Performance Evaluation of ZigBee in Indoor and Outdoor Environment

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***Abstract*— Wireless Sensor Network (WSN) comprises of many distributed independent tiny sensors that used to monitor statistical data of specific environmental conditions such as temperature, humidity, rain, pressure and many other. WSN use unlicensed 2.4 GHz Industrial, Scientific and Medical (ISM) radio frequency band for data transmission. WSN applications are being used in many industries and civilian areas, for various purposes such as environmental monitoring, habitat monitoring, traffic monitoring, precision agriculture monitoring, security monitoring, facility automation and traceability systems. Deployment of WSN in an outdoor or indoor environment always raised issue of signal loses and signal interference. In WSN, data is transmitted over wireless medium which is easily affected by external aspect such as walls, trees, heavy bushes, multiple signal interference and others. Currently, IEEE standard 802.15.4 MAC protocol and ZigBee are the most famous protocols which are been used in WSN industry. In this paper, we have performed several experiments under various conditions such as indoor, outdoor, co-existence of Bluetooth to observe the ZigBee performance and interference effects. The experiments were performed physically in real environments which showed ZigBee signal degradation under various indoor and outdoor conditions.**

Keywords—Wireless Sensor Network; Bluetooth; ZigBee; Interference and Performance Evaluation.

I. INTRODUCTION

Wireless Sensor Network (WSN) is formed by deploying number of sensor nodes within specific area range 100 to 1000 meter. These sensor nodes have sensing, processing, communicating and transmitting capabilities. A WSN consists of various types of sensors such as mechanical, thermal, electrical, chemical and motion sensors [1]. These sensor nodes are capable to monitor diverse environmental or object conditions such as temperature, pressure, humidity, lighting, soil moisture, speed, direction under various weather conditions. Currently, many industries are using WSN to minimize their labor cost and maximize their productivity because WSN helps industry to achieve better standards and results, with an automatic manner. Due to its flexibility and adoptability, WSN has become very famous devices to assist and facilitate people who live in rural areas. In many countries such as Germany, Denmark and Malaysia the governments are helping their people in rural area by introducing and implementing wireless sensor networks in agriculture industry. For example, wireless sensor networks help people by monitoring their crop growth automatically. There are many example of WSN applications which are been used for rural enrichment such as Water waste monitoring, Landfill ground well level monitoring and pump counter, Flare Stack monitoring and Greenhouse monitoring systems [2].

Currently, wireless sensor network utilizes ZigBee and IEEE 802.15.4 wireless standards for communication. IEEE 802.15.4 is a largest standard for low data rate Wireless Personal Area Networks (WPANs) that defines the physical layer (PHY) and media access control (MAC) layer. The PHY layer defines frequency, power, modulation, and other wireless conditions of the link in an Open Systems Interconnection (OSI) model. The MAC layer defines the format of the data handling [3].

ZigBee is an enhancement of IEEE 802.15.4 standards which used layer 3 and layer 4 to define additional communication features such as authentication, encryption, data routing and forwarding capabilities. The low power consumption limits the transmission range to only 10-100 meters with line of sight. WSN can be deployed in a large area range with the help of mesh network topology in which data is passed through many intermediate devices [3].

Mostly, personal area networks, short range and lower power devices use 2.4 GHz band for their communication which is an unlicensed spectrum. Therefore, many technologies such as WiFi, Cordless Phones, Microwave ovens, Wireless USB, Bluetooth and ZigBee run on 2.4 GHz band. As a result the level of interference is quite heavy on 2.4 GHz band which cause of signal drop or lose, multiple devices signal interference and throughput drop.

In this paper we have performed few indoor experiments with co-existence of multiple devices interference and outdoor in heavy shrubby environment to observe the ZigBee performance. This paper emphasis on practical work and considered real time scenarios, whereas previously most of the works have been done in simulation mode. The main purpose of this research is to understand the environmental effects on ZigBee performance including technological and environmental interference and to observe its signal degradation under various conditions. These issues need to be considered when deploy a WSN into agriculture environment for example; if WSN is deployed in a heavy shrubby environment without considering the line of sight, it will have performance degradation due to bad signal reception and signal interference.