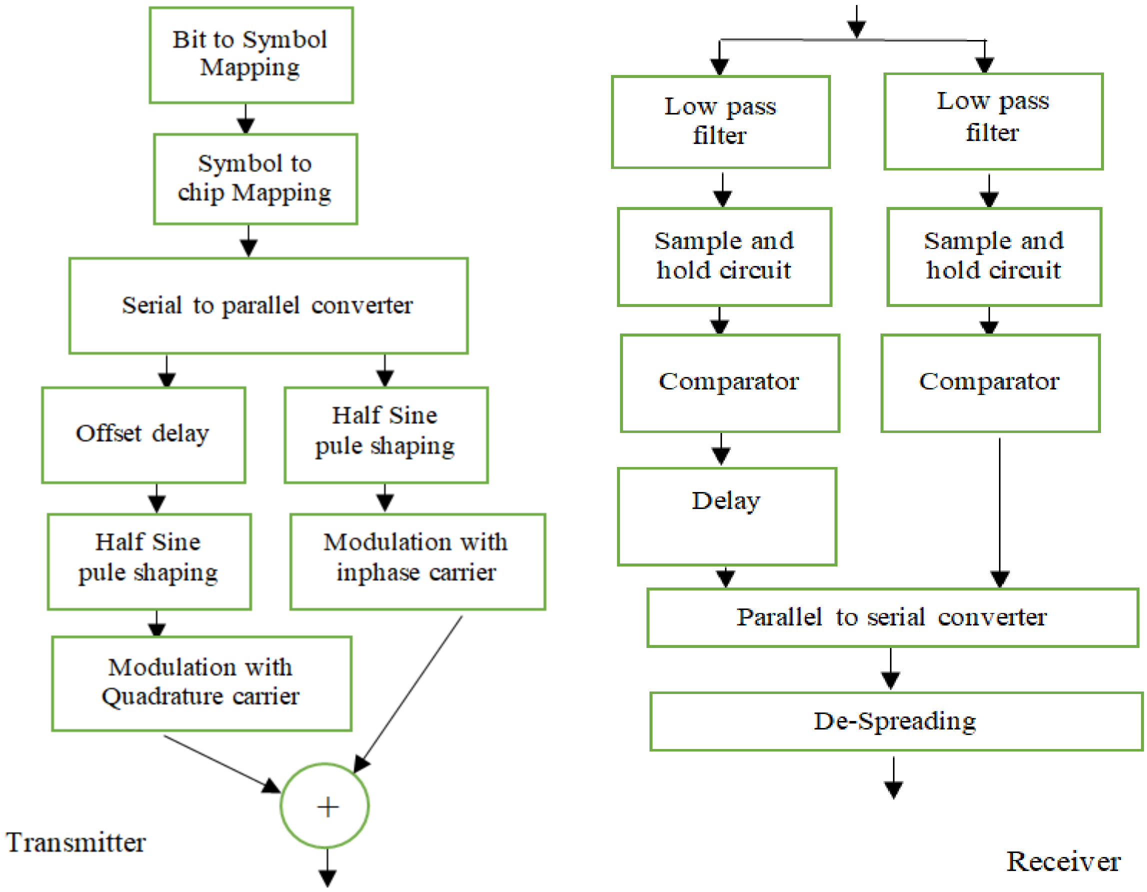

Figure 3.Transmitter and receiver of IEEE 802.15.4 [20]

Here, the research describes the execution of IEEE 802.15.4 receiver system and we are focusing on the MSK coherent detection strategy for recovering unique information in the receiver, moreoverthe receiver of IEEE 802.15.4 has appeared in Figure 3.In the receiver configuration of IEEE 802.15.4, we are utilizing an MSK demodulator and a multiplier for dispreading[21]. This multiplier is provided by a PN sequence information that is an exact replica that utilized in the transmitter. The information originating from the MSK demodulator is having an information rate of two Mega bit per second alsofrom this information[22]. The original information is removed by increasing with the PN arrangement information. However, the 2Mbps information obtained at the output of parallel to sequential converter contains some offset delay. This offset delay must be presented in the PN sequence information while increasing with 2Mbps information, So that output contains unique bit stream without any errors.

