Design & Simulation of Zigbee Transceiver System Using Matlab

Yash Vardhan Varshney*1, Anil Kumar Sharma*2

*1 M. Tech Scholar, Department of Electronics & Communication Engineering
Institute of Engineering & Technology, Alwar, Rajasthan-301030 (India),

*2 Professor & Vice Principal, Department of Electronics & Communication Engineering
Institute of Engineering & Technology, Alwar, Rajasthan-301030 (India)

Abstract— ZigBee technology was developed for special wireless networks where Bluetooth & Wi-fi technologies are not showing better results. In wireless personal area networks (PAN) where we need to transmit low data rate information in comparatively large area (10-100 m) [1]. We can use Zigbee transceiver system instead of other technologies. As the functionality of SimpliciTI and Zigbee Technology is similar still we are preferring Zigbee system. So this paper will show that how Zigbee technology is different from SimpliciTI and other wireless networking technologies and what are basic advantages of Zigbee technology over other systems. To design the Zigbee transceiver system different modulation techniques can be used. In this paper, the design methodology and simulation results of Zigbee transceiver at physical layer are presented using MSK modulation technique [6].

Keywords- IEEE 802.15.4, SimpliciTI, MSK, Zigbee.

I. INTRODUCTION

ZigBee is a home-area network designed specifically to replace the proliferation of individual remote controls. ZigBee was created to satisfy the market need for a cost-efficient, standards-based wireless network that supports low data rates, low power consumption, security, and reliability. To address this need, the ZigBee Alliance, an industry working group is developing standardized application software on top of the IEEE 802.15.4 wireless standard. Zigbee standard is basically design for low cost, low power consuming & low data rate required system. Zigbee standard is placed in Physical and Medium Access Layer (MAC). As Zigbee is an standard of Zigbee Alliance. Higher layer specified in the Zigbee standard is for industry alliance. The application of Zigbee Technology can be seen in home monitoring system, climate sensors communication, collection of data in small area in research field & industrial control etc. The major application of Zigbee transceiver is shown in wireless sensor networking and automatic control system such as home controlling, biotelemetry, personal caring (for senior citizens) etc. Home, industry and other organization automation is the major application of Zigbee transmission. Light (Power) control, Light machinery control, SCADA networking etc are some more important application areas of Zigbee technology [2]. Here a comparatively analysis of Zigbee, Bluetooth and Wi-Fi technology is also present that will help us that how Zigbee is different than other wireless networking technologies [3].

<table>
<thead>
<tr>
<th>System</th>
<th>Zigbee</th>
<th>Bluetooth</th>
<th>Wi-fi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Monitoring &amp; Control</td>
<td>Cable Replacement</td>
<td>Internet</td>
</tr>
<tr>
<td>System Resources</td>
<td>4-32 KB</td>
<td>250KB</td>
<td>1 MB+</td>
</tr>
<tr>
<td>Battery Life (Days)</td>
<td>100-1000</td>
<td>1-7</td>
<td>Hours</td>
</tr>
<tr>
<td>Nodes in Network</td>
<td>255/65K</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td>Baseband(Kb/s)</td>
<td>20-250</td>
<td>720</td>
<td>11 Mbps</td>
</tr>
<tr>
<td>Distance</td>
<td>1-100 m</td>
<td>1-10m</td>
<td>100 m</td>
</tr>
<tr>
<td>Key Characteristics</td>
<td>Stability, low consumption, low cost</td>
<td>Price, Easy use, High Data Rate</td>
<td>Very High Speed, Large network</td>
</tr>
</tbody>
</table>

II. COMPARISON WITH SIMPLICITI

SimpliciTI is Texas Instruments proprietary network protocol for low-power radio frequency wireless communication. Main properties of SimpliciTI are, Low cost which means that SimpliciTI network protocol can be implemented in systems with small memory capacity. Flexibility is achieved by multiple network topologies namely star and peer-to-peer. The basic Application Programmers Interface (API) makes SimpliciTI simple to be used. Wide selection of transceiver chips made to work with SimpliciTI operating in sub-1GHz frequencies and in 2.4 GHz band makes this protocol versatile. Finally very low current consumption in sleep state makes SimpliciTI very well suited for battery powered applications. SimpliciTI and ZigBee modules have slightly different characteristics. ZigBee has greater range but power consumption in sleep state is higher than SimpliciTI module. Both modules can be battery powered and both are small in size. However ZigBee has more peripherals, so in complicated personal area network zigbee module is more preferable than any other technology [4].
III. CONSTRUCTION OF TRANSCEIVER