The approaching received signal is connected to two synchronous demodulators, comprising of a multiplier followed by a low pass filter. Here one multiplier is provided with a signal, which is the duplicated signal of carrier $\cos w_0 t$ and $\cos(2\pi t/4Tb)$. Another multiplier is provided with quadrature signals i.e., with $\sin w_0 t * \sin(2\pi t/4Tb)$. Generally, a third request butterworth filter having a cut off recurrence of 2/2Tb Hz is utilized for the extraction of baseband information. The resultant information is gone through a sampler; A straight forward zero request sample and hold circuit is enough for this reason.

4. SIMULATION RESULTS AND ANALYSIS

In simulation section, experiments have been done to find out and study the parameters that influence IEEE 802.15.4 modulation and demodulation procedure utilizing Offset Quadrature Phase Shift Key, moreoverthe outcomes are shown as previews of scope signals alsowe can know effectively what happens precisely inside an IEEE 802.15.4 transmitter. At the transmitter end, the input signal stream generated using the random integer signal generator. İnput stream data rate is 250 Kbps with 4 µs. Figure 4 shows the network topology of IEEE 802.15.4 system.

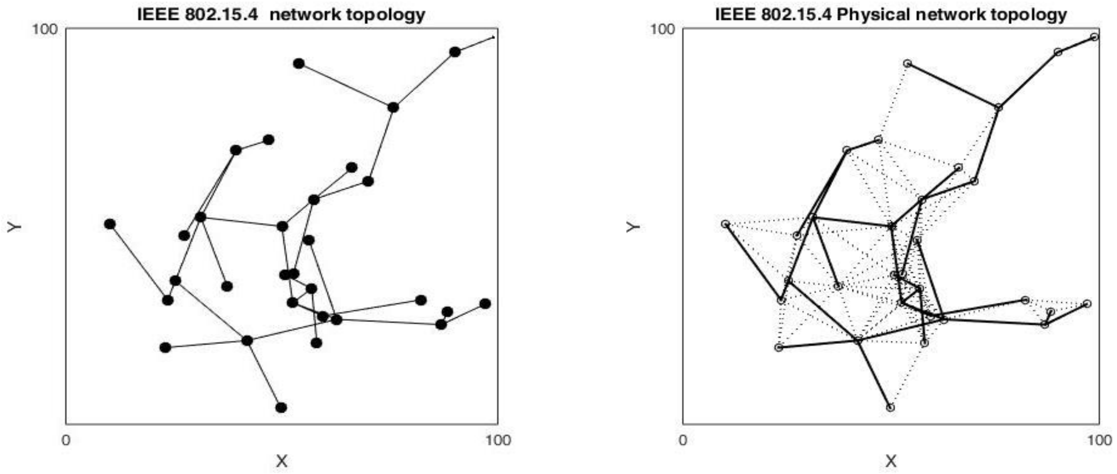

Figure 4. Simulation of network topology of IEEE 802.15.4 system

The input data is mapped into a symbol according to 62.5K symbol per second or 16 µs symbol time period while pseudo noise sequence generator has been used to generate NP code with 2Mbps (0.5µs bit time period) data rate. The chip rate is equal to 8 (4µs/0.5µs) times and 32 (16µs/0.5µs) times the bit rate of input stream rate and symbol rate simultaneously. Furthermore, A square wave has been used as an input signal into the system, PN sequence generator has been used too. A product block has been used in the simulation to incorporate the aforementioned signals producing.

IEEE 802.15.4 needs to exploit the offset of QPSK modulation for the operation of 2.4 GHz method. On the other hand, OQPSK has offset period equals to one-half of the pulse time frame between the quadrature pulse and in-phase pulse. This little distinction between OQPSK and QPSK will restrain the maximum extreme phase shift of a signal modulated using OQPSK to 90 degrees [23-24]. This property settles on OQPSK a better decision over QPSK for most useful implementations. According to the following Figure 5 of OQPSK modulation constellation points, each data of 2 bits is mapped into a particular signal phase.

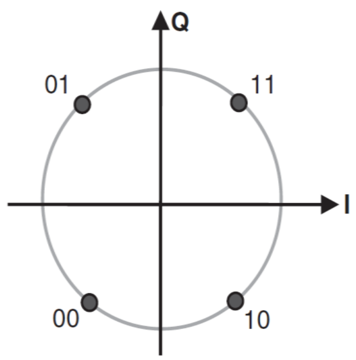

Figure 5. OQPSK Modulation constellation points

The product output signal is fed into modulator block which uses Offset Quadrature Phase Shift Key (OQPSK) method in the transmitter section. While, the modulated signal in the transmitter side received by the receiver side then the signal demodulated by a demodulator block and generate the signal by observing these figures, we can know easily what happens exactly in-side the IEEE 802.15.4 receiver. The transmitted signal is passed through a AWGN channel [25]. The modulated signal will be received by the receiver section in the demodulator block to produce the output signal as follow.The process of the receiver section will be inversely as same as transmitter stage; by reversing process stages of the transmitter, the demodula ted signal will be processed somehow to produce the final output of the system that represented by Figure 6.

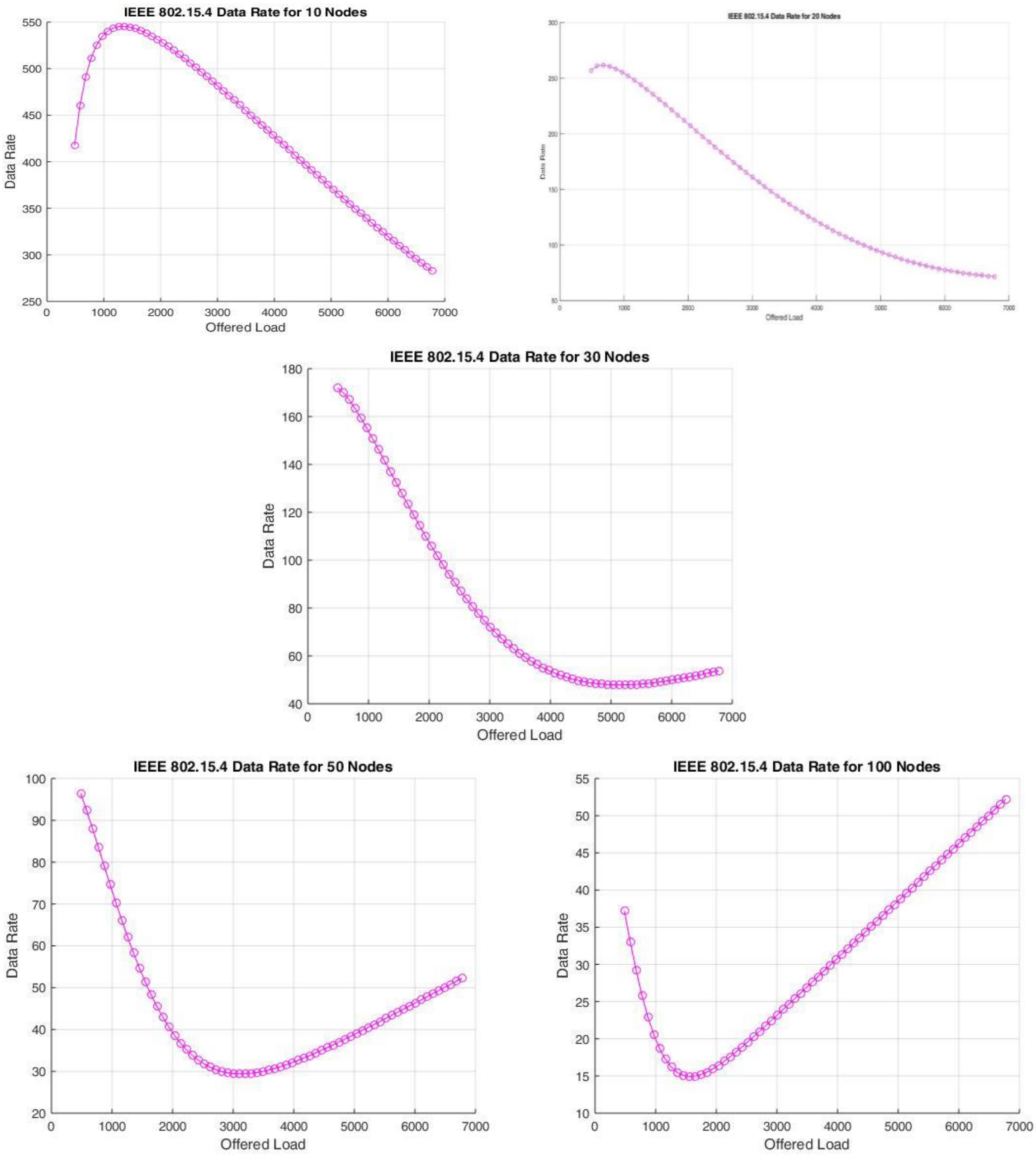

Figure 6. IEEE 802.15.4 Data rate with different number of nods

The research paper, experiments have been done to find out and study the parameters that affect IEEE 802.15.4 modulation and demodulation process using OQPSK. In experiments, we found that a synchronization between transmitter and receiver should be taken into account to modulate and demodulate the signal properly. The following results