The implementation was built on Matlab/Simulink using fundamental components in Simulink to demonstrate how reliably complex modulation schemes can be built, cost effectively and efficiently [5]. The design of ZigBee transmitter using MSK modulation is shown in the Figure 1. Here we map input data bits to 8-chip PN sequences to be transmitted and results in a chip rate of two mega chips per second. After that, resultant chip sequence is send to the serial to parallel converter. It is used here to separate the odd and even bit indexed chips. Following this bipolar data formatting is performed and signal modulated with a 2.4 GHz carrier on the In Phase and Quadrature Phase data stream and adds it to get the required transmitter output signal.

IV. RESULTS

After simulation of the Zigbee transceiver system as shown in figure 1, the following results have been obtained. As the input bit stream generated by Bernoulli binary generator of 250Kbps is shown here in figure 2.

The DSSS signal has a data rate of 2Mbps. So PN Sequence is chosen with 32chips/s. So chip rate is achieved of 2Mops. PN Sequence and spreaded input signal is shown in figure 3 and 4.

Using serial to parallel data converter, odd bits and even bits are achieved. To generate it we need clock pulse as shown in figure 5.

The In-phase and Quadrature-Phase data after serial to parallel conversion are shown in figure 6.
In MSK modulation technique we need bipolar signal in place of unipolar data sequence. So using bipolar converter we got bipolar in-phase and quadrature-phase data sequence is obtained as shown in figure 7.

After multiplying with carrier of center frequency 2.4 GHz MSK modulation of in-phase and quadrature-phase data signal is obtained.

Addition of both data will generated the final MSK modulated Zigbee transmitter signal (Figure 9).

As human eyes are not able to see the high frequency transmitted signal so here the zoomed signal is presented in figure 10.

After passing through AWGN Channel, white Gaussian noise is added to the transmitted signal. So the changes in signal and zoomed signal are shown in figure 11 and 12 respectively.

To recover signal carrier signal of center frequency 2.4GHz is multiplied with received signal. Which create in-phase and quadrature-phase signal as shown in figure 13.

Sample & hold circuit & comparator provide us the original inphase & quadrature phase data. Then after providing one bit delay in quadrature phase data & find out the parallel to serial data.

Now signal can be serially received after using parallel to serial converter as shown in figure 15.
Here we recovered the original data after use of shifted version of PN sequence at the receiver end as shown in figure 16.

![Delayed Baseband Digital Signal at Receiver](image)

**V. CONCLUSION**

Design and simulation of Zigbee transceiver using MSK modulation technique in Simulink is presented here. This shows that this is most promising technology which provide low data rate with low BER & large acquired area. So, this technology can be used for future Personal Area Network in general purpose. This paper also presents the comparative analysis of Zigbee transceiver system with other networking technologies like Wi-fi, Bluetooth, SimplicityTI.

**REFERENCES**


**Authors Profile**

Yash Vardhan Varshney has completed his bachelor degree from UPTU, Lucknow in 2009. He is currently doing his M Tech thesis work at the Deptt. of ECE, Institute of Engineering & Technology, Alwar affiliated to Rajasthan Technical University, Kota. His research area is Digital communication.

Dr. Anil Kumar Sharma MIEEE received his M.E. degree in Electronics & Communication Engineering (ECE) from Birla Institute of Technology, Deemed University, Mesra, Ranchi, India, in 2007 with CGPA of 8.45 and Ph. D in ECE in 2011. He has an experience of 20 years on various RADARs and Communication Equipments. He is currently a Professor in the Department of ECE and Vice Principal, Institute of Engineering and Technology, Alwar- 301030, Rajasthan, India. He has published 15 papers in International Journals and over 40 papers in Conferences. His research/teaching interest includes WSN, VLSI Design, RADARs and Soft Computing.