show the effects of the synchronization and DE synchronization system, in which, the modulation and demodulation sections have either different or same parameters. We note that there is no change in value of BER when phase shift of OQPSK in the transmitter and receiver are identical. It's clearly shown in the Figure 7 that if asymmetric parameters are used in the system, this could produce different output signals based on chosen values.

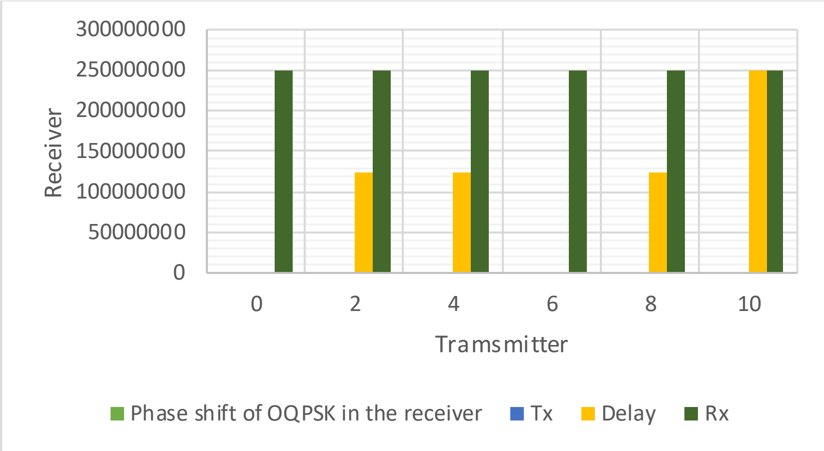

Figure 7. Phase shift of OQPSK in the IEEE 802. 15.4 recevier

5. CONCLUSION

The research paper has introduced a fundamental execution investigation of the IEEE 802.15.4 wireless standard through pragmatic examinations IEEE 802.15.4 is among the most conspicuous communication advancements for low power wireless systems administration, for example, wireless sensor/actuator networks (WSANs). The future work incorporates the assessment of the power utilizations, association time, a tree or a device-to-device topology, and device nodes. The research paper discussed a standard structure of IEEE 802.15.4 transmitter and receiver modulation systems by MATLAB program while they are secured and a large portion of the physical layer blocks utilized in IEEE 802.15.4 protocol. In addition, OQPSK technique is utilized in this simulation.